THE HANDS-ON GUIDE FOR SCIENCE COMMUNICATORS

A STEP-BY-STEP APPROACH TO PUBLIC OUTREACH

Lars Lindberg Christensen

Springer

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For my father
& mother (*In Memoriam*)

FOREWORD

Astronomy and fundamental research in physics are *a priori* of no practical use at all. Work in these fields is carried out to reveal the beauty of nature, in the spirit of scientific endeavour, to satisfy human curiosity — and because it is great fun! There is no reason to be ashamed of that. After many years a piece of fundamental research may find a practical application — but it's not the main initial driver for it. However, if the general public is to fund fundamental research, the taxpayer must get something back. Communication is essential — not only because of some vague "obligation", but for the long term benefit of people working in the areas of astronomy, spaceflight and physics. So long as the general public is interested in these areas of research they will accept the need to pay for it.

Easy, right? Well, at least in theory. Unfortunately, there are many players out there who obviously haven't got the message. Many institutions, agencies, observatories, laboratories and scientists believe that they communicate, but, actually, they don't. Some of the world's leading observatories only publish a few print-ready pictures per year. Some space agencies operate spacecraft that are virtually unknown to everyone except the most curious enthusiasts for years. Unbelievable? No, just two examples of astronomical "communication" today.

On average, scientists and organisations in the US are doing much better in public outreach activities than their European counterparts. Why? It is not only a matter of funding. There is a completely different attitude to science communication in the US. Most scientists, science organisations and funding agencies in the US have realised that active communication is critically important to keep the system running smoothly and effectively.

For those of you still neglecting science communication, there is a ready cure available: this book! Lars Lindberg Christensen presents a handbook with detailed instructions and examples for devising a proper communication strategy for your project or institute. After the publication of this book there is no longer any reason for "We didn't know"-type excuses. If a single scientist or institution follows only ten percent of the advice given in this book, then communication prospects for their respective areas of science will be in much better shape than they are today.

Communicating endeavours in astronomy, spaceflight and physics is both so important and so easy: Great pictures, extreme numbers, issues that fascinate many people. In my view, scientists who still consider their research, projects, instruments etc as private 'toys', should be excluded from public funding. Astronomy and spaceflight are door-openers to the world of physics for many people. They attract young people to professional careers in natural sciences or engineering. Apollo created a whole generation of scientists and engineers. If you communicate your science in a proper way, you could do the same for the amazing big science projects of today. It pays to communicate!

A telescope or a detector unveils the secrets of the Universe. This book unveils the Universe of communication, which — unfortunately — is still shrouded in mystery for many scientists. Scientists, you need to read this book!

Dirk H. Lorenzen
Hamburg, 14 April 2006
Senior science reporter for German Public Radio, Author of *Mission: Mars*

PREFACE

This book springs from my own deep well of love for nature and the Universe to which we have been granted a temporary visitor's visa. Without curiosity we humans are poor. Without the ability to pass on our own curiosity for, and knowledge about, the Universe around us, we will never be able to inspire and induce those short, but incredibly rewarding moments of awe in the minds of other people. We live to learn. We live to inspire. Only the sky is the limit!

This book offers hands-on advice concerning some of the most central topics of practical popular science communication. I have often used examples from astronomy[1] and physics, partly because astronomy and related disciplines have some natural advantages for communication (see section 1.3), and partly because such examples are easy to find, for instance on the web.

The book is divided into four parts. The introductory chapters form Part I, *Setting the Scene*. The actual production of communication products is covered in Part II, *The Production Flow*. Some special topics in science communication are discussed in Part III, *Selected Topics*. The final chapters contain conclusions, references, an index, web links and appendices (Part IV, *Finishing Off*). There is also a comprehensive glossary with definitions and explanations of the many terms and concepts used. Glossary words are marked in **bold** in the index.

Many different aspects of practical science communication aimed at the public[2] are covered in this book, some of general interest and some of a more specialised nature, but all, I feel, with an important role in science communication, although, admittedly, not all are relevant for every communication office.

One obvious omission from the book is the entire field of formal education. Formal education is an odd and unapproachable creature. Although many of the same communication products are used in both informal (free-choice learning) and formal education as in communication to adults (outreach), material for formal education has to be tailored very specifically to the age group in question and to fit into the curriculum. Curricula change relatively often and are also subject to significant geographic and national variations that make the task of generalising difficult. Other books treat education in great detail, such as, for instance, Ortiz-Gil & Martínez (2005) and references therein.

The book also only touches peripherally on the creative process involved in producing good science communication. Talent and an eye for delicate and aesthetic expression cannot be learnt from a guide such as this. The focus in this text is much more on the mechanical part of the production, not on that spark of creative genius that brings a communication alive.

The material in this book is aimed at full-time science communicators working in communication offices in scientific institutions (the public information officers, abbreviated PIOs), scientists, decision-makers, journalists, teachers, science amateurs and others with an interest in science communication.

1 The term astronomy is broadly used here for "everything that has to do with space", ie space science, human spaceflight, Earth observation and related disciplines.

2 Public science communication is a subset of the wider topic of general science communication that also involves intra-scientist communication. This book deals exclusively with communication aimed at the general public, ie "popular communication". In the following, the word popular or public will be omitted.

Despite the fact that a great many people know something about communication — it is after all an innate human ability — this overview of the more practical aspects of (popular) science communication is appropriate as science communication spans so many different disciplines that no one person can be an expert in them all (the author included). A full appreciation of how to make science communication effective is not easily acquired and it is hoped that new science communicators especially may find this book helpful and inspirational.

Naturally, reading this book alone will not make a good communicator. Good science communication requires a lot of hard work, practice, dedication and talent. Just as the good scientist investigates the laws of nature, or finds an innovative way to send a spacecraft to Mars, so the good science communicator must evaluate how best to communicate scientific results to the target groups within the given framework of his/her organisation.

A wealth of inspiration for this book has been found in excellent resources such as:

- Mitton (2001);
- Finley (2002);
- Madsen & West (2000);
- NASW (2003);
- Maran (2000);
- “The golden volume”, aka. *Astronomy Communication* edited by Heck and Madsen (2003);
- Mahoney (2005-II);
- Robson & Christensen (2005).

I recommend the reader to consult these sources for more ideas and information. I have most certainly overlooked other excellent references, and I would appreciate emails indicating this. I have also tried to be as conscientious as possible with respect to quoting references to other works, but have surely made some inadvertent errors, and would warmly welcome corrections on this point.

This book draws heavily on personal experience, acquired at the European Space Agency’s Hubble Space Telescope office in Munich, Germany. It presents some of the background and the motivation behind the choices made there daily to find the most efficient way of presenting the work of the many talented European Hubble scientists. The author in no way pretends to be an expert in all areas, but rather a jack-of-all-trades, with some knowledge of every branch of science communication. As all science communicators handle the practical aspects of their work in different ways, this book can do no more than present just one view of how to do it. For completeness I would like to mention two other books with similar titles as this Guide, but with rather different, and perhaps complementary, content: Stocklmayer et al. (2001) and Laszlo (2006).

Smaller parts of the material here have appeared in earlier incarnations in Christensen (2005), Christensen (2003) and Nielsen et al. (2006).

Lars Lindberg Christensen (lars@eso.org)
Munich, 31 December 2005

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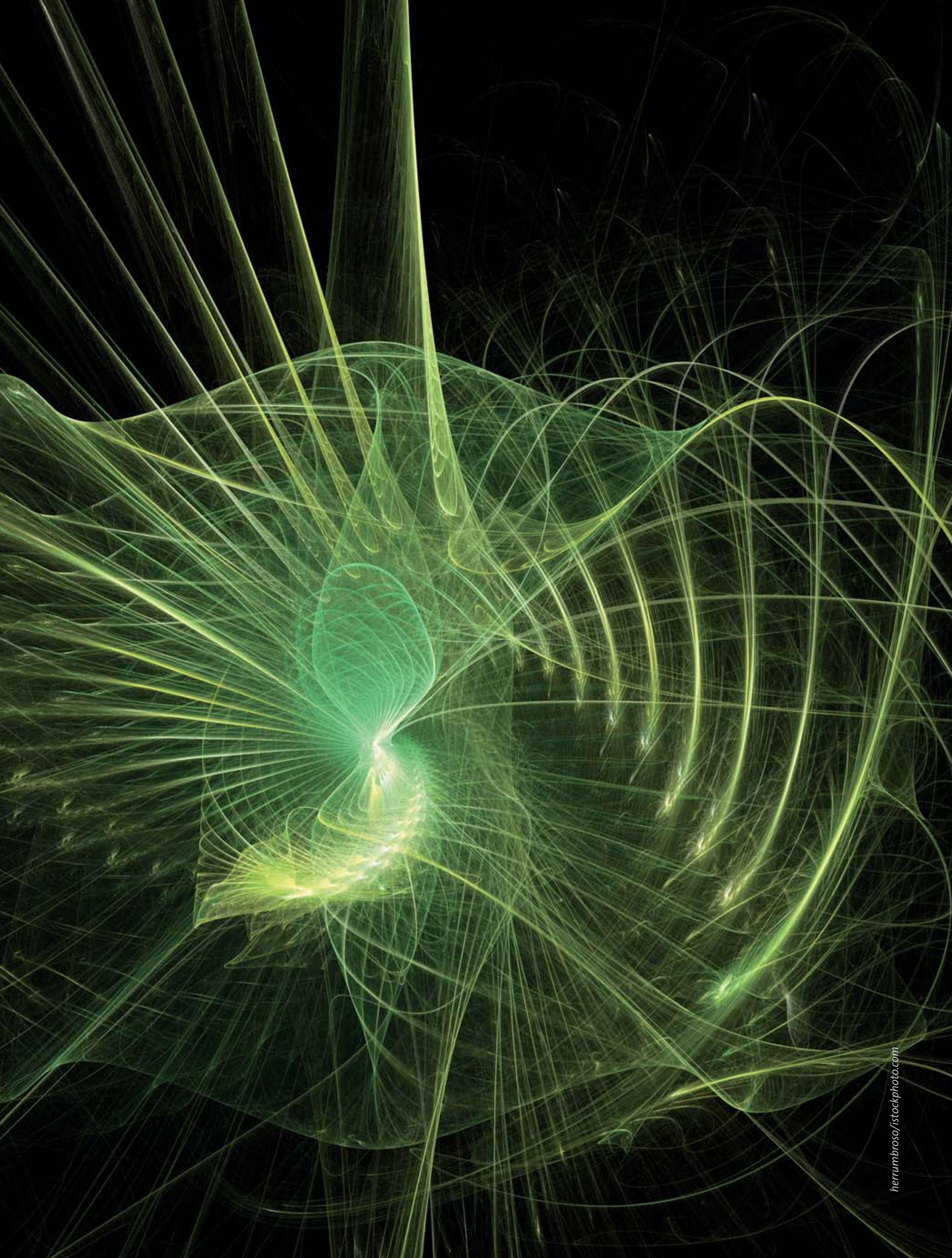
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PART I

SETTING THE SCENE

1. SCIENCE COMMUNICATION

1.1 ABOUT SCIENCE COMMUNICATION

"The majority of stories in the television evening news arise as a result of media placement. In science we are not good enough in this area."

Claus Madsen (2006)

We live in an era of unprecedented scientific progress. The growing impact of technology has brought science ever more into our daily lives. However, without a general awareness of science in the public domain and a lack of a broad appreciation of scientific progress, the public is left with nothing to counterbalance the pervasive influence of mystical beliefs, such as astrology (see, for instance, Treise & Weigold, 2002).

The role of science communication is to remedy this lack and bring achievements in science into the public eye and to the attention of important stakeholders such as politicians and industry. Science communication allows people to learn about exciting developments that affect everyone. Information about science is necessary to make educated decisions in a world dominated more and more by technological progress and can directly influence the quality of people's lives.

Popular science communication provides a bridge between the scientific community and the wider world, providing examples of the scientific method and success stories to the society at large and supporting the educational use of scientific products. Science communicators are preparing an instant meal of science results that can be easily digested by journalists, saving them the labour of scanning hundreds of scientific

Nino Panagia (Space Telescope Science Institute)

***Figure 1:** We live in an era of unprecedented scientific progress. This is a not untypical scientist's office and serves to illustrate the inevitable communication gap between scientists and press or public.*

"The social contract is not complete until the results are communicated"
Mitton (2001)

journals every week and reading thousands of scientific papers just to find that elusive big story.

One of the main tasks of science communication is to publicise the presence of the natural sciences in all aspects of society and our daily lives. Increased public scientific awareness benefits science itself, scientific organisations, scientists, the individual citizens and even whole nations (Thomas & Durant, 1987). On top of that, without continuously informing the public and decision-makers about science it will become increasingly difficult to recruit new scientists and to attract new funding.

In short, public information officers (PIOs) are fulfilling part of the obligation that scientific institutions have to share scientific results with the public and with important stakeholders. Mitton (2001) expressed this ideal elegantly: *"The social contract is not complete until the results are communicated"*.

Science communication as a field is multi-faceted and includes many disciplines: science outreach, science popularisation, science PR or even scientific marketing. Sometimes education is defined as being part of this, as a special branch of science communication that focuses on one particular target group, sometimes not. One of the particular features of science communication work is that it touches on numerous different topics, issues and areas. Science communication demands knowledge not only of science, but of technology, journalism and of visual communication (see Staffing, section 3.4).

Science communication and the topic known as public understanding of science (PUS) are closely connected. Among science communication scholars the definition of PUS is actively discussed and many scholars use public appreciation of science (PAS) instead. When studying the public impact of science communication it important to define in detail which parameter is measured: Is it the public's level of knowledge about science? Is it the basic understanding of scientific facts and theories? Is it the appreciation for the scientific method? Is it familiarity with new technologies? (Treise & Weigold, 2002). The levels of "understanding" or "appreciation" of science are difficult quantities to define and measure. A given person may have difficulty remembering and describing the third story from the evening news last night, but can nonetheless be well-informed about the topic when others bring it up in conversation. Borchelt (2001) makes an interesting point about another field with similar problems, that of politics:

> *"...politicians and their press officers often are unrivaled experts at message packaging and presentation (in stark contrast to common portrayals of scientists). In other words, in politics, the public receives a large amount of news by expert reporters interviewing the masters of sound bites. Yet, people frequently cannot name both of*

> *their senators, have no idea who the nine justices on the Supreme Court are (or even that there are nine justices), and in general claim to lack respect for elected officials and the people who cover them".*

There is certainly room for improvement in the field of science communication. As Treise & Weigold (2002) put it so elegantly:

> *"The writings of science communication scholars suggest two dominant themes about science communication: it is important and it is not done well."*

"The writings of science communication scholars suggest two dominant themes about science communication: it is important and it is not done well".
Treise & Weigold (2002)

This is also the outcome of a large study by *The Research Roadmap Panel for Public Communication of Science and Technology in the Twenty-first Century*. In their words:

> *"The panel was struck overall by the general lack of intellectual rigor applied to science and technology communication activities, especially as contrasted with the very rigorous scientific environment in which this communication arises. Communication often remains an afterthought, a by-product of scientific endeavor somehow removed from the scientific process itself."*
> Borchelt (2001)

Although most readers will have a good idea what science is, it is interesting to note that these ideas may not necessarily be the same (see Weigold, 2001). To some, science means pure science (knowledge for its own sake); to some it also includes applied science (exploring solutions to immediate problems). To some science even includes medicine and the political and economical aspects of science (Friedman, Dunwoody and Rogers, 1986). In this text science is used in its widest sense, ie including all of the definitions mentioned above.

1.2 GEOGRAPHIC DIFFERENCES

There is no doubt that the US today is leading the field of science communication. However, in recent years many scientific institutions elsewhere, for instance in Europe, have stepped up their communication efforts[1]. It is slowly becoming normal in Europe to have communication offices at universities, within a faculty and at scientific institutions in general. This has been the standard in the US for many years, where even the smallest universities have communication offices. Read more about how to overcome national barriers in chapter 19.

1.3 CASE STUDY: ASTRONOMY AS INSPIRATION

For any branch of science it is necessary to find its communication-niche.

For any branch of science it is necessary to find its communication-niche — the features that will best enable the communication of its results. As an example, communication of astronomy and related

1 The largest European scientific institutions have had communication offices for quite some time: the *European Southern Observatory* (ESO) since 1986 (Madsen & West, 2000), *CERN* (*Centre Européen de Recherche Nucléaire*) since 1958, the *Royal Astronomical Society* (RAS) since 1989 (Mitton, 2001) and PPARC (*Particle Physics and Astronomy Research Council*) since 1996.

(space) sciences are just sub-branches of the more general field of physics communication or, even more broadly, communication of natural sciences. Astronomy does however, play a special role in the field of science communication. It covers a very broad area of research with instant photogenic appeal and a scale and scope that go far beyond our daily lives to stimulate the imagination.

As one of the greatest adventures in the history of mankind, space travel, continues to hold the interest of the general public.

As one of the greatest adventures in the history of mankind, space travel continues to hold the interest of the general public. Many of the phenomena we observe in the near and distant Universe have the necessary "Wow!" factor beloved of Hollywood. Space is an all-action, violent arena (admittedly on rather large scales in terms of time and space), hosting many exotic phenomena that are counter-intuitive, spectacular, mystifying, intriguing, dazzling, fascinating. The list of adjectives is almost endless. There is a large element of discovery in astronomy as the field is extremely fast moving, delivering new results on a daily basis.

On top of all this, astronomy touches on some of the largest philosophical questions of the human race. Questions that seek to explain our very existence. Where do we come from? Where will we end? How did life arise? Is there life elsewhere in the Universe?

This, and more, gives astronomy special benefits in the 'battle to be heard', and, to some degree, astronomical institutions are using the appeal of their science more extensively than many other branches of science. Also, since astronomy, in most respects, has *almost no direct practical application whatsoever*, the need to excite the population with good results is even more important than in other branches of science and so, possibly, astronomical institutions are just one step ahead in the science communication game.

In summary, astronomy can lead the way for other natural sciences and be a frontrunner in science communication. Astronomy has a natural ability to fascinate and enthral, and can open young people's minds to the beauty of science.

Astronomy can lead the way for other natural sciences and be a frontrunner in science communication.

There is, however, a big "but": astronomy is also, practically speaking, fairly useless and applicable results from this kind of fundamental science can take centuries to materialise. We should make this clear to ourselves and answer questions from the media about this issue honestly and play on the "inspiration-factor" of astronomy and the general value of fundamental research instead.

2. THE COMMUNICATION PROCESS

It is difficult to fit every aspect of science communication into one model.

Several models, both simple and sophisticated, that describe the dissemination of science news exist (see for instance Gregory & Miller, 1998, Madsen, 2003, Mahoney, 2005-I and also Fiske, 2004 (textbook on general communication)). However, since science news may be communicated by many different methods, in many different situations and to many different audiences, it is difficult to fit every aspect of science communication into one model. As an example, science news reported in the media may originate from a variety of different sources such as:

- press releases and announcements from scientific institutions, funding agencies and government organisations;
- press conferences;
- scientists giving public talks;
- science journalists who carry out their own story research in scientific journals or from scientific preprint services like Astro-ph;
- journalists attending scientific conferences.

This illustrates the difficulty in describing the situation comprehensively with just one model.

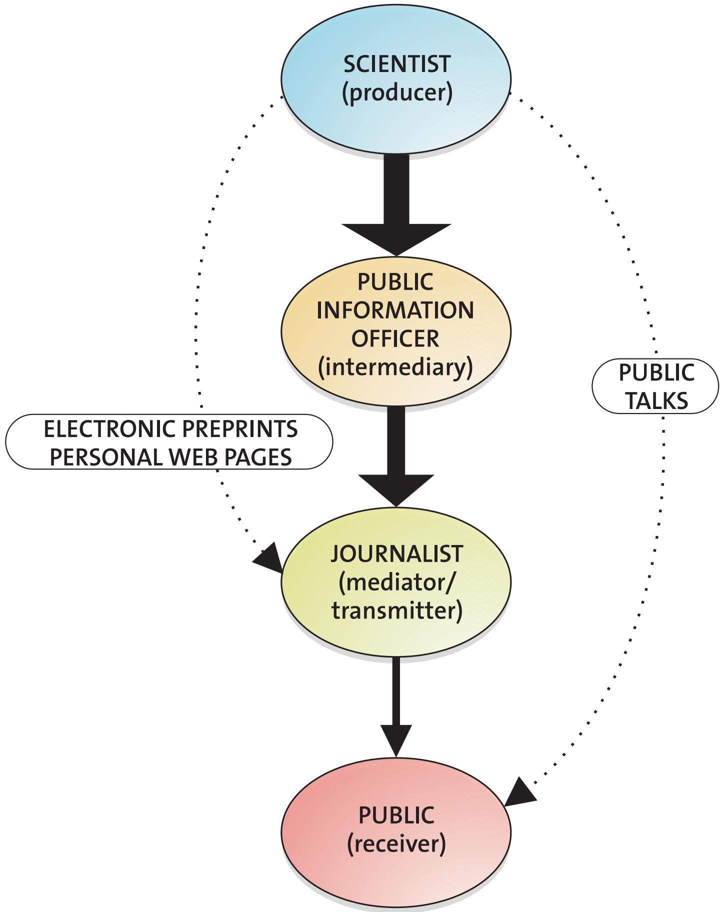
2.1 THE LINEAR MODEL

As a first approximation we are dealing with four different communities in the flow of scientific information: scientists, full-time communicators, the press and the public. One of the most used models for their interaction is the simple linear model in which information flow can be depicted as a funnel that starts at the scientist and ends at the general public (figure 2). Before the general public receives the message, the information is passed through two other communication actors: the public information officer and the journalist. The narrowing of the funnel also indicates that a simplification of the information takes place along the way.

The linear model is often used to simplify the overall picture, but it may also reflect an important part of the situation and therefore be useful to communicators. Madsen (2003) finds that nearly 50%, and possibly more, of science news in the European print media has a direct origin in a press release from a scientific institution. This finding is supported by other studies quoted in Madsen (2003). Although other quantitative studies of this issue are not readily available the conclusion is also supported by Weigold (2001). It seems safe to state that a large fraction of the science news reported in the media comes from an education and public outreach (EPO) office and has passed through the process that the simple linear model describes.

Naturally, many cases exist that involve interactions between communication actors where the simple linear model is insufficient. In some cases (marked with dotted lines in figure 2) the scientist may commu-

Figure 2: The simple linear model for the science communication process — a funnel-type model for the communication from scientists (producer) to public (receiver). This simple model where the bold black arrows show:
a) the sequential transport of information from actor to actor;
b) a simplification of information. Two additional special "direct" routes of information are shown.



nicate directly with the journalist, for instance, when an interesting electronic preprint has attracted the attention of the journalist, or the scientist may address the public directly through public lectures (see also, below in section 2.5). Furthermore the simple linear model does not take the complex nature of the general public into account (see also, section 5.1.1).

Another reason that the linear model is important for practical science communication is that it most likely represents the most effective flow of communication in terms of units of readers reached per man-hour spent communicating.

2.2 THE COMMUNICATION ACTORS

The linear model implies that the main interaction takes place between scientists and science communicators, and between science communicators and journalists. One of the goals of good science communication is to facilitate interviews of scientists by journalists, but it should also free these two important actors from tedious preparatory work. This scheme does not diminish the role of the scientist, but ensures that the scientist's valuable time is used effectively in the communication process.

There is some disagreement, particularly among scientists, as to whether the linear model described here is the right one to employ. They see science communication largely as a process of interaction between scientists and journalists (ie without the mediation of EPO offices). However many years of experience from the US (for instance Villard, 1999), backed up by Madsen's findings, have shown that this is not an effective way of communicating. If science communication is done in this way, scientists complain that they are not compensated for the time-consuming communication work they carry out, and journalists are accused of not spending enough time searching for the valuable scientific results that are hiding in the individual universities and organisations. These are exactly the problems solved by the mediation of science communication professionals and the linear model will be used as basis for the remainder of this book.

The linear model implies that the main interaction takes place between scientists and science communicators, and between science communicators and journalists.

Some understanding of the flow of information and the roles of the different actors is important for a better understanding of how the overall communication of scientific information works.

2.2.1 From scientist to PIO

The communication process starts with a scream of "Eureka!" from a scientist who has completed some research with interesting results that he/she writes up in a scientific paper. Before being published in a scientific journal the scientific paper will be peer reviewed. This is a form of scientific quality control where other expert scientists read the paper and assess the scientific method, factual accuracy and the conclusions of the author. This process of checking, criticising and improving research increases the chance that errors and inaccuracies, which might not have been caught by the scientist herself, are found before the paper is published in a journal. The scientist refereeing the paper can reject the paper, accept the paper unconditionally or send it back for further improvements by the scientist.

Peer reviewing cannot guarantee against fraud, but increases the chance of publishing credible science. If scientists communicate important scientific results to the media before it has been peer reviewed they are setting themselves outside the scientific method and one should question why this is.

Peer reviewing cannot guarantee against fraud, but increases the chance of publishing credible science.

The Science Media Centre's leaflet *Peer Review in a Nutshell* (Science Media Centre, 2005) sums up the peer review process:

> *"Peer review is where scientists open their research to the scrutiny of other experts in the field. It is there to help journal editors to ensure that the scientific research*

that they publish is credible, new and interesting. It's a fundamental form of crap detection."

The refereeing process can take anything from a few months to a few years in rare circumstances. Once accepted the paper can be published in the journal. The scientist may then choose to issue an electronic preprint on a suitable preprint server (such as *Astro-Ph* in astronomy) and contact the local EPO office.

Some journals, especially the largest and most important journals such as *Nature* and *Science*, enforce the Ingelfinger rule strictly. This is the principle that scientific results must not be published elsewhere (including public dissemination and electronic preprints) before the paper has been published by the journal it was submitted to. The Ingelfinger rule (Toy, 2002) is named after the former editor of *New England Journal of Medicine*, Franz Joseph Ingelfinger (1910-1980). This rule was invented partly to protect the (legitimate) commercial interests of the publishers of scientific journals and partly to control the timing of the release of a given scientific result into the public domain as a response to increasing external pressure (as described in chapter 21).

The original intentions of the Ingelfinger rule make some sense, as it seems fair for a publication to protect its newsworthiness and also to put a brake on the accelerating pace of the public dissemination of science results. However the rule can inhibit the developing landscape of the scientific publication process in the electronic era, and gives PIOs a very short lead time to do their work, as scientists are often discouraged by strict journal guidelines from contacting their EPO office ahead of publication.

2.2.2 From PIO to journalist

When a science result has reached the PIO it is his job to judge if the result is interesting enough and has enough public appeal to merit a press release. If it has, a press release has to be written that is accurate, true to the scientific data and also with an interesting angle to catch journalists' attention (see chapter 8).

PIOs normally follow a series of pre-defined steps before they issue a press release. The process varies from organisation to organisation, but, in general, the following happens. The PIO will, in co-operation with the scientist, create the draft for a press release. Often an in-house staff scientist collaborates with the PIO unless he himself is a scientist, and helps him with background research and scientific evaluation of the release. When the scientist has approved the release it is often sent to an internal editorial board for review of political and scientific issues (see section 4.5). When the editorial board has approved the release it is ready to be announced.

2.2.3 From journalist to the public

In science communication we operate with two different types of journalists: science journalists and general journalists. Science journalists are often general journalists who are interested in science and have taught themselves over a number of years, rather than being former scientists (Gregory & Miller, 1998).

The journalist will complete his research and write up the story to be printed or broadcast (see chapter 5 for more on how the stories are written). He may want to contact the scientist for quotes or to clarify certain issues. Even for the best journalists a press release cannot substitute for the contact with the scientist (Siegfried & Witze, 2005). The trust between PIOs and journalists often means that general journalists use PIOs as an unchecked source (Madsen, 2003). According to Schilling (2005):

> *"The difference between a general journalist and a science journalist is that the general journalist does not have the contacts and does not know who to call."*

2.3 THE "CONTRACTS" BETWEEN THE ACTORS

In the linear model in figure 2, each bold arrow indicates an informal "contract", between the different actors in the information flow. Without any direct mention of this contract (see the tables below) the different participants usually seem to be aware of the "deal" between the actors — what to deliver and what to expect in return.

Scientists and journalists have much in common, for instance objectivity and an inquisitive mind, but they also have many differences that can give rise to conflicts (see below). We will first look at the mutual obligations of the three actors in an ideal situation, summarised in the three tables below.

Scientists and journalists have much in common, for instance objectivity and an inquisitive mind, but they also have many differences that can give rise to conflicts.

Table 1: *The "contract" between the scientist and the PIO.*

Scientist delivers to PIO	⟷	PIO delivers to scientist
Top class scientific results		Manpower to 'promote' the scientist's results
A clear overview of the field		An outsider's (and expert's) view on what constitutes the most interesting parts of the result (the angle)
Links to good literature		Press release texts
Explanations and answers to (sometimes stupid) questions		Press release visuals
Patience		Sometimes a Video News Release
Quick response to the PIO's requests		A wide distribution through the media and others
Raw images, image ideas, illustration ideas		
Scientific proofreading of press releases, visuals etc in the final approval phase		
Availability (to PIO himself or to journalist)		

Table 2: *The "contract" between the PIO and the journalist.*

PIO delivers to journalist	⟷	Journalist delivers to PIO
Good news stories picked from the best scientific resources		Visibility to science
Summarised info		(Positive) publicity for organisation or project
Excellent visuals		A wide dissemination of the information
Contacts for scientists		
Some exclusive stories		
Special services if needed		
Additional info: scientific papers, web links, factsheets etc.		
A steady flow of news stories		

Journalist delivers to end-user	⟷	**End-user delivers to journalist**
Excellent journalistic writing		Payment
Selection of the best results		Loyalty
Reasonable or good visuals		
Timely delivery		

Table 3: *The "contract" between the journalist and the public end-user.*

Whoever breaks the "contract" severs the (often personal) link with the other participant in the information flow and runs the risks that the story will not be successful. The participants in this information flow are truly interdependent. To oversimplify a little, without the support of the journalist, the PIO will (after a while) not be able to demonstrate the necessary results. And the journalist will not have the stories without a continuous flow of high-quality products from the PIO.

2.4 POTENTIAL AREAS OF CONFLICT

Journalists and scientists often operate at opposite ends of the communication spectrum. As Treise & Weigold (2002) express it:

> *"... scientists are frequently disappointed or angry about media coverage of their research, their fields, or science generally. Journalists report frustration with the difficulties of describing and understanding important scientific findings and with the low levels of support provided by their news organisations for reporting on science news".*

There are many other examples, but suffice it to say that journalists and scientists, for natural reasons, work in two very different environments. It should be obvious that there is plenty of room for mistrust to build and problematic issues to arise. The list in table 4 below is compiled with input from Valenti (1999).

There is plenty of room for mistrust to build and problematic issues to arise.

Some scientists are uncomfortable about participating in science communication (and most especially in talking to the media). They often express concerns like: "*What will my colleagues think?*", "*Will they simplify or distort my results beyond what is reasonable?*" or "*I really do not have time for reporters*". Fortunately increasing numbers of scientists appreciate the importance of participating in media work, but there will always be sceptics.

***Table 4:** The three main science communication actors work in very different environments. Compiled with inputs from Valenti (1999).*

Scientist	PIO	Journalist
Values advanced knowledge	Uses the advanced knowledge in a broad context	Values diffuse knowledge
Values technical language	Reshapes technical language into simple language	Values simple language
Values near certain information	Uses facts, but also more speculative indications to give perspective	Values indications
Values quantitative information	Balances facts with emotional and personal accounts	Values qualitative information
Values near complete information	"Cuts through" when the results are trustworthy, but perhaps still not complete	Values incomplete information
Values narrow information	Uses the frontline narrow science to open doors to the broader context	Values comprehensive broad spectrum information
Specialist	Specialist in communicating science to the general public	Generalist
Theorist	Understands theory and applies it in the real world context	Pragmatist
Values knowledge for knowledge's sake	Focuses on the knowledge that is relevant to society	Focuses on what is relevant to society
Is cumulative	Is very picky with which information to accumulate	Is non-cumulative
Is slow	Can develop stories over long time, but always delivers on time	Is fast
Enjoys high professional status	Respects all other actors	Is in the lower ranks of professional status

There are many good reasons why scientists should participate in public science communication:

- to expose the work of his/her specific community;
- to highlight a specific result;
- to highlight the work of an institution;

- to highlight the work of a group;
- to highlight individual efforts (which is perfectly all right!);
- to acknowledge a sponsor;
- to do a favour to the scientific community as a whole (a sense of duty).

It is the job of the PIO to mediate in the tension field between the scientist and the journalist and to argue the importance of science communication to the scientist. The return usually exceeds the investment of time.

It is the job of the PIO to mediate in the tension field between the scientist and the journalist.

For practical advice on how scientists may improve their science communication skills see chapter 17.

2.5 DIRECT COMMUNICATION BETWEEN SCIENTISTS AND THE PUBLIC/PRESS

The direct contact between scientists and the public or press (the dotted lines in figure 2) has a special importance. Direct contact with a scientist is "expensive" in terms of manpower, but can have a very large impact, especially on young minds. As Alan Leshner, CEO of the *American Association for the Advancement of Science* said at the *Communicating European Research 2005* conference:

The direct contact between scientists and the public or press has a special importance.

> *"Go out to churches, synagogues, mosques, community organisations, like clubs and lodges. Do not ask people to come to you. Go to them where they are. Listen to their interests, to their concerns."*

Scientists can appear in public and give a personal account of various scientific topics, for instance by giving public talks or talks at media writing workshops, by being available at open house days and other public events. The face-to-face dialogue enables people to ask the questions they have always wondered about. In different countries there are opportunities to appear at various annual science day events. If at all possible this dialogue should be topic- and problem-oriented and, most importantly, interdisciplinary, while concerning topics with direct implications for people's lives (see section 8.2 for inspiration).

Direct contact between the public and scientists can also be established with blogging, or through a discussion-platform or chat-room on the web. This is also a very labour intensive type of science communication, especially for scientists, but can be significant.

Scientific talks can be systematised and optimised with a "talk catalogue" that aims to gather more people per talk and by repeating the same talk several times (thereby reducing the preparation time on the part of the scientist).

3. THE COMMUNICATION OFFICE

An education and public outreach (EPO) office is also known as a communication office, an information office, a public affairs office or a media relations office. Science communicators working there are called public information officers (PIOs). For simplicity all these offices will be called EPO offices here.

The roles of an EPO office are very varied, but two important ones are as a content provider and an intermediary. As a content provider an EPO office is not usually there to produce the end result — television programmes, books or magazine articles — for public consumption. These require professionals with many years of specialised experience within a given medium. PIOs find themselves as go-betweens between the scientists and the media, providing the raw material that enables the best coverage of the science. As intermediaries PIOs assist the scientists and the media in any way possible and aid the communication process.

The roles of an EPO Office are very varied, but two important ones are as a content provider and an intermediary.

In the real world (as opposed to the perfect world) the EPO offices that succeed are those who manage their resources in the cleverest ways, who learn from experience and never merely solve problems, but analyse and use every solution and outcome to make strategic decisions for the future.

In the real world (as opposed to the perfect world) the EPO offices that succeed are those who manage their resources in the cleverest ways.

3.1 SCIENCE COMMUNICATION STRATEGY

Companies in the “outside world” need to be profitable to survive in a competitive world and therefore often have much stricter operational and strategic demands than a scientific institute. However when setting up a science communication strategy it can be a very good idea to look at the instruments these companies use to state their strategy clearly by writing a vision, a mission, a list of objectives and corresponding deliverables.

The examples below are picked from the strategy of the ESA/Hubble EPO office. Replace the specific organisations, instruments and projects with your own.

Example vision
ESA/Hubble should become one of the world’s science communication powerhouses, especially within the areas of visual science communication and innovative information management.

Example mission statement
Our mission is to:

- Increase the awareness of the *European Space Agency*.
- Increase the awareness of (the European parts of) Hubble Space Telescope and James Webb Space Telescope.
- Increase the awareness of astronomy and the scientific work process.

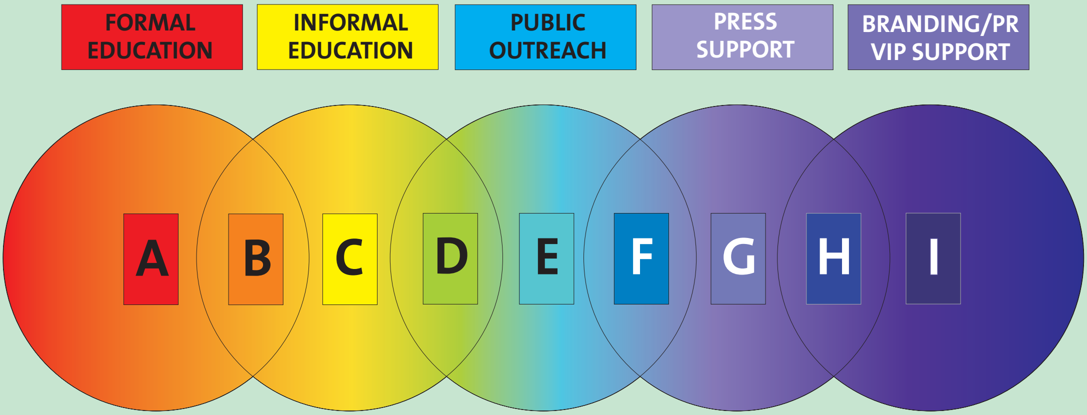
One may add a set of more specific objectives, that, for instance, describes the balance between educational efforts, institutional PR and press work, and these naturally depend heavily on local circumstances. The goals may also include quantitative deliverables, but bear in mind that the effect of science communication is notoriously difficult to evaluate (see chapter 12). An example list of objectives and deliverables is seen in table 5.

***Table 5** (facing page): Example list of objectives and deliverables*

Ranking	Objective	Deliverable	Effort
Must-haves	1. Publish and distribute world-class news and photo releases with European flavour per year.	• About 15 news, photo and video releases on the web and in printed form.	34%
	2. Develop and maintain a complete user-friendly archive of Hubble outreach material in optimal resolution and quality.	• Repositories on the web: images, videos, brochures etc. Seamless, fast, searchable, well-tagged and maintained.	12%
	3. Rapid response hotline to requests from media, scientists, educators and public.	• Number of requests; • Request response time.	9%
Want-to-haves	4. Support *Space Telescope-European Coordinating Facilities*.	• Number of products: newsletters, scientists' posters, websites, logos, stationary items, etc.	4%
	5. Train and publish: Be a recognised science communication training facility for students, other communicators and for scientists.	• Number of students trained; • Number of science communicators trained; • Number of scientists trained; • Number of reports and scientific publications in science communication and visualization journals.	9%
	6. Explore and develop innovative ground-breaking astronomy communication techniques and tools, especially with respect to visualisation.	• Number and quality of visualisation techniques developed (3D, 2D etc); • Image quality; • Time from raw data to final image; • Number and quality of software tools developed (*Photoshop* plug-ins, web systems etc).	13%
Nice-to-haves	7. Be one of the main actors in the worldwide coordination of astronomy communication through the *International Astronomical Union* (IAU), for instance by developing technical standards for science communication, standards for best practice in science communication implementation, standards for science communication management, and science communication codes of conduct.	• IAU websites; • IAU repositories; • IAU coordination projects (eg 2009 Year of Astronomy); • Progress reports; • List of standards, lists of best practices.	5%
	8. Educational projects.	• Number of exercises and other materials for teachers; • Number of teachers trained.	4%
	9. Exhibitions.	• Number of exhibitions done in-house; • Number of exhibitions done with external partners.	3%
	10. Special products development.	• Number of products: DVDs, non-news animations, fulldome animations; art exhibits, posters, postcards.	6%
	11. Support *European Virtual Observatory* and *International Virtual Observatory Alliance* activities.	• Number of websites, hand-outs, merchandising, logos, stationary items, etc.	1%

3.2 THE TYPES OF COMMUNICATION

The figure below, adapted from Morrow (2000), shows a clear overview of the different flavours of science communication (from education to branding/PR/VIP support), the target groups and the products used to communicate.



Raquel Yumi Shida (ESA/Hubble)

Figure 3: *An overview of the entire science communication "space". Different products will move along the horizontal axis depending on their target group and content. Curriculum driven formal education is seen to the left, and the more PR oriented activities to the right. Inspired by Morrow (2000).*

- ***A:*** *Curriculum-driven: textbooks, teacher training, undergraduate courses ...*
- ***B:*** *Educational programmes at planetaria, museums, libraries, parks ...*
- ***C:*** *Museum exhibits, observing trips (eclipses, comets ...), star parties ...*
- ***D:*** *Planetariums shows, IMAX movies, public talks, hands-on demos ...*
- ***E:*** *TV/radio documentaries, podcasts, magazine articles, popular books, webchats, weblogs, cultural/scientific events, CD-ROMs ...*
- ***F:*** *Photo releases, popular brochures ...*
- ***G:*** *Press releases, press conferences, press kits, Video News Releases, media interviews, media courses for scientists ...*
- ***H:*** *Exhibition booths, technical brochures, newsletters, annual reports, posters, postcards ...*
- ***I:*** *Merchandise: pins, stickers, caps, t-shirts, bookmarks, mugs ...*

3.3 BUDGET

A budget allocation for science communication of between 1 and 2% seems reasonable.

The typical number quoted as being a "reasonable" budget allocation for science communication is at least 1% of the total organisational budget (see for instance DeGett, 2003). According to Hanisch (2000), the American organisation NASA uses 2% of the overall budget for each project on science communication. Other sources (Kinney, 2004) say that the number is closer to 1%. A budget allocation for science communication of between 1 and 2% of the total operations budget seems reasonable.

3.4 STAFFING

The practical production of any science communication product is an intertwined mix of three main manpower skills:

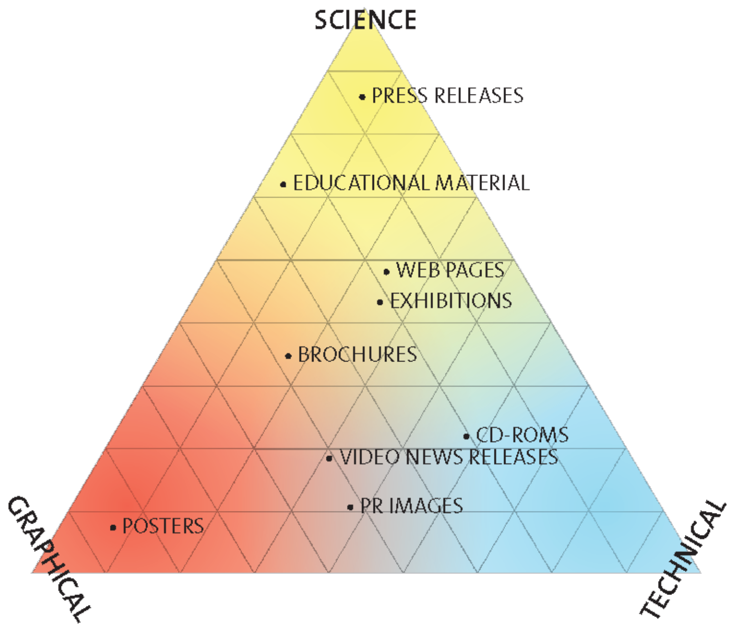


Figure 4: *The skills triangle. Every communication product is created by an intertwined mix of three main skills: science skills, graphics skills and technical skills.*

- scientific skills;
- graphical skills;
- technical skills.

The practical production of science communication is a mix of three main manpower skills:

- *scientific skills;*
- *graphical skills;*
- *technical skills.*

The diagram above is an attempt to show that the different products each occupy a different spot of this skill space, illustrated as a triangle, depending on where the weight of the production lies. Naturally a given product "flows" around in skill space depending on the exact nature of the production. The production of a product can have an emphasis on technical issues — for example, if new technology is being used, or if it is the first time for a given product type. Having different people in the team can also make the product flow towards different parts of the diagram.

No two scientific organisations are the same, or have the same budget for communication. It is nevertheless possible to set some guidelines for the functions that a fully professional science communication office should ideally have, either as individuals, or, depending on the resources, as functions shared among fewer people. The easiest approach is to look at this list as a 9-person team and then scale it according to actual resources and needs.

- **Head, coordinator, manager** (sometimes also the PIO):
  - Reports to the head of the organisation (to ensure a direct line to the decisions and deals with political issues);
  - Makes strategic decisions;
  - Coordinates meetings;

  - Manages resources;
  - Leads discussions to find the right presentation for a given story;
  - Leads discussions on which projects or stories to work on
  - Handles impact statistics/success metrics.;
  - Deals with information management and archiving;
  - Makes budgets, expenditure checks;
  - Acts as spokesperson for the organisation.
- **Public information officer, science communicator, journalist, researcher:**
  - Researches proactively for science stories;
  - Works with the scientist to develop stories (often through his/her personal network);
  - Works with science data to produce illustration/image/visualization drafts for the graphic designer;
  - Writes science stories;
  - Answers scientific questions from the public;
  - Writes brochure texts;
  - Interfaces with other scientific institutions;
  - Produces miscellaneous material for the web;
  - Functions as group internal scientific advisor and science validator;
  - Would typically have a strong science background to gain respect among the scientists.
- **Graphic designer:**
  - Creates illustrations;
  - Does image processing;
  - Designs brochures;
  - Makes animations and video editing;
  - Designs the corporate visual identity (stationery, letter-heads, logos etc);
  - Photographs, films video;
  - Prepares products for printing;
  - Miscellaneous web graphics.
- **Press officer:**
  - Finds the right media contacts for distribution lists;
  - Answers requests from, and interfaces with, media (often on a personal level);
  - Promotes good stories directly to the most important media;
  - Miscellaneous web content.
- **Educator:**
  - Prepares educational material;
  - Finds teachers for the teacher distribution list;
  - Handles requests from teachers;
  - Miscellaneous educational web content.
- **Internal communicator:**
  - Edits and produces newsletters;
  - Edits and produces annual reports;
  - Is responsible for the corporate visual identity;

    - Handles internal communication requests from scientists and others;
    - Communicates communication guidelines internally;
    - Takes care of visits.
- **Technical communicator:**
    - Web master;
    - Maintains computing facilities;
    - Maintains printing facilities;
    - Researches market proactively for more efficient and cost-effective technical solutions.
- **Editor, proof reader:**
    - Edits texts;
    - Proofreads texts.
- **Secretary:**
    - Handles distribution lists;
    - Distributes hard copies, posters, brochures;
    - Arranges meetings (also press meetings);
    - Arranges travel activity;
    - Answers external requests and questions if possible;
    - Handles purchasing;
    - Keeps track of expenses;
    - Miscellaneous web activities.

Depending on the size of the organisation, not all functions in the communication office necessarily need a full-time person. Some functions may be taken over by external contractors, although external tasks generally need to be well defined and limited in scope (but not necessarily simple). For example, a typical graphics task, which may sound well defined, proves very difficult or time-consuming to complete in practice without having the artist in-office to facilitate the almost infinite number of iterations. An editor/proof reader is however an example of a responsibility that works well as an external task as it is sufficiently well defined.

3.5 FLEXIBILITY AND FREEDOM

Flexibility and freedom are two keynotes of a communication office. The staff must be able to make their own decisions and have some degree of economic freedom within budgetary limits. Technical freedom, or technical autonomy, is more important in science communication than in many other fields. A simple thing like running out of toner the weekend before a press conference without access to spares can suddenly pose a mission critical problem.

Flexibility and freedom are two keynotes of a communication office.

Some (as Mitton, 2001) have the freedom of speaking on behalf of the organisation. Naturally this freedom bestows a great deal of responsibility and the head of the group must be prepared to take criticism for decisions made, be prepared to admit mistakes or misjudgements and to justify decisions on a daily basis.

Due to the steady stream of various deadlines and requests from journalists needing quick answers, it is very important that the staff of a communication office interact continuously. They should inform each other about their work regularly, for example, by giving short presentations about selected topics at weekly group meetings or similar. The group should be flexible enough to cover each other in cases of vacation, sickness, travel etc. This flexibility also implies the crucial availability of parts of the personnel outside normal office hours, notably to service media in other time zones (Mitton, 2001, agrees in this respect).

3.6 STRATEGIC ADVICE FOR EVERYDAY

It is often the obvious that is forgotten in crisis moments as a deadline approaches.

The selection of tips for everyday procedure presented below is based on personal experience acquired in doing science communication over many years. Although some of the advice may appear naïve, or just plain common-sense, or with general application beyond science communication, it is often the obvious that is forgotten in crisis moments as a deadline approaches.

Strategy

- *Problems can be solved in two ways: Fire-fighting, or strategically*. Applying a strategic solution enables others to benefit from the solution and will contribute to the firm foundation of the office in the long run. When solving a problem, think about the potential long-term benefits for other customers. As a practical example, consider how to handle a request from a journalist for a custom-made graphic. There is a big difference between producing the graphic and sending it to just the one journalist, or making it, posting it on the web and then referring the journalist to the site (thereby giving everyone access).
- *If one customer cannot find a product, there will be others you don't know about (and never hear from).*
- *If one customer needs a non-existent product, others would also probably like to have it*.

Quality

- *Aim for the "highest quality", but compromise to reach "awesome"*.
- *Never give in to the temptation to produce inferior quality*.
- *If it is not necessary, do not compromise on quality*.
- *Apply the 80/20 principle*: The often somewhat misconstrued Pareto's principle states that 80% of the consequences often stem from 20% of the causes. When applied to science communication the principle can be expressed simply as: 80% of the result will be achieved with 20% of the effort. In the real world, results arise from in a trade-off between quality and time. Perfection does not pay off as communication moves too fast and real perfect results may not even exist in a complex communication environment. Pareto's principle in science communication may also favour shifting the balance somewhat towards less planning and a rapid transition to the first proto-

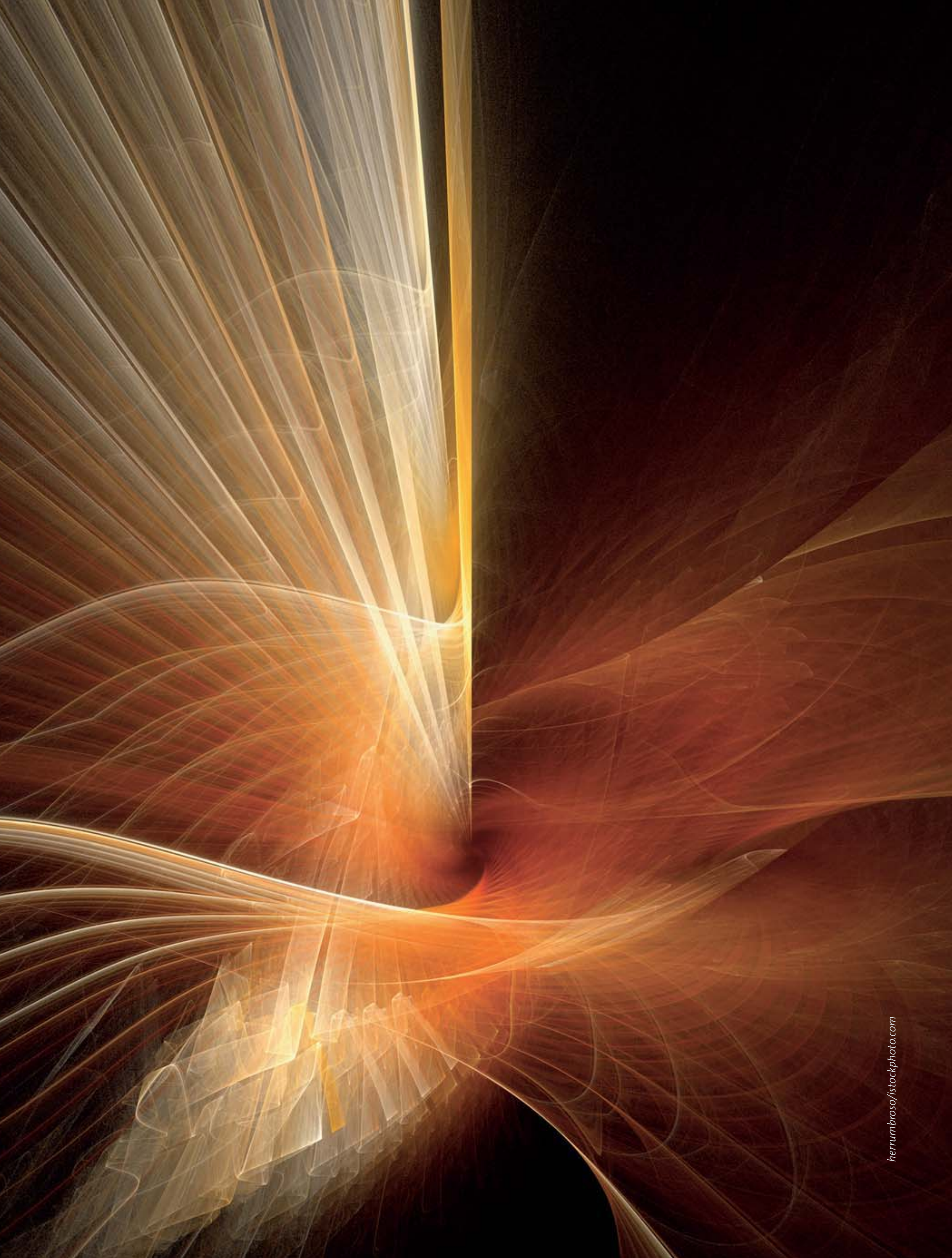
type (could also be called rapid prototyping, a concept borrowed from the machine-production of 3D tools).

Opportunities

- *Every day is filled with opportunities, but also with opportunities wasted.*
- *Time is our most precious resource. Do not waste it.*
- *Ideas are invaluable commodities.*
- *Any idea lost is a lost opportunity*. Make a note of your ideas and keep a ToDo list with you at all times.
- *Creativity is a little shy furry animal. It is easily scared by the noise of the daily grind.*

Production

- *There are two dominating poles in the production process: the chaos of creativity and the order of a rigorous workflow. In the struggle between the two, excellence is born.* Experiments spawn chaos. From chaos comes order. Before entropy can be reduced by construction, it must be increased through deconstruction.
- *We may make mistakes, but we do not fail.* Eliminate single-point failures if possible. Trial and error is still, however, the best way to learn. Another formulation of this advice is: *Failure is not an option.* This statement was made famous by Gene Kranz during NASA's Apollo 13 mission, but still holds true in many areas, including science communication.
- *If no mistakes are made, the envelope has not been pushed far enough.*
- *Always integrate all three skills in the skills triangle*: Science communication, graphical design and technical know-how are all indispensable elements of any production.
- *Maintain a full overview and control of the entire production chain.*
- *Apply low-tech solutions when possible*. This reduces the risk of any major technology-induced malfunction.
- *Any EPO product can be produced in a thousand ways*. No single solution will ever be shown to be the best.
- *Any product can always be improved*. The decision when to stop requires experience-based knowledge of the careful balance between potential gain in quality and the excessive expenditure of time. Sometimes "blindness" occurs and it is better to put the product away for a while, for example, over lunch or overnight, or to survey other people's opinions.
- *Any production will involve many more iterations than expected.* Expect this and factor it into time and resource planning. Test, test and test again. Errors will creep in.
- *The devil lies in the detail.*
- *Always be open to criticism*. Be open-minded about all your work, from written words to the latest graphical creations.
- *We live by other people's first-hand impressions*. Since we fall in love with the product we are working on, it makes more sense to listen to people who have never laid eyes on it before.



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THE PRODUCTION

PART II

4. OVERVIEW OF THE PRODUCTION CHAIN

The production phases for a typical science communication product, whether a press release, a brochure or a CD-ROM, follow a very similar pattern. In this chapter a brief overview of the individual steps is given and in subsequent chapters the most important steps are treated in more detail.

A typical production sequence can be perceived as a chain with a number of links. The individual links in the production chain will be discussed below.

The old cliché, "*No chain is stronger than the weakest link*", holds true and this chain is extremely fragile. In every link there are numerous possible partial or total failure points, and hence a high probability that the chain will break if care is not taken. If the chain breaks the product will not be successful. The seventh link, Distribution, is especially sensitive (see the discussion below).

"No chain is stronger than the weakest link"

Each link should be optimised to ensure smooth progress to the final product. Some communicators use a checklist of the individual steps in the production flow. Each point in the production flow is checked off when it has been done. This is especially useful for the novice. Ask: What do I need to do to complete this product, and write the answers down to form a checklist.

Each link of the production chain is a collaboration that relies heavily on the cooperation of various internal and external parties. As an example, the production of a press release relies heavily on the lead

Figure 5: *The production chain. A typical production flow for a communication product.*

Phase	Action
Planning	☐ Read the scientific paper if available. ☐ Propose the release to the internal scientists or editorial board. ☐ Make a web bookmark folder for the release. ☐ Make a hard disk directory for the files (use release number). ☐ Search for literature on the scientific topic/object. ☐ Search for previously published images and news/photo releases. ☐ Search the web for relevant links about the object and its constellation. Check the lead scientist‘s webpages (if they exist). File the bookmarks in the appropriate folder. ☐ Get image data from the archive/scientist
Production of visual and written products	☐ Research and acquire raw material for the visuals. ☐ Produce videos. ☐ Make initial image processing (for instance with specialised external software). ☐ Combine the image material in *Photoshop*. ☐ Adjust the image levels, curves, colours etc for the best aesthetic effect (maintain scientific correctness). ☐ Copy old press release templates to the current folder and start writing/editing process.
Editing and validation	☐ Send draft text and draft visuals to the lead scientist for comments etc. ☐ Send edited text for proofing. ☐ Send proofed text to lead scientist for validation. After a few iterations the release text will be ready. ☐ Produce figure captions and “additional info” (title, credits etc) for image archive. ☐ Send captions to scientists for validation. ☐ Send captions for proofing. ☐ Send the final release package to the editorial board for validation.
Archiving	☐ Make a “final” folder and archive the finished products there. ☐ Produce the various products needed for distribution of the release on the web. ☐ Prepare the embargo website.
Distribution	☐ Send the embargoed release to “trusted journalists” with a link to the embargo website (a few days in advance of the public release). ☐ Send the embargoed release for distribution via external distribution lists. ☐ Post embargoed versions of the release at press release portals. ☐ Produce glossy prints of the main image for VIPs. ☐ Print text versions of the release to send out to VIPs. ☐ Pack and send hardcopy versions of the release. ☐ Put all products on the main website, ready for public release. ☐ Preview final products. ☐ Publish! ☐ Send emails to members of the public distribution list.
Evaluation	☐ Check the press impact, for instance with *Google News*. ☐ Search web for other press coverage. ☐ Monitor web traffic etc. ☐ Post-mortem: Discuss and evaluate the production process internally and externally (also with the lead scientist).

***Table 6:** Example checklist for the production of astronomy press releases. Also see the press release production timeline in section 8.7.*

scientist in the research phase and in the subsequent iterations of the text. The scientist is also needed in the distribution phase where he/she should be available to journalists for quotes, interviews and for elaborations.

As the success of any given communication product relies on the individual steps in the production process the interpersonal relationships within the team are of vital importance — mutual trust and respect is needed to open and preserve good communication channels.

The links in the production chain are described in slightly more detail below.

4.1 MARKET RESEARCH

Researching the market where the products are to be "sold" is vital. It is necessary to understand both the communication environment and the habits and motivations of the target groups. Communication is a highly result driven field and our customers — the "consumers" — decide when, where, how and why our products will be "purchased". In science communication the customers are often the media and understanding their needs, modus operandi and operational time scales is vital (also see chapter 5).

Researching the market where the products are to be 'sold' is vital.

4.2 PLANNING

Based on the market research, a feasibility analysis will clarify the details of the production, for example, the right choice of product or medium (see chapter 6), the right choice of target group (see chapter 5), the resource budget (such as time and money) and schedule. Set an overall goal for the product and plan how to reach that goal. Devise a benchmarking strategy for the evaluation process to recognise when the goal has been reached. It is also worth considering how the product fits into the overall communication strategy and product line.

Ask yourself the following questions:

- What do you want to achieve?
- With whom?
- By when?
- Within which budget?
- How?
- How do you know when you get there?

When you have a plan, ask yourself whether it is SMART:

- Is it **S**trategic? Will it have significant impact?
- Is it **M**easurable? How will you know that your goals have been achieved?
- Is it **A**ttainable? Are the goals realistic?
- Is it **R**elevant (to the target group)?

- Is it **T**ime-specific? Does it have a clear beginning and end-date?

4.3 WRITTEN COMMUNICATION

This topic has been selected for a more in-depth treatment, see chapter 7.

Images equal discovery in the eyes of most people you'll meet on the street.

4.4 VISUAL COMMUNICATION

To quote Robinson (2002) on the importance of images — in this case astronomical: *"Images equal discovery in the eyes of most people you'll meet on the street"*. Science often deals with abstract and complex issues. Good visuals and the communication of science belong together.

Read more about visual communication in chapter 10.

Scientific accuracy is one of the most basic prerequisites in science communication

4.5 SCIENTIFIC AND POLITICAL VALIDATION

Scientific accuracy is one of the most basic prerequisites in science communication and an all-round scientific knowledge is mandatory for the expert communicator. It is necessary for the communicator to be able to interpret diverse science results from many different fields. Scientific correctness enables the successful communication department to maintain the confidence of mediators and to gain the trust of scientists who rely on a fair and expert treatment of their hard-earned scientific results. For a user such as the general public, quality communication will mean enlightenment and a "fair" insight into technical areas not normally accessible to the layman.

A validation of the scientific content of a product is a necessary step in the process, but needs to be handled very smoothly so as not cause problems for the schedule for the completion of the product. One way to do this is to rely partly on the scientific qualifications internally within the communication office. Another is to appoint scientists to act as semi-external advisors or validators — semi-external since they often have a close contact with the source organisation and are most likely volunteers. This type of editorial board ventures deep into potential scientist-communicator conflict areas (section 2.4) and steps should be taken so that the approval process does not interfere with the daily business. Often an EPO office has to move rapidly, limiting the scope for external intervention. The intervention of such a board is usually most relevant for "sensitive issues" where the release can pose a political or scientific problem for the organisation. Credibility problems could arise if a release is not based on peer-reviewed science (section 21.6) for example. The scientific experience of the board is extremely useful in this case.

At the *Office for Public Outreach* (OPO) at the *Space Telescope Science Institute* (STScI, Hubble's American home institute) there are part-time staff scientists whose job it is to validate the scientific content (independently of the lead scientist whose story is featured)[2]. At the *Euro-*

2 Villard (2000)

pean Southern Observatory (ESO) there is an editorial board consisting of four scientists who read and check releases for potential political and scientific problems[3].

4.6 TECHNICAL PRODUCTION

In a rapidly changing high-technological marketplace it is necessary to have a relatively high degree of "technical autonomy" to make the final product a success. An EPO office needs to be able to answer the fast-moving and dynamically changing needs of the consumers. Depending on the product, advanced technology is used. Media such as video and 3D animations for television are technology-heavy, but also have a very high impact when successful. The main point here is that technology is an important part of science communication, and needs to be fully integrated into the workflow.

In a rapidly changing high-technological marketplace it is necessary to have a relatively high degree of "technical autonomy".

Technical production is discussed in more detail in chapter 10.

4.7 DISTRIBUTION

The distribution link is the physical or virtual transfer of the product from the communication office to the end-user. This often happens via mediators acting as multipliers. This part of the production chain is often difficult to handle, especially for small offices, but if the chain breaks here failure is guaranteed. Commercial players competing for the attention of the same audience put a great deal of effort into distribution and naturally also in promotion. Distribution is treated in more depth in chapter 12.

4.8 PROMOTION

The product may be out, but without some effort in marketing, or promoting and advertising the product no one will really know about it, apart from the very limited audience that can be reached by direct mailing.

The kind of promotion practised by EPO offices is rather different from the work of conventional commercial marketing departments. However, many research institutions predict that conventional marketing will play a more important role in the near future, due to the ever increasing competition in the global marketplace and increased competition amongst research institutes (Hamacher, 2003).

Science communicators do not deal with customers, in the usual sense of vendees that purchase with money, but they still deliver a given product or service. What is "advertised" and "sold" here is not, as an example, produce in an agricultural sense, but the yield resulting from year-long intellectual efforts. We are in a sense reaping the academic harvest and sharing it with the public.

3 Fosbury (2003)

4.9 EVALUATION/ARCHIVING

When the product has been produced, distributed and promoted after Herculean efforts all round, most communicators breathe a well-earned sigh of relief. But it may be worth making that extra effort to archive the materials and evaluate the results. This involves finding out whether the product was a success and then trying to investigate why or why not, so as to be able to do an even better job next time. The topics of evaluation and archiving are treated in chapter 13.

5. TARGET GROUPS

Communication is a highly result driven field and our customers — the consumers — decide when, where, how and why our products will be "purchased". The narrower the target for a product, the better the product can be tailored to the target group. However, in the real world, where resources are limited, it is sometimes necessary to hit several target groups at once for instance when distributing press releases.

Communication is a highly result driven field and our customers — the consumers — decide when, where, how and why our products will be "purchased".

Although the main target groups can be reasonably clearly defined, the importance of couching the right level of technical and scientific detail in language appropriate for the given group as precisely as possible is more important than ever. It is easy to underestimate the significance of this point. The importance of fine-tuning the targeting increases as the competition increases. Sometimes even small short-comings here can mean that the communication fails completely.

Although the audience for science communication is as diverse as the population itself, some rudimentary categorisation, or segmentation of the target groups, can assist in understanding their needs and so reach the maximum audience with a particular communication product.

The final target groups (the "end-users", "end-targets" or "end-consumers") for science communicators are usually the general public and — to some degree — decision-makers and scientists[4]. End-consumers are not readily reached without the assistance of mediators. Although "the science attentive" part of the population can be reached directly, it still requires a disproportionate effort to overcome the immense competition with other media voices.

It is of vital importance to try to be innovative, and to follow current trends by keeping in steady close contact with the audience to listen to their needs and redirect the work accordingly. In certain cases it may be fruitful to change the form of communication from monologue to dialogue and promote two-way communication directly between scientists and laypeople or media (see also section 2.5). This dialogue should be topic- and problem-oriented and, most importantly, interdisciplinary. It should, if at all possible, concern topics with direct implications for people's lives. Another way to hit outlier target groups, such as teenagers, is to try to use alternative vehicles for, or as a means of, communication. One may, as an extreme example, try to get (simple) science messages beamed out on music channels by collaborating with a popular up-and-coming rock band.

It is of vital importance to try to be innovative, and to follow current trends by keeping in steady close contact with the audience to listen to their needs and redirect the work accordingly.

5.1 TARGET GROUPS REACHED DIRECTLY

- **The general public (end-customers)**: The large group known as tax-payers, general public or laypeople (also sometimes known as "Joe Sixpack", "R-Ps" (Real People) or "the man in the street") may be reached directly, for instance, via institutional webpages. However the large size of this target group (the US has a population of roughly 300 million and Europe 450 million),

4 Defined as scientists other than the scientists whose results are being communicated.

combined with national differences and other obstacles, means that this group is much more efficiently reached via mediators (see section 5.2 below). The importance of this target group justifies a closer look below (section 5.1.1).

- **Decision-makers**: Decision-makers, opinion-makers or influencers are key stakeholders and should be reached via highly targeted products. These may be of a higher standard (ie more glossy) and have higher costs than broader-based products. As decision-makers usually have very little time, the product has to be very concise and simple. Examples are brochures, annual reports, printed press releases and glossy prints of the type known from press packs at press conferences. These products are sent directly to a select, exclusive group of decision-makers and politicians. This target group is political in nature, but also includes special groups such as industry.
- **Scientists**: Although the popular science communication described here is not officially targeted towards other scientists (who will often consider the products over-simplified, too popular or "glossy"), there is a (small and mostly subconscious) factor whereby scientists become aware of each other's work through press releases, news coverage, webpages etc Kiernan (2003) made a study of this effect and concludes that there seems to be at least some connection between coverage of a given science result in the media and the subsequent citation rates for the science paper (although it is difficult to compare with citation rates for papers that have not been in the media as the two science results may not have the same "science quality"). Good science will always be covered more by the media, which in turn creates a background correlation between the coverage and the citation rate. In the author's own informal conversations with scientists there seems to be a clear correlation between media coverage and citation rates. This may raise some concern as media coverage may have a feedback effect on the scientific method.
- **Industry**: Some organisations have strong industrial connections and also need to communicate directly with others in the industry. Some do this via press releases and similar products for lack of better means to address this target group. One should be cautious using products such as press releases for other target groups than the one originally intended as this may confuse the original target group (in this case journalists), and degrade the quality of your products in their eyes.

5.1.1 A closer look at the general public[5]

Reaching the general public directly with information from the communication office relies almost totally on the public "pulling"[6] the information from institutional webpages and the like. This requires some interest in science on the part of the public. There are large geographic

5 Discussions with, and inputs from, Anna-Lynn Wegener (ESO) have been valuable for this section.

6 Pulling is the process whereby the audience draws the information from the communication office of their own free will. The opposite is "pushing" where the office pushes the information to the customer (as in direct mail).

differences in this interest as well as many different ways to measure it, so it is not easy to get a good overview. Also the style and level of the product, as well as its relevance to the reader, may directly influence his level of interest. According to Villard (1991) the science attentive part of the population is roughly 25% in the US. 50% do not seem interested in science and there is an intermediate group of 25%. According to the European Commission (European Commission, 2005) 30% of people in the EU are "very interested" in science, 48% "moderately interested" and 20% "not interested". A Norwegian study (Eide & Ottesen, 1994) found that 37% of Norwegian readers regularly read the science articles presented in newspapers.

Although it is often reported that the level of science literacy in Europe is declining, statistics do not support this. According to the European Commission (European Commission, 2005) there was an increase of correct answers to a small science quiz of something like 8-9% on average from 1992 to 2005 in the original EC countries. According to Miller (2004) the civic literate part of the US population was 17% in 1999, up from 10% in 1988. These numbers are encouraging as the ultimate long-term goal for science communication is to inform and to develop a foundation of trust between science, scientists and the population.

Targeting the general public

It is important to consider the knowledge and interest of the public for successful science communication, as well as the fact that the public is an active participant in the communication process rather than merely a passive recipient of a message. Science communication has long been almost exclusively based on the "deficit model" of the public understanding of science. According to this model the public is considered as a blank slate without any pre-existing knowledge, ideas and expectations about science (Gregory and Miller, 1998).

The public is an active participant in the communication process rather than merely a passive recipient of a message.

However, research by the European Commission (European Commission, 2001) and by Irwin & Wynne (1997) has shown that the public mind is anything but a blank slate. According to studies by Durant et al. (1989) and Durant & Bauer (1996) the public has certain pre-existing expectations, values and misconceptions about science, which influence the way in which a given message is understood. Furthermore, research quoted by the House of Lords' Committee on Science and Technology (2001), suggests that the public makes sense of scientific information by assimilating it into a framework of common sense reasoning and by trying to make it relevant to their everyday lives.

This process of active interpretation by the public should be taken into account by communicators to maximise the efficiency of communication. Thus, science communicators should present information with concrete examples and with a relevance to people's lives to suit the public's ways of thinking. Moreover, commonly found misconceptions, such as the idea that genes are only found in genetically modified material (OST, 1999), should be researched and directly addressed in articles of science communication to avoid misunderstandings.

The better the interpretative processes of the public can be predicted, the more efficient communication will be and therefore the slogan "know your audience" is more important than ever in science communication.

5.2 MEDIATOR TARGET GROUPS

Mediators are the omnipresent and overwhelmingly important "helpers" or "multipliers" that feed the information to the population.

Mediators are the omnipresent and overwhelmingly important "helpers" or "multipliers" that feed the information to the population.

- **Media**:
  - **Television**: see section 5.3.
  - **News agencies/wire services**: Work as outlets and distribution partners for news stories. They can have a very large influence on the impact of a story. The largest wire services are AP (*Associated Press*, American), UPI (*United Press International*, American), AFP (*Agence France-Presse*, French), and *Reuters* (British). If the story is picked up by a large wire service the chances are that smaller, local newspapers will also carry it. Most stories are sent out nationally or internationally, but if a story has a strong local angle, distribution may be limited to the local media.
  - **Radio**: see section 5.4, below.
  - **Newspapers**: see section 5.5, below.

Astronomía magazine

Figure 6: *A science trade publication as an example of a mediator target group.*

  - **Weekly magazines**: For instance *Newsweek*, *Time*. These have a longer lead time (weeks or even months) and therefore much more time to carry out proper research. Often these cannot run news stories, but try to connect various stories and to identify scientific trends. They are often printed in colour, which can be a significant bonus for the visual material produced, but also demands visual products of extremely high quality. They usually have a large circulation.
  - **News websites**: Websites like *CNN web*, and *BBCi* can react almost instantly to news events, are easy to update, work 24-7, can have added value product such as multimedia sources. News websites are used by many people regularly and the importance of this medium will grow in the coming years.
  - **Science magazines/trade publications**: Including *Science*, *New Scientist*, *Nature*, *Scientific American*, *Discover Magazine, Science News, Astronomy Magazine, Sky & Telescope*. These are usually issued monthly and therefore have lead times of the order of months. They are usually printed in full colour. They place much emphasis on visual communication products. These magazines do not usually reach the broad swathe of the general public, but many decision-makers, science attentive groups (such as amateur astronomers) and other mediators read them and their importance should not be underestimated.
- **Educators**: A special type of mediator with the potential to make a lasting impression on the minds of the younger generation. This group usually needs material that is specially tailored to their students: formal or informal educational material.
- **Popular book authors**: Books can work as long-lasting reference sources (also in education) and the exposure of a communication product in a book can have a lasting impact. The audience for books is usually relatively small, although may extend more towards decision-makers. Some high profile examples are Richard Dawkins's *The Selfish Gene*, Simon Singh's *Fermat's Last Theorem*, Bill Bryson's *A Short History of Nearly Everything* or James Gleick's *Chaos*.
- **Scientists, amateur communities**: Informing experts such as scientists and others with specialised knowledge, for example, amateur astronomers, can also be very useful as they can act as mediators or may themselves have political influence.
- **Fellow communicators in science centres, museums, planetaria and public observatories**: A valuable group of mediators, as they can have a huge surface of contact with the public through hands-on demonstrations, planetarium shows, small news services and press contacts. A current estimate states that there are ~2750 planetaria in the world, with roughly 87 million visitors per year (Petersen & Petersen, 2000).

Some of the most important media are treated in more detail below.

Figure 7: *A web news site. Most of the large printed and electronic media supplement their main activities with news websites (here bbc.co.uk). Sometimes the presence of a story there can mean that the story was run in the main medium as well (for instance TV).*

BBC Online

5.3 TELEVISION

Television is one of the most powerful news media and its importance has continued to increase.

Television is one of the most powerful news media and its importance has continued to increase. Some of the main reasons for its success as a news medium:

a. The public's appetite for quick access to news about world events.
b. A given news topic can be described very quickly on screen by means of animations, illustrative footage, sound bytes from experts and the like.
c. The medium serves or "pushes" information towards the user. The user only has to turn on the television set, sit back, and relax.

For these reasons television has a huge audience and is one of the most attractive media to use for distributing news oriented products, although it is also a very demanding medium. Television viewers have a strong influence on the content (the programme selection). Ratings will steer the decisions of television producers. Science programme producers have long realised that they have to follow the needs and wishes of the main part of the audience, and that means the production of edutainment style programmes, instead of in-depth science programmes.

Television requires visual material (video), so the typical way to attract the attention of a television channel is to issue Video News Releases

Danish Broadcasting Corporation

Figure 8: *An example of a science programme on television. From the Danish programme* Viden Om.

(VNRs). The medium is "expensive" in more than one way. VNRs are relatively costly to produce, both for technical and manpower reasons. Furthermore the entire broadcasting system is expensive, meaning that competition for airtime is fierce. Therefore, a communication office should only use this medium for the very best news stories and take great pride in producing the best possible VNRs. Read more about video production in chapter 15.

5.4 RADIO

Radio is the second of the large electronic media and relies a lot on storytelling and on soundscapes. The written part, or the non-visual part, of a press release is the main component to get radio stations interested in a story. The stories in news broadcasts are usually very, very short (typically 30-40 seconds). It is important to use pictorial language and metaphors to create an image in the mind of the listeners. A standard example from biology is to describe DNA's double helix as a spiral staircase. Some direct advice for radio journalists from Radio France (2003) on the extreme need for brevity and clarity in press releases:

> *"In radio it's even more important than in print to get the five 'w's into the first 40 words of a story — who, what, when, where, why and sometimes how*[7]*. Radio journalism aims to align the facts in an 'inverted pyramid', going from the most important to the least important fact. It should be possible to cut almost any story from the bottom up without losing anything essential. Never take for granted what listeners are supposed to know. Put a story in context and briefly explain the background."*

In radio it's even more important than in print to get the five "w"s into the first 40 words of a story — who, what, when, where, why and sometimes how.

Longer format radio broadcasts, such as *National Public Radio*'s *Science Friday*[8], *BBC Radio 4*'s science programmes[9], can give deliver good in-depth coverage of scientific themes.

5.5 NEWSPAPERS

Newspapers are among the most important printed media and among the most important mass media for news about scientific research and technological developments for the public (see Hijmans et al. 2003, and references therein). Science is not normally covered as a "high-profile" topic in newspapers and is in fierce competition with topics such as politics, health, disasters and war that have a much more direct impact

Fewer than 1% of US journalists are science journalists.

7 The five "w"s are part of the six "golden questions" along with How? (see the glossary entry).
8 http://www.sciencefriday.com/
9 http://www.bbc.co.uk/radio4/science/

on people's lives. The low paper quality makes the pictures in newspapers appear less impressive than elsewhere. They are still eye-catching, and therefore important to the reader.

Deadlines for most newspapers are in the early evening, which makes mornings a good time for releasing stories, having press conferences etc. Today most newspapers have electronic editions in addition to the paper versions. This means that some stories are published with a time lag of hours.

In a rigorous study of Dutch newspapers Hijmans et al. (2003) find that two thirds of science pieces appear in the news sections of the newspapers. They also find that Dutch newspapers give relatively high attention to science stories, but that the coverage, perhaps not surprisingly, does not penetrate very deeply into the topic. The scientific method and the relevance of the scientific results are hardly discussed.

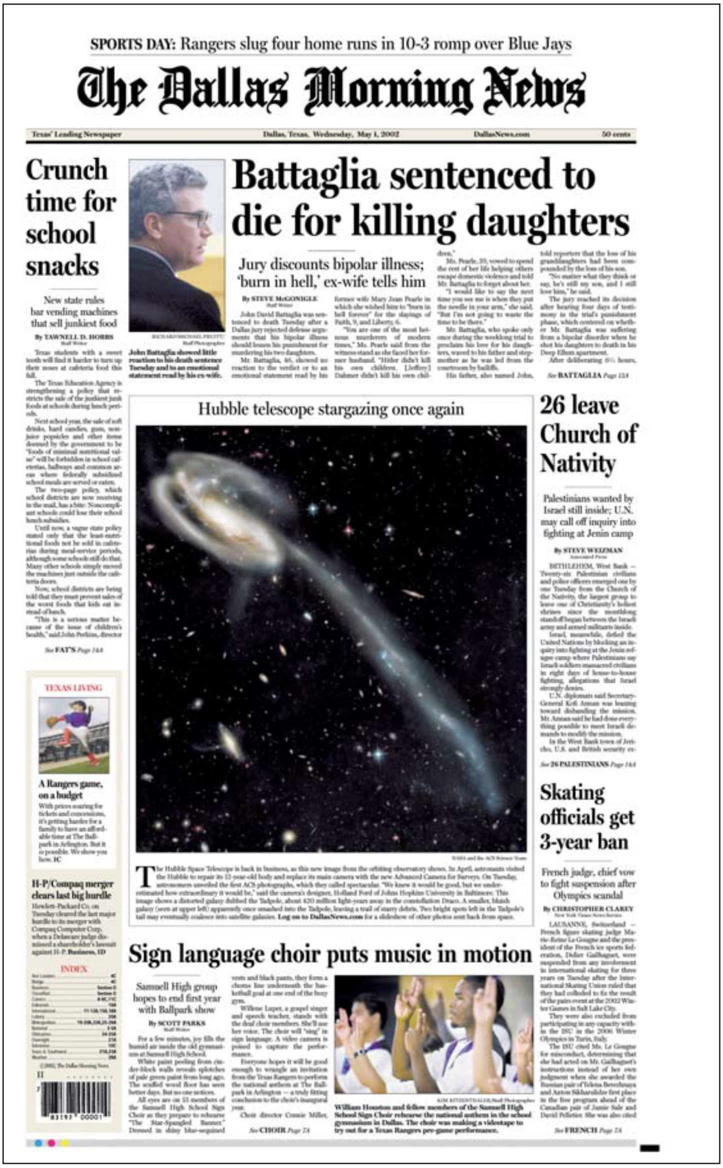
Newspapers can be split into the following three groups:

- **International**: For example, the *Times*, the *Herald Tribune*, the *New York Times* and the *Washington Post*. These papers have the necessary funds to undertake in-depth research and typically will have dedicated science journalists on staff. According to Weigold (2001) and sources quoted therein, larger newspapers such as the international newspapers have better educated readers and cater to an audience that are more science attentive. Getting a story "above the fold" (on the upper half) on the front page in one of these newspapers seems to be the holy grail for many EPO offices.
- **National**: The national media will often favour stories with some relation to the country either institutionally (for example, the location of the institute) or personally (such as the nationality of the scientist). Some national newspapers have weekly supplements in colour that are similar to weekly magazines.
- **Local**: Will often need a local pitch on the story, such as a result from a local university. These newspapers can sometimes not afford to write their own stories and often take stories directly from wire services. Do not underestimate the importance of local newspapers. Their readers are usually very loyal and the impact of a story in a few local newspapers may measure up with one in a national newspaper.

5.6 THE JOURNALIST

The person who is most likely to receive the media-oriented products produced by an EPO office is the journalist. Depending on the product they can be specialised science journalists or general journalists working in many different fields. As we do not know in advance who will receive the product, it should be produced so that it can be used by many different types of journalists (see also section 7.1). Treise & Weigold (2002) state:

Dallas Morning News


SPORTS DAY: Rangers slug four home runs in 10-3 romp over Blue Jays

The Dallas Morning News

Texas' Leading Newspaper | Dallas, Texas, Wednesday, May 1, 2002 | DallasNews.com | 50 cents

Battaglia sentenced to die for killing daughters

Jury discounts bipolar illness; 'burn in hell,' ex-wife tells him

By STEVE McGONIGLE

John Battaglia showed little reaction to his death sentence Tuesday and to an emotional statement read by his ex-wife.

See BATTAGLIA Page 13A

Crunch time for school snacks

New state rules bar vending machines that sell junkiest food

By TAWNELL D. HOBBS

See FAT'S Page 14A

Hubble telescope stargazing once again

26 leave Church of Nativity

Palestinians wanted by Israel still inside; U.N. may call off inquiry into fighting at Jenin camp

By STEVE WEIZMAN

See 26 PALESTINIANS Page 18A

Skating officials get 3-year ban

French judge, chief vow to fight suspension after Olympics scandal

By CHRISTOPHER CLAREY

See FRENCH Page 7A

TEXAS LIVING

A Rangers game, on a budget

H-P/Compaq merger clears last big hurdle

INDEX

Sign language choir puts music in motion

Samuell High group hopes to end first year with Ballpark show

By SCOTT PARKS

See CHOIR Page 7A

Figure 9: A national newspaper: Some large newspapers may look regional, but are in fact national in scope. As seen here, science does occasionally reach the headlines. Courtesy of the Dallas Morning News.

"...research suggests that those who cover science frequently lack any but the most cursory backgrounds in the science and mathematics".

This is naturally an over-generalisation, with science journalists being the most notable exception, but, to a first approximation, very few journalists do have a science background. According to Weigold (2001) and sources quoted therein fewer than 1% of US journalists are science journalists. If you target journalists with products at the level aimed at the general public you are not making a mistake.

6. PRODUCT TYPES

Communicators use a number of different methods, communication products, vehicles and physical or virtual services for different occasions and/or different target groups, here for simplicity collectively called "products". A large education and public outreach office will presumably have all, or nearly all, of these products in its communication portfolio and thereby reach a wide and diverse selection of target groups. Smaller offices normally choose to target more narrowly and focus on the most important products, such as press releases. Because of its primary role as content provider, products from an EPO office will typically be more focused on content delivery than on being a "polished" ready-to-use product for the end-user.

Some examples of products produced in a communication office:

- **Press releases**: Containing texts and images. Usually distributed in electronic form, but the images can also be distributed as glossy prints to decision-makers and to selected editorial offices (judged to be drowning in electronic news bulletins). See chapter 8.
- **Images**: A very important product. See chapter 10.
- **Video News Releases** (VNRs): See section 15.2.
- **Popular brochures**: Usually not so digestible for the end-users, but immensely useful to mediators as background information. See chapter 9.
- **Technical brochures**: Includes annual reports, newsletters. These are usually of a technical nature aimed at the scientific or technical community.
- **Books**: Produced either in house or with the assistance of external writers and a proper publishing house. One can also regard books from other organisations that contain text or images from the EPO office as a kind of "derived product".
- **DVDs and CD-ROMs**: For "simple" use as a repository for images and information, or more advanced use with interactive content.
- **Webpages**: The main repository for texts, images and animations and a very important tool for distribution. See below.
- **Educational material:** Material used in either formal or informal education. Usually targeted at school-aged children and their teachers.
- **Exhibitions**: Exhibition stands at public venues, or at scientific venues. The latter mainly targets the community and decision-makers. The material often has a strong visual, and at times, interactive content.
- **Press conferences**: For instance as part of the press activities at scientific meetings. Read more in chapter 18.
- **Press packs**: Handed to journalists at a press conference. It is not customary to send this type of material out in advance under embargo as it means that journalists are less likely to attend. A press pack typically contains:
    - press release;

    - glossy prints;
    - background articles;
    - additional illustrations;
    - biographies etc;
    - contact information for the participating scientists.
- **Merchandise**: Pins, pens, stickers and the like. Mainly for branding purposes in a promotional context targeted towards decision-makers.
- **Posters**: Posters with beautiful scientific images and simple messages can be very inspirational, especially for the younger generation.
- **Public talks**: Direct dialogue between scientists and the public that can take place at public talks, open house events, "Circus of Physics"-type events or similar. These events can be very inspirational (see also section 2.5) and are usually arranged by scientists or the communication office. The scientist should be supported with visuals, information, template presentations, interactive gimmicks and ideas.
- **Exclusives**: A special product where a PIO can offer a story exclusively to one medium. Usually this is done with background or feature stories that do not fulfil enough of the news criteria to make a fully-fledged press release (see section 8.2).
- **Podcasts**: Podcasts allow a user to collect audio and video programs (sometimes known as vodcasts) from a variety of sources for listening or viewing offline at whatever time and place is convenient on an iPod or similar device. A number of scientific organisations use Podcasts as an interesting and valuable expansion to their product portfolio.

For some of the most important products some comments are added below.

6.1 PRESS RELEASES

Press releases have become a de facto *standard of our industry and various target groups expect to find press releases on the webpages of scientific organisations.*

Press releases (treated in more detail in chapter 8) are very important and can be produced and distributed without excessive investments of time and effort. Press releases have become a *de facto* standard of our industry and various target groups expect to find press releases on the webpages of scientific organisations. They establish a communication framework, a vehicle for a particular type of information, designed so that recipients understand the basic concept without too much additional description. Note that although the main target group for press releases is the press, press releases reach further. Press releases communicate important information to decision-makers, other mediators, scientists and even to the public.

6.2 VIDEO NEWS RELEASES

Video News Releases are treated in more detail below (section 15.2) and the significance of this product type will in all likelihood continue to grow. It is worth noting that as television has increased in popularity, the necessary production technology is now within reach of even small communication offices. I firmly believe that an investment in this area will be repaid many times over as the recipients of your communication products start being counted in millions instead of thousands.

6.3 BROCHURES

Different communication professionals have divided opinions about the production of "glossy" brochures. Some think they are a waste of time and money as they take quite some time to conceptualise, to write and to design. Others say that they are part of the "standard" portfolio of communication products for any organisation and that we cannot afford not to produce them.

I think part of the reason for the different opinions is that the product itself — the brochure — can be created in so many different ways. Some brochures tend to be very promotional in nature — the main purpose sometimes is PR or fundraising, rather than communication. Other brochures are very factual, perhaps even dry and will never be read by the target group they were originally intended for. My own opinion is that it *is* possible to produce excellent brochures by analysing the different target groups very carefully and striking a careful balance between promotion, facts and entertainment. There should be enough factual information for a teacher to teach from, or a science museum exhibition producer to start writing from, and the topic should be presented in such an attractive, visual way that even a layperson will feel the urge to browse through some of the figure captions.

For more remarks on the technical production of brochures, see chapter 9.

6.4 THE IMPORTANCE OF WEBPAGES

If it is not on the web it doesn't exist.

Although the web (short for the World Wide Web which is a part of the Internet) has come of age and many organisations have well-established sites that are now celebrating 10 years and more in existence, webpages are still a relatively new product type. The web has convinced even the most hardcore sceptics that it is *the* standard tool for distributing communication information. I would even dare to say: *"If it is not on the web it doesn't exist"*. This may not be quite true yet, but over the next years people will *exclusively* turn to the web in their search for texts, images, video clips and other PR products. And we, as communication professionals, had better get our act together and make sure that our communication material is made readily available on the web. Read more about how to make websites in chapter 14 and about using the web for archiving and distribution in section 13.3.

7. WRITTEN COMMUNICATION

7.1 WRITING FOR DIFFERENT AUDIENCES

Aim for the target group!

One of the most important messages in science communication is: Aim for the target group. And yes, in principle, different target groups should be "hit" with different products tailored specifically for the needs of that group, but in the real world resources are often sparse. For this reason, multiple layers of text, such as a summary, captions, main text and supporting addenda are recommended and make it possible to aim material at several target groups at once. Different consumers need material with differing levels of detail and terminology, but there is a balance between being too broad ("messy" and over-generalising) and too narrow (addressing too few). As an example, a well-written press release should be accessible and readable for the inexperienced journalist as well as look exciting enough to entice the battle-hardened "seen-it-all before" expert journalist. Supporting materials, factsheets, references, web links and all other background information play an important role when targeting different groups with the same product.

7.2 CORRECTNESS VS SIMPLIFICATION

There is always a built-in conflict between scientific correctness and the appeal and simplification necessary to obtain the public interest.

When communicating science, there is always a built-in conflict between scientific correctness and the appeal and simplification necessary to obtain the public interest — known as "sexiness" in the jargon. This is a point where the good science communicator will excel through good judgement and a broad overview of the field. How far can you take a given story without crossing the hype-threshold (see section 21.4) where credibility problems occur?

> **The "perfect world" ...**
> *The main objective of science communication is to describe the workings of nature truthfully.*
>
> **...vs. the "real world"**
> *But without the necessary appeal you may have very few readers and your efforts will be futile.*

Over-simplification can cause credibility problems and this is treated in detail for the case of press releases in chapter 20. The actual production workflow must be set up so as to address this point at the time of writing and as the iterative process moves towards a final conclusion. An independent text validation method can be a useful tool (see sections 2.2.2 and 4.5).

7.3 SPECIFIC ADVICE FOR SCIENCE WRITING

The following sections offer some direct advice that may make it easier to complete a written piece, be it a press release or an article for a glossy magazine. Some communicators find it easy to write good copy, *Setting boundary conditions is always one of the important starting points.*

Start by answering the six golden questions: What? When? Where? Who? Why? and How?

others dread the confrontation with those blank sheets of paper. This section has been inspired by the good advice to be found in Shortland & Gregory (1991), Laux (1985), Zinsser (1994), Wilson (1998), Hancock (2002) and Alley (1996).

7.3.1 Prepare properly

Setting boundary conditions is always one of the important starting points. Identify the specifications of the piece you are writing, such as:

- topic ;
- length;
- target group;
- style (often depends on the medium).

7.3.2 Do your research

Start by answering the six golden questions: What? When? Where? Who? Why? and How?

- Scan the current scientific literature on the topic.
- Review your own writing on the topic.
- Mine the web:
  - Scan popular writing on the topic, such as news items, articles, for instance via *Google News* search engine: http://news.google.com/ .
  - Use *Google*: http://www.google.com/ and, abstract services (such as, *Astrophysics Data Systems* (ADS) for astronomy and physics communicators: http://adsabs.harvard.edu/ads_abstracts.html) which has access to references to (nearly) all relevant literature and in many cases the full articles as PDF files (although some journals demand payment).
  - Use an online encyclopaedia like *Wikipedia* (http://en.wikipedia.org/wiki/Wikipedia).

There is no doubt that the web plays an ever more important role for science communicators in the research phase. Dumlao & Duke (2003) has made a clear and rigorous study of the use of the web and email as research tools among science writers. Their conclusions show that using web and email as tools for writing science stories will lead to a range of positive effects, notably an increase in productivity. Among the positive effects they note:

1. Faster responses to questions and quicker fact checking leads to a quicker turn around time when writing a story.
2. Time freed from tedious tasks (fact checking or looking for details in print) can be spent developing new stories.
3. Information from distant sources arrives more quickly, making international stories more feasible and also introduces new angles for local science stories.
4. Getting information and visuals quickly can help meet and beat deadlines.
5. Breaking science news can be accessed readily via the web and maybe email.

Not surprisingly they also find some negative effects, especially an increase in work stress. And on the negative side they conclude:

1. More competition on stories means the writer needs to stay ahead to get the scoop.
2. Less time to reflect on the meaning of stories is available, making it harder to develop carefully conceived interpretations.
3. Too many choices about possible stories can be overwhelming.
4. Increased likelihood of incomplete, false or misleading stories or story ideas (that may be widely distributed and believed by consumers).
5. More hours on the job may be needed to keep up with breaking science news posted via the web or email.

7.3.3 Structure your thinking

- Brainstorm the topic. Check if some of the elements are connected in patterns that may help you choose your angle.
- Decide on a possible angle/slant.
- Decide on the core message of your story. Try to answer: "*What is the main point of this story*?", in one line. This (oversimplified) sentence will most likely never appear in the final text, but it helps to focus on the bottom line of the story.
- Make a short, simple synopsis of the baseline of the story. Sketch out the article, think through the ideas to be presented, identify key concepts, split ideas into possible sections.
- Plan the lead sentence and the ending as early as possible.
- Think about possible images and illustrations early in the planning phase.
- Write sexy and spicy subheadings for each section. These subheadings will help you and the reader to see the overview and focus.

7.3.4 Relax

In his excellent book *On Writing Well* (Zinsser, 1994) Zinsser advises that a writer should *relax* and not be too concerned about the needs of the reader in order to sound genuine. But, as Zinsser writes:

> *"Telling a writer to relax is like telling a man to relax while being prodded for a possible hernia, and as for confidence, see how stiffly he sits, glaring at the screen that awaits his words. See how often he gets up to look for something to eat. A writer will do anything to avoid the act of writing. I can testify from my newspaper days that the number of trips to the water cooler per reporter-hour far exceeds the body's need for fluids."*

"Telling a writer to relax is like telling a man to relax while being prodded for a possible hernia."

7.3.5 Be consistent

Follow some consistent writing guideline, either of your own choice or imposed by the system (for instance via your organisation's style guide):

- spelling;
- grammar;
- hyphenation;
- punctuation;
- abbreviations;
- choice of pronoun (first person, second person etc);
- capitalisation etc.

Work within this framework to develop a distinctive personal style, too much adherence to the rules results in a stilted text, and some individuality will add pace and interest to the material. See Cappan (2000) and Kalbfeld (2001) for overviews of the *Associated Press*'s style guide.

7.3.6 Simplify

A fundamental rule of written science communication is to make texts as simple as possible. This advice must not be neglected. Although one or two extra words or paragraphs may seem irrelevant on the computer screen, out in the real world there is a great difference. Nowadays people simply do not have time for lengthy explanations. Get to the point, but make additional material available for the very interested reader (see also section 7.1). Remember too, "*each equation halves the audience*".

Some specific advice:

- Be clear, concise, precise: *"Use language, not abuse it"* (Laux, 1985).
- Use short sentences to render a complex topic intelligible.
- Use simple language.
- Do not use jargon.
- Avoid clichés.
- Make a given text as brief as possible.
- Do not give in to self-indulgence ("*kill your darlings*").
- Hold back on the scientific caveats (although scientists will try hard to have them included in the text).

7.3.7 Explain

It is always necessary to match the writing to the level of the target group, but never more so than in science writing. Remember that "*the reader knows nothing*". Always spell out abbreviations. Build up your explanations from the lowest level, but try not to patronize, and avoid being overly didactic. In the best communication the educational aspects go unnoticed. Tie the science into an entertaining and relevant context and slowly introduce the key concepts you need in order to explain the result. To quote NASW (2003):

"Of the many kinds of specialized writers, the science writer has a unique responsibility to the reader. Unlike the sportswriter, for example, whose reader already knows, often in extraordinary detail, the rules of the game and who the players are, science writers must often introduce readers to a new 'game' with every article. Imagine if a sportswriter had to assume readers had no knowledge of football every time he or she had to write about the latest NFL game."

One can not stress enough the need for images, comparisons, analogies and metaphors to communicate abstract and complex concepts. It is vital to create an image in the reader's mind as this is how we best store the information.

7.3.8 Edit

Depending on the product and the target group, the workflow varies tremendously, but some advice on the final stages of text production may help. Good advice on editing your own and the texts of others may be found in Alley (2000).

- When writing it is often much easier to finish the first rough draft in one go, since the writing process needs all the researched material to be vividly present in your mind. As time passes it is difficult to go back if the first draft is not complete.
- Having written the first rough draft it is often useful to put it away for a day or two (deadline permitting) and then review and edit the material with fresh eyes.
- Rewrite the material once more.
- Once the draft is in shape, pass it on to the scientist or expert with whom you are working. If you are not yet working with an expert, now is the time to find one. Remember, the text is nowhere near finished at this stage. The scientist may not be totally happy with the style and perhaps your approach, probably regarding the result as an oversimplification. The struggle to find the delicate balance between correctness and simplicity has begun. The scientist is right. The text will be too simple, but (unfortunately) it needs to be, to be accessible and readable enough to reach a wide audience (also see section 7.2).
- When you feel the text is ready, pass it on to another person, maybe a colleague or a "real" editor, as a "sparring partner". A real editor will see possible shortfalls and clumsy language in your text and really make it "fly". This naturally applies even more to those who write in a language that is not their mother tongue. It is important to remember that a given story can be written in a thousand different ways (Principle of a Thousand Ways). Maybe the one you chose is the best for parts of the audience, maybe the editor's preferences are better for another or a larger part of the audience? No one will ever know for sure, but it is very important to be open to suggested corrections and changes. Remember that we are not able to look at a text we

"Thou shalt hold nothing thou hast written as sacred".

have written ourselves objectively. Detach yourself from your own writing, as Laux (1985) writes: "*Thou shalt hold nothing thou hast written as sacred*". Do not assume too much ownership of your text. Be proud, but not possessive. No editor is always correct, but it is often better to go with his/her suggestions. Value the opinion of others highly, except in cases where you have a clear feeling that changes are simply being made for the sake of changing the text.

- In the end a professional proof reader should go through the text and make sure everything is consistent. Remember that you become "blind" after a while and will have difficulty in detecting even some obvious mistakes.

7.3.9 Modern aids

In modern word processing software there are a number of useful features that make life easier for authors. Here are some examples from *Microsoft Word*:

- **Spellchecker**: marks misspelled words in red. Corrections are offered by right-clicking on top of the misspelled words.
- **Thesaurus**: The thesaurus offers/presents/displays synonyms. This can often make a text more lively/energetic/vigorous/sparkling/dynamic.
- **Grammar check**: useful for "non-mother-tongue authors".
- **Track changes**: For collaborations with colleagues and editors, the track changes tool is to be recommended. It reduces the number of rewrites necessary as disagreements and misunderstandings can be detected immediately after the edit has been made. The track changes tool has not been turned on, a simple "compare" will do the same job and show the changes.

7.4 TIM RADFORD'S 25 TIPS FOR THE SIMPLE SCRIBE

Tim Radford, retired science writer for the *Guardian*, shares some advice here on how to write well, collected through his 13 years as science editor of the *Guardian*.

1. When you sit down to write, there is only one important person in your life. This is someone you will never meet, called a reader.
2. You are not writing to impress the scientist you have just interviewed, nor the professor who got you through your degree, nor the editor who foolishly turned you down, or the rather dishy person you just met at a party and told you were a writer. Or even your mother. You are writing to impress someone hanging from a strap in the tube between Parson's Green and Putney[10], who will stop reading in a fifth of a second, given a chance. Remember that the story next to your science story about genetic modifications of mice in the newspaper will be about a famous footballer, two disgraceful ladies and three lines of white powder.

10 Two London Underground stations on the outer reaches of the District line, typical commuter territory.

3. So the first sentence you write will be the most important sentence in your life, and so will the second, and the third. This is because, although you — an employee, an apostle or an apologist — may feel obliged to write, nobody has ever felt obliged to read. A story is something you can tell in one line but will make people ask more and more and more.
4. Journalism is important. It must never, however, be full of its own self-importance. Nothing sends a reader scurrying to the crossword, or the racing column, faster than pomposity. Therefore simple words, clear ideas and short sentences are vital in all story-telling. So is a sense of irreverence.
5. Here is a thing to carve in pokerwork and hang over your typewriter. *"No-one will ever complain because you have made something too easy to understand."* The words "Who, what, where, how, why and when?" are the only tools we need for our research.
6. And here is another thing to remember every time you sit down at the keyboard: a little sign that says *"Nobody has to read this crap"*.
7. If in doubt, assume the reader knows nothing. However, never make the mistake of assuming that the reader is stupid. The classic error in journalism is to over-estimate what the reader knows and under-estimate the reader's intelligence.
8. Life is complicated, but journalism cannot be complicated. It is precisely because issues — medicine, politics, accountancy, the rules of Mornington Crescent[11] — are complicated that readers turn to the *Guardian*, or the *BBC*, or the *Lancet*, or my old papers *Fish Selling* and *Self Service Times*[12], expecting to have them made simple.
9. So if an issue is tangled like a plate of spaghetti, then regard your story as just one strand of spaghetti, carefully drawn from the whole. Ideally with the oil, garlic and tomato sauce adhering to it. The reader will be grateful for being given the simple part, not the complicated whole. That is because a) the reader knows life is complicated, but is grateful to have at least one strand explained clearly, and b) because nobody ever reads stories that say: *"What follows is inexplicably complicated..."*
10. So here is a rule. A story will only ever say one big thing. If (for example, and you are feeling very brave) you have to deal with four strands of a tale, make the intertwining of those four strands the one big thing you have to say. You may put twiddly bits into your story, but only if you can do so without departing from the one linear narrative you have chosen.
11. Here is an observation. Don't even start writing till you have decided what the one big thing is going to be, and then say it to yourself in just one sentence. Then ask yourself whether you could imagine your mother listening to this sentence for longer than a microsecond before she reaches for the ironing. Should

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11 A radio panel game involving the stations of the London Underground, the rules of which, in all their fine complexity, are transparently clear to the players and elusive to the rest of us. Interested readers are referred to the BBC webpage, but are warned that it is curiously addictive: http://www.bbc.co.uk/dna/mbradio4/F2766775

12 Two splendid examples of British journals.

you try to sell an editor an idea for an article, you will get about the same level of attention, so pay attention to this sentence. It is often — not always, but often — the first sentence of your article anyway.

12. There is always an ideal first sentence — an intro, a way in — for any article. It really helps to think of this one before you start writing, because you will discover that the subsequent sentences write themselves, very quickly. This is not evidence that you are glib, facile, shallow or slick. Or even gifted. It merely means you hit the right first sentence.
13. Words like shallow, facile, glib and slick are not insults to a journalist. The whole point of paying for a newspaper is that you want information that slides down easily and quickly, without footnotes, obscure references and footnotes to footnotes.
14. Words like "sensational" and "trivial" are not insults to a journalist. You read what you read — Elizabethan plays, Russian novels, French comic strips, American thrillers — because something in them appeals to your sense of excitement, humour, romance or irony. Good journalism should give you the sensation of humour, excitement, poignancy or piquancy. Trivial is a favourite insult administered by scholars. But even they became interested in their subject in the first place because they were attracted by something gleaming, flashy and — yes, trivial.
15. Words have meanings. Respect those meanings. Get radical and look them up in the dictionary, find out where they have been. Then use them properly. Don't flaunt authority by flouting your ignorance. Don't whatever you do go down a hard road to hoe, without asking yourself how you would hoe a road. Or for that matter, a roe[13].
16. Clichés are, in the newspaper classic instruction, to be avoided like the plague. Except when they are the right cliché. You'd be surprised how useful a cliché can be, used judiciously. This is because the thing about journalism is that you don't have to be ever so clever but you do have to be ever so quick.
17. Metaphors are great. Just don't choose loopy metaphors, and never, never mix them. Subs on the Guardian used to have a special Muzzled Piranha Award, a kind of Oscar of incompetence, handed to an industrial relations reporter who warned the world that the TUC wildcats[14] were lurking in the undergrowth, ready to dart out like piranhas, unless they were muzzled. George Orwell reports on the case of an MP who claimed that the jackbooted fascist octopus had sung its swansong[15].
18. Beware of street credibility. When Moses ordered his commanders to slay the Midianites he wasn't doing it to show that he was well hard. When he warned Pharaoh to let his people go he wasn't saying *"and then I go, give us room to breathe, man, and Pharaoh's like no way feller"*. The language of the pub or

13 The proper phrase is a hard row to hoe, referring to agriculture specifically, but to any difficult task in particular.

14 TUC: Trades Union Congress, the British labour organisation.

15 Non native speakers of English who fear their command of the language is slipping should not worry. These sentences do not make sense and are examples and Awful Warnings as to how to misuse and mix metaphors.

the café has its own rhythms, its own body language, its own signalling devices. The language of the page has no accent, no helpful signalling tone of irony or comedy or self-mockery. It must be straight, clear and vivid. And to be straight and vivid, it must follow the received grammar.

19. Beware of long and preposterous words. Beware of jargon. If you are a science writer this is doubly important. If you are a science writer, you occasionally have to bandy words that no ordinary human ever uses, like phenotype, mitochondrion, cosmic inflation, gaussian distribution and isostasy. So you really don't want to be effulgent or felicitous as well. You could just try being bright and happy.
20. English is better than Latin. You don't exterminate, you kill. You don't salivate, you drool. You don't conflagrate, you burn. Moses did not say to Pharaoh: *"The consequence of non-release of one particular subject ethnic population could result ultimately in some kind of algal manifestation in the main river basin, with unforeseen outcomes for flora and fauna, not excluding consumer services".* He said: "*the waters which are in the river... shall be turned to blood, and the fish that is in the river shall die, and the river shall stink*".
21. Remember that people will always respond to something close to them. Concerned citizens of South London should care more about economic reform in Surinam than about Millwall's fate on Saturday[16], but mostly they don't. Accept it. On November 24, 1963, the Hull Daily Mail sent me in search of a Hull angle on the assassination of President Kennedy. Once I had found a line that began: *"Hull citizens were in mourning today as...",* we could get on with reporting that happened in Dallas.
22. Read. Read lots of different things. Read the King James Bible, and Dickens, and poems by Shelley, and Marvel Comics and thrillers by Chester Himes and Dashiel Hammett. Look at the astonishing things you can do with words. Note the way they can conjure up whole worlds in the space of half a page.
23. Beware of all definitives. The last horse trough in Surrey will turn out not even to be the last horse trough in Godalming[17]. There will almost always be someone who turns out to be bigger, faster, older, earlier, richer or more nauseating than the candidate to whom you have just awarded a superlative. Save yourself the bother: *"One of the first..."* will usually save the moment. If not, then at least qualify it: *"According to the Guinness Book of Records....", "The Sunday Times Rich List..."* and so on.
24. There are things that good taste and the law will simply not let you say in print. My current favourites are *"Murderer acquitted"* and (in a report of an Easter religious play) *"Paul Myers, who played Jesus Christ, emerged as the star of the show".* Try and work out which one has the taste problem, which one will cost you approximately half a million per word.

16 A south London football club, known for its partisan fans. British league football matches are traditionally played on a Saturday afternoon.

17 A small town in Surrey.

25. Writers have a responsibility, not just in law. So aim for the truth. If that's elusive, and it often is, at least aim for fairness, the awareness that there is always another side to the story. Beware of all claims to objectivity. This one is the dodgiest of all. You may report that the *Royal Society* says that genetic modification is a good thing, and that depleted uranium is mostly harmless. But you should remember that genetic modification was invented by people who were immediately elected to the Royal Society for their cleverness, by people already in there because they knew how to enrich uranium fuel rods and deplete the rest. So to paraphrase Miss Mandy Rice-Davies (1963)[18]: "*They would say that, wouldn't they?*"

7.5 SPECIAL CASE: INTERVIEWS

The interview is a special situation. It can be a way for the science writer to introduce a personal angle, and possibly add a surprising and refreshing angle to the story. Read more about interviews in Zinsser (1994) and Kalbfeld (2001).

- Be prepared:
    - Read about the topic in general and especially the interviewee's work.
    - Make a list of questions to ask in case you need to guide the flow of the interview.
    - Bring pencils and notepad.
- Make the interviewee relax. Don't pull out your notepad or recorder right away. In many cases the interviewee will open up

Figure 10: *Scientist Wolfram Freudling (ESO/ST-ECF) in an interview situation.*

18 Mandy Rice Davies was one of the girls involved in the 1963 Profumo affair http://en.wikipedia.org/wiki/Profumo_Affair, who gave her famous response "*Well, he would, wouldn't he?*" when told in court that her former lover Viscount Astor had denied their affair or even knowing her. It has become a catch phrase denoting that the vested or self interest in a particular matter is so strong that any statement by the interested party can't be relied on.

more if the situation is relaxed and the conversation as casual as possible.

- Be polite because you or your institution may have to rely on the same person in the future.
- Use a recorder (MP3 recorder, DAT, MiniDisk, tape...) as a support to your notes, if a) it is really necessary, b) it suits your work style and c) your subject is comfortable with it. Keep it somewhere discreet, and do not let the machine disturb you or your victim. Remember that machines occasionally fail.
- Do not hesitate to stray from your plan and your questions if the conversation flows. Concentrate on the situation and what is said instead of your list.
- People like being interviewed, especially if the interview is published in an interesting publication. Use this to get access to material and people you need.
- Treat the interviewee fairly in your selection of quotes.
- If necessary correct incorrect language in the quotes to make meaningful sentences. It may be a good idea to check the quotes with the interviewee before publication, especially if the topic is new to you.

8. PRESS RELEASES

A press release is one of the main vehicles used by a communication office to inform the world about scientific advances. Naturally the results themselves should make a press release. No "hot air" releases, please. Each institution has its own criteria for communicating a scientific result to a wider audience (most probably defined via the content of the communication department's mission statement, see section 3.1). Typically, either the institution scientists or a project managed by the institution is involved.

A close collaboration with the scientist (sometimes called the Principal Investigator) is vital for the practical work. He or she can help by either supplying a short text describing their result in simple terms or by explaining the situation over the phone.

8.1 ALPHAGALILEO'S PRESS RELEASE PRIMER

The news release portal *AlphaGalileo* has published this excellent overview[19] on how to write press releases.

What is a press release?

A press release is a précis of a news item designed to communicate the essence of a story, making it obvious that it is news. Every item, no matter how short, should answer the six golden questions: What? When? Where? Who? Why? and How? Try to make your press release simple, with one key message. Start with the most important point. Press releases are not aimed at scientists and therefore clarity should prevail over absolute scientific rigour.

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Is it news?

News is topical. Since science is by nature a slow process, news in science and technology is often linked to publication of research in a peer-reviewed journal, a conference in which research results are presented, or to an event such as the award of a patent. A research result is news when it has never been done before and when it contributes to the progress of knowledge or the development of technology.

Title

Include a simple heading that describes exactly what the news is, but is not necessarily a headline. Journalists browse hundreds of press releases so your title must be catchy to draw their attention.

The first paragraph

Make sure the first paragraph contains the main points and explains why this is relevant to the public. This may be your only opportunity to get the journalist's attention.

The first paragraph should answer ALL of the six golden questions:

- Who? = who did the research;

19 http://www.alphagalileo.org/index.cfm?fuseaction=ShowPage&pageid=14

- What? = what is the main point;
- Where? = location of the research organisation or event;
- Why? = why is it news?
- When? = time of the research publication or event;
- How? = how the research was done.

Main text

The main text should be written in a short, concise style using the active voice, avoiding acronyms and scientific jargon. Uncommon terms will require a quick explanation of what they mean. Each sentence should contain one concept.

Write your main text as newspaper stories are written, as an inverted pyramid. This means that the most important information must go at the beginning, then the less important details, in descending order of importance. Make it obvious why it is news so the journalist can see at a glance why this release contains information of interest to his/her readers.

Embargo

An embargo prevents publication of material before the date specified. Embargoes of research material allow journalists to undertake background research before publication. They are intended to help informed debate whilst retaining the intellectual right of prior publication. Embargoes are therefore fundamental to publishing scientific results.

Timing

The time you post your release depends on the media you wish to target. Hence, you need to be aware of the needs of radio, TV, dailies, weekly and monthly magazines before choosing the date and time. For example, posting on Monday morning is likely to reach more journalists than posting on Friday evening.

Contacts

Nothing is more irritating for a journalist than being given contact names of people who are unavailable. It is good practice to check that your contacts are available to answer telephone calls and emails, but also to ensure that these contacts are appropriate. Usually these contacts are the researchers who did the work, who also have the authority to be quoted on it. When listing telephone numbers for contacts, please include the international country code as journalists may not be in the same country.

Notes for Editors

The Notes for Editors section should contain background information about your organisation and/or researchers or details which further explain the story. You can also use the Notes for Editors section to add links to your organisation's website or images accompanying your release.

Peer-reviewed publication and references

If your research is to be published in a peer-reviewed journal, you should include the full citation/reference. Check that your embargo matches that of the journal to avoid breaking their embargo or publishing after the information is in the public domain.

Reference URL

The reference URL should be an exact link to a page about the research, or to your organisation's home page.

Proof-reading

When you've written your press release and have proofread it, take a break before you look at it again. Remove all unnecessary words or phrases and check that you have answered all of the golden questions: Who? What? Where? Why? When? and How?

Checklist

- ☐ Keep it short and simple.
- ☐ Include a short, simple heading, not a headline.
- ☐ Answer all six golden questions in the first paragraph: Who? What? Where? Why? When? and How?
- ☐ Choose your angle carefully.
- ☐ Use direct quotes where possible.
- ☐ Keep the text concise and interesting, but provide all complementary details in the Notes for Editors section.
- ☐ Include the date and time of release, and the name, address and telephone number — including international country code — of your contact(s).
- ☐ Time your release publication for maximum impact.

8.2 NEWS CRITERIA

Before making a press release there are a number of considerations to be weighed carefully. It is of vital importance for the survival and the success of a communication office to issue the right type and number of press releases with the right quality. The relationship with the media relies on the "quality" of the releases. It takes years to build up a good reputation and issuing a few inferior releases can damage the relationship beyond repair. Journalists on the distribution lists must know the product and that they can rely on your office to provide them with what *they* need — on time and of the highest quality.

It is of vital importance for the survival and the success of a communication office to issue the right type and number of press releases with the right quality.

Maran et al. (2003) has an extremely important point:

> *"Offer stories that reporters want to cover; not just stories that organizations, agencies, and institutions want to publicize."*

Some of the factors that make a story hit the headlines are outlined below. If one or more of these criteria of newsworthiness are satisfied, the chances are that you have a "good story" on your hands. Most of these criteria would also apply to fields outside science (perhaps slightly modified). Treise and Weigold (2002) quote (Friedman, 1986):

> *"Editors and reporters tend to value stories that contain drama, human interest, relevance, or application to the reader, criteria that don't always map easily onto scientific importance."*

1. **Timing**: The story is "news" (the event has just taken place).
2. **Relevance**: An issue that has direct or near-direct influence on people's lives such as fatalities and material damage.
3. **Proximity**: The story has local appeal or local interest (happened in the town or the country).
4. **Implications**: A result that has profound consequences.
5. **Conflict**: Settles a controversial debate or a much-debated topic that contains intrigues.
6. **Human interest**: For instance: "*Astronomer discovers new galaxies while raising three children and teaching women's self-defence in her spare time*".
7. **Mystery:** A mysterious phenomenon, quirky details, an unexpected result or a chance discovery.
8. **Major discovery:** Represents a major discovery of a new phenomenon or class of object. Or an incremental gain in knowledge about a principal field of research.
9. **New interesting angle**: Twisting an old result in a new way, such as a new, better image that confirms a known result.
10. **A record**: First, largest, most distant, fastest, oldest ....
11. **A sexy topic:** Some topics almost always capture the attention of the public (despite not necessarily being great science) and therefore have a fast track to the headlines. Some examples from astronomy are: Solar System topics, space weather, black holes, extrasolar planets, extraterrestrial life, the future of the Earth and Sun and human spaceflight.
12. **Aesthetics**: For example, an exceptionally beautiful image.
13. **Publication in a distinguished journal**: Results published in, for example, *Nature* or *Science* tend to get more interest from journalists.
14. **Crosslinking**: Letting a result piggyback on another news story in a related, parallel or remotely related field.

Remember the following about the news process, in the words of Maran (2000):

> *"Breaking news is rarely reported in terms of the incremental advances that constitute most scientific results. Science journalists find that to meet the requirements of the 'gatekeepers' of their publications and networks, discoveries must usually be reported as isolated events or quantum leaps, rather than as steps on a long ladder to better understanding."*

Read more about news criteria in News Judgement (Anon., 1985), Funsten (2004) and Space Telescope Science Institute (2005).

8.3 TRACKING DOWN THE GOOD STORY

When a scientific result has been published, either in the scientific journals or in the media, it becomes "old news", so it is the job of the science communicator to find communicable results as early as possible. Here are some possible ways:

- Personal contact with scientists: make your office and your services known to the community. Build up relationships with scientists (Finley 2002).
- Post guidelines for the scientists explaining what they should do if they have potentially newsworthy science stories. See Space Telescope Science Institute (2005) and Spitzer Science Center (2005) for examples.
- Read electronic preprints: (for example the preprint archive at *Los Alamos National Laboratory*[20]).
- Read electronically published journal articles on for example the websites of *Nature* magazine, *Science* magazine etc.
- Browse *Nature*'s press embargo site.
- Browse *Science*'s press site.

One critical issue is naturally timing — when to make a press release out of a given newsworthy result (as defined by the criteria above). This topic is dealt with in more detail in the chapter about Credibility (see section 21.4.3). One particular part of this is attention to time zones. Due to the time difference, European and US press conferences or public releases of press releases will have difficulties in getting coverage outside the local time zones most of the time. Early morning releases may give the best chance for a good resonance with media in other time zones.

8.4 ROBERT ROY BRITT'S SEVEN "C"S OF SUCCESSFUL COMMUNICATION

As should be clear by now, we should listen carefully to the needs of our customers. In the case of press releases, our customers are obviously journalists. Here is what Robert Roy Britt, Senior Science Writer with *SPACE.com*, has to say on how to best exploit the media: His seven "c"s of successful communication.

20 http://xxx.lanl.gov/

8.4.1 The seven "c"s of successful communication

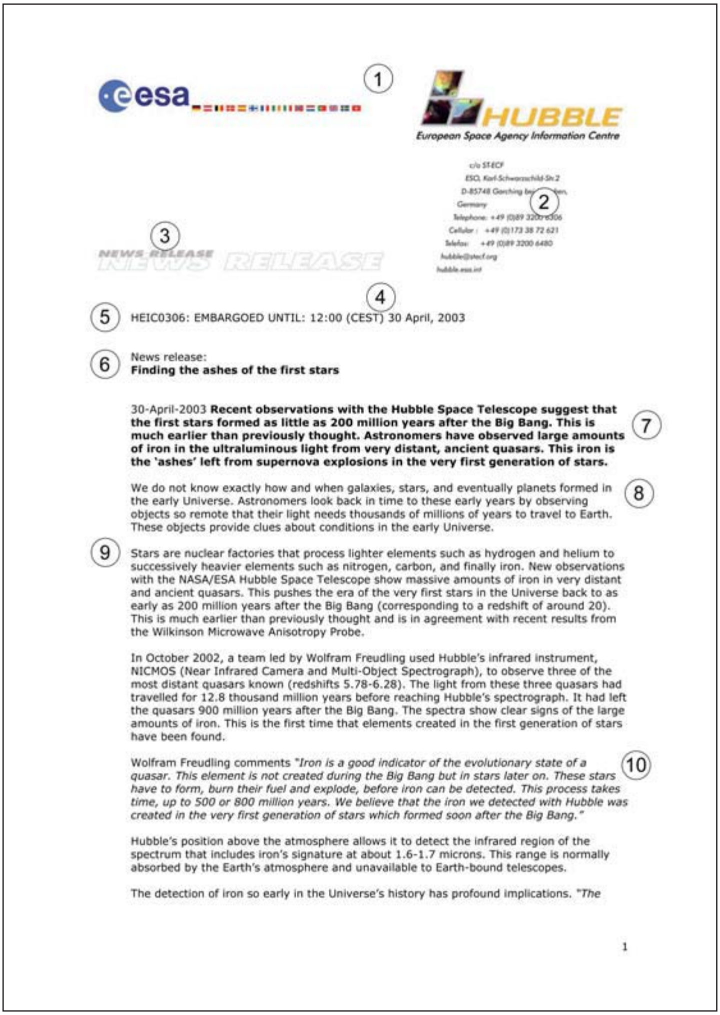
Communication success requires continual revisiting of the basics and a vigilant effort to focus on the gems, hidden or obvious. So be:

1. Correct:
    - Be accurate, sure, but ...
    - Don't add weight to the findings.
2. Clear:
    - This is journalism, not the *New Yorker*.
    - Find an honest critic.
3. Concise:
    - Don't make me wonder, don't make me wait.
    - 3-30-300 rule: 3 seconds, 30 words to tell finding, 300 words total.
4. Comprehensive:
    - The rest of the story ... or ... your other 300 words.
    - Q&A.
    - Backgrounder.
5. Compelling:
    - Good writing is important, but ...
    - Photos — do you know my format?
    - Animations — gifs are great.
    - Graphic explainers rule the Universe ...
    - ... broadband does not.
6. Concrete:
    - Compelling story does not need a writer's embellishments.
    - Give examples grounded in real life.
    - Watch the adjectives.
7. Concentrated:
    - Know what sells (black holes do, gamma ray bursts don't).
    - Put some science behind your communication — watch those clips.
    - Know your audience and your distribution channels.
    - Your job is outreach. So reach out. Call us.

8.5 THE ANATOMY OF A PRESS RELEASE

In this section an example of a press release is dissected and some of the most important elements are identified.

1. **Letterhead:** Logos give credibility credits.
2. **Address**: Don't forget the official address.
3. **Release type**: Indicate clearly what type of release it is — some are "news releases" (science discoveries) and others "photo releases" (pretty pictures, no big discovery).
4. **Date**: Indicate when the release goes out, either with the words "Immediately" or the embargo date.
5. **Release number**: It is convenient for journalists to have a release number to refer to.
6. **Headline**: The headline should use active verbs, be short, precise and sexy.



HEIC0306: EMBARGOED UNTIL: 12:00 (CEST) 30 April, 2003

News release:
Finding the ashes of the first stars

30-April-2003 **Recent observations with the Hubble Space Telescope suggest that the first stars formed as little as 200 million years after the Big Bang. This is much earlier than previously thought. Astronomers have observed large amounts of iron in the ultraluminous light from very distant, ancient quasars. This iron is the 'ashes' left from supernova explosions in the very first generation of stars.**

We do not know exactly how and when galaxies, stars, and eventually planets formed in the early Universe. Astronomers look back in time to these early years by observing objects so remote that their light needs thousands of millions of years to travel to Earth. These objects provide clues about conditions in the early Universe.

Stars are nuclear factories that process lighter elements such as hydrogen and helium to successively heavier elements such as nitrogen, carbon, and finally iron. New observations with the NASA/ESA Hubble Space Telescope show massive amounts of iron in very distant and ancient quasars. This pushes the era of the very first stars in the Universe back to as early as 200 million years after the Big Bang (corresponding to a redshift of around 20). This is much earlier than previously thought and is in agreement with recent results from the Wilkinson Microwave Anisotropy Probe.

In October 2002, a team led by Wolfram Freudling used Hubble's infrared instrument, NICMOS (Near Infrared Camera and Multi-Object Spectrograph), to observe three of the most distant quasars known (redshifts 5.78-6.28). The light from these three quasars had travelled for 12.8 thousand million years before reaching Hubble's spectrograph. It had left the quasars 900 million years after the Big Bang. The spectra show clear signs of the large amounts of iron. This is the first time that elements created in the first generation of stars have been found.

Wolfram Freudling comments *"Iron is a good indicator of the evolutionary state of a quasar. This element is not created during the Big Bang but in stars later on. These stars have to form, burn their fuel and explode, before iron can be detected. This process takes time, up to 500 or 800 million years. We believe that the iron we detected with Hubble was created in the very first generation of stars which formed soon after the Big Bang."*

Hubble's position above the atmosphere allows it to detect the infrared region of the spectrum that includes iron's signature at about 1.6-1.7 microns. This range is normally absorbed by the Earth's atmosphere and unavailable to Earth-bound telescopes.

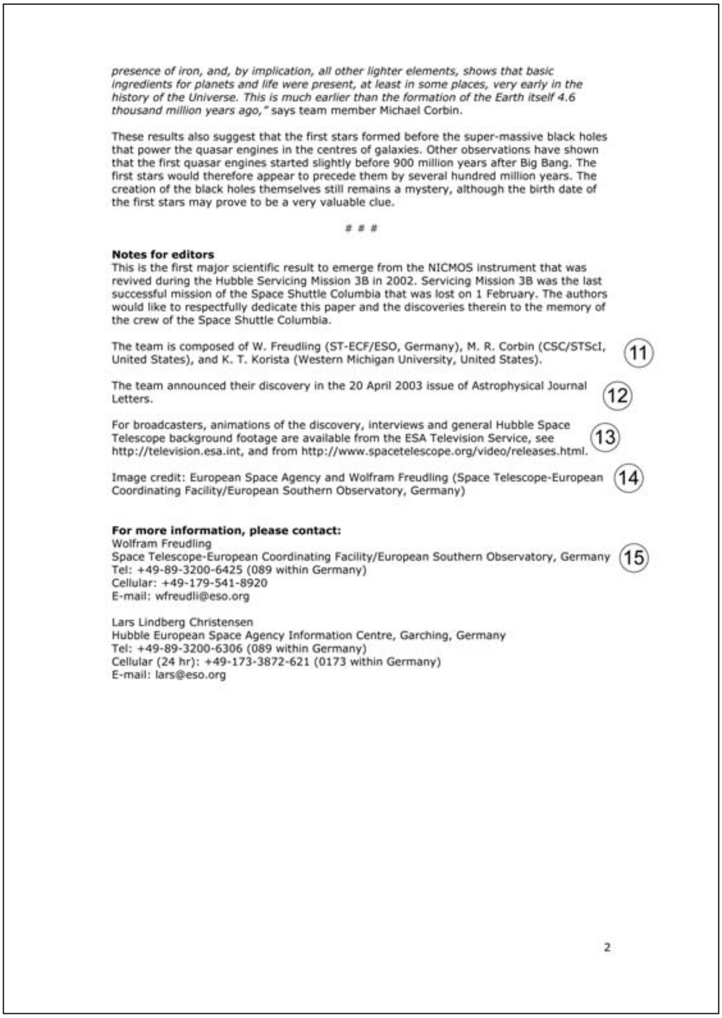
The detection of iron so early in the Universe's history has profound implications. *"The*

1

Figure 11: *A sample press release page 1. For numbering see text.*

7. **First paragraph**: The lead. Should summarise the entire result in one or two sentences: Who? What? Where? Why? When?
8. **Main text**: Maximum 3-600 words. The shorter, the better (remember KISS: Keep It Simple Stupid!). With short paragraphs: 5 lines or shorter. Minimise the use of acronyms. Use subheadings if the release is long (see section 7.3.3). Introduce the reader to the science gradually while telling the story.
9. **Analogies**: Use them!
10. **Quotes**: Get informative, exciting and personal quotes from the scientist involved. They should explain how this result fits into the larger picture.
11. **Acknowledgements**: It is fair to give credit to the entire team.
12. **Scientific paper**: Indicate where the result has been published, or even add a link to the original paper.
13. **Additional material**: Animations etc should be marked clearly.

Figure 12: *A sample press release, page 2. For numbering see text.*



presence of iron, and, by implication, all other lighter elements, shows that basic ingredients for planets and life were present, at least in some places, very early in the history of the Universe. This is much earlier than the formation of the Earth itself 4.6 thousand million years ago," says team member Michael Corbin.

These results also suggest that the first stars formed before the super-massive black holes that power the quasar engines in the centres of galaxies. Other observations have shown that the first quasar engines started slightly before 900 million years after Big Bang. The first stars would therefore appear to precede them by several hundred million years. The creation of the black holes themselves still remains a mystery, although the birth date of the first stars may prove to be a very valuable clue.

# # #

Notes for editors
This is the first major scientific result to emerge from the NICMOS instrument that was revived during the Hubble Servicing Mission 3B in 2002. Servicing Mission 3B was the last successful mission of the Space Shuttle Columbia that was lost on 1 February. The authors would like to respectfully dedicate this paper and the discoveries therein to the memory of the crew of the Space Shuttle Columbia.

The team is composed of W. Freudling (ST-ECF/ESO, Germany), M. R. Corbin (CSC/STScI, United States), and K. T. Korista (Western Michigan University, United States). (11)

The team announced their discovery in the 20 April 2003 issue of Astrophysical Journal Letters. (12)

For broadcasters, animations of the discovery, interviews and general Hubble Space Telescope background footage are available from the ESA Television Service, see http://television.esa.int, and from http://www.spacetelescope.org/video/releases.html. (13)

Image credit: European Space Agency and Wolfram Freudling (Space Telescope-European Coordinating Facility/European Southern Observatory, Germany) (14)

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Tel: +49-89-3200-6306 (089 within Germany)
Cellular (24 hr): +49-173-3872-621 (0173 within Germany)
E-mail: lars@eso.org

2

14. **Image credit**: As this point often is difficult for the media to get right, make sure it is clearly marked in both the image caption and in the release.
15. **Contacts**: Of vital information to the information hungry journalist. It is also standard for journalists to get a personal quote from the scientist involved. Some put this in the header, some at the bottom.

The practical steps in the production of a press release are described in more detail in the checklist shown in table 6, p. 32.

It can often be of great assistance to the journalist if additional material is provided, for instance:

- the original scientific paper;

- factsheets with in-depth explanation of central topics;
- additional illustrations;
- links to the scientist's own value-added website;
- biographies;
- links to further information (for instance from the web).

8.6 EMBARGOED RELEASES

A press release needs to be issued to journalists a few days (at least) in advance of publication, in order:

a. To give journalists some lead time to do research and work on their story.
b. To ensure that the electronic media do not have a substantial advantage over the printed media due to their shorter lead time.
c. To avoid putting your office in direct competition with the media when you publish a press release on your website.

A press release needs to be issued to journalists a few days (at least) in advance of publication.

This is done via a so-called embargoed press release where the press release is released to a controlled group of journalists "under embargo" until a certain date. If journalists do not respect the embargo they should be excluded from further distribution (out of courtesy to other hardworking journalists) and should be "blacklisted" among your colleagues as well. Note that embargo times tend to favour the media in your own time zone or area of the world.

Special attention must be given to the restrictive embargo policy of the journals *Nature* and *Science*. In general their stories can only be distributed via wire services etc 24 hours ahead of the expiration of the embargo. It is a matter of definition whether an education and public outreach office embargo distribution list belongs to the "wire service" category.

The *American Astronomical Society* also maintains an embargo, "journalists-only" strand in their emailing list (Maran, 2000).

8.7 AN EXAMPLE PRESS RELEASE PRODUCTION TIMELINE

Often the production of press releases is tied to the date of the publication of a scientific paper, a conference talk, a press conference or similar. In addition elaborate internal and external approval procedures may exist (also see section 4.5). Both of these factors make a production timeline a critical instrument. The next page, table 7, is an example of a detailed production timeline for press releases at the *Space Telescope Science Institute*.

T-minus days	Action
T-15+	☐ Telecon with Principal Investigators/request science papers
T-14	☐ Science literature search
T-12	☐ First draft press release and caption text generated and posted to the internal website ☐ Animation storyboard generated ☐ First draft graphics/illustrations ☐ First draft press release image ☐ Science literature search posted to internal website
T-11	☐ Supplemental draft images
T-10	☐ Science papers posted to internal website ☐ Final graphics/illustrations/2D components to video producer ☐ Final release image(s) posted to internal website
T-9	☐ Supplemental image/illustration captions/titles/credits ☐ First draft video files
T-8	☐ Draft video files reviewed ☐ Final draft press release and caption text reviewed by Principal Investigators ☐ First draft factsheet text ☐ Video files posted to internal website for review ☐ Video files reviewed
T-7	☐ All video files forwarded to for Video News Release (VNR) production ☐ Final press release, captions and factsheet text reviewed by internal scientist and Principal Investigators ☐ Press release, video still captions, titles, credits to be put on slates ☐ Image Fast Facts produced ☐ Final draft text posted to internal website
T-6	☐ Q&A generated ☐ Slates reviewed and approved
T-5	☐ Final draft release text for NASA Headquarters' approval ☐ Q&A reviewed ☐ VNR files generated for review ☐ Slates posted to internal website ☐ Wallpaper files
T-4	☐ Slates for review ☐ VNR engineering review ☐ VNR files reviewed ☐ Production of related links and categories
T-3	☐ Draft text back from NASA Headquarters' Newsroom ☐ VNR thumbnails & final files posted to internal website
T-2	☐ All final files posted to Embargo website ☐ All final text and image files to staging server
T-1	☐ All final live server text and image files reviewed
T-0	☐ Release goes live on live server ☐ Emailing list messages posted, release posted on press release portals

8.8 PRESS RELEASE TEXT EXAMPLE

An excellent example of the role an education and public outreach office plays is given in Mitton (2001) as a "before and after" comparison.

First, the draft submitted by the scientists:

> *"Infrared observations made with CGS4 on the UKIRT reveal the presence of brown dwarf-like mass donor stars in the cataclysmic variables LL And and EF Eri. Cataclysmic variables (CVs) consist of a white dwarf primary and a less massive, cooler secondary star. Theoretical calculations have shown that as a cataclysmic variable becomes very old, the mass losing star will be whittled down to a cold, Jupiter-sized body similar to a white dwarf."*

Then the final version in the press notice (as transformed by Mitton):

> *"Astronomers using the UK Infrared Telescope (UKIRT) in Hawaii have discovered two examples of a kind of star never previously observed. These small cool stars look superficially like brown dwarfs, but are actually remnants of ordinary stars that have been whittled down to cool Jupiter-sized bodies over billions of years by spilling material over to a white dwarf companion star."*

Without doubt a much simpler and more readable presentation of the scientific result.

8.9 CASE STUDY: A SELECTED PRESS RELEASE

This section takes a closer at look four different elements in the life of a particular press release. I have chosen – somewhat at random – a story that was presented at the *American Astronomical Society*'s 201st meeting (January 2003): "*Young Star Probably Ejected from Triple System*".

Here we look at four components:

1. The abstract from the original conference paper.
2. The Press realease from *National Radio Astronomy Observatory* (NRAO)[21].
3. The article published on *Sky & Telescope*'s website[22].
4. The article from *USA Today*.

***Table 7** (facing page): Timeline for the production of full press release packages. T-0 is the time of the public release of the package. This timeline may serve as inspiration for similar timelines and also illustrates the level of professionalism of this particular organisation. Courtesy of Cheryl Gundy,* Space Telescope Science Institute.

21 From http://www.nrao.edu/pr/2003/stareject/

22 From http://skyandtelescope.com/news/current/article_841_1.asp

1. The abstract from the scientific paper[23] (a conference paper was also presented at the *American Astronomical Society*'s 201st meeting[24]):

> ***Ejection of a Low-Mass Star in a Young Stellar System in Taurus***
>
> *L. Loinard, L.F. Rodriguez, M. Rodriguez (IA UNAM, Morelia Mexico)*
>
> *Abstract*
> *We present the analysis of high angular resolution Very Large Array radio observations, made at 11 epochs over the last 20 years, of the multiple system T Tauri. One of the sources (Sb) in the system has moved at moderate speed (5-10 km/s) on an apparently elliptical orbit during the first 15 yr of observations, but after a close (<2 AU) encounter with the source Sa, it appears to have accelerated westward to about 20 km/s in the last few years. Such a dramatic orbital change most probably indicates that Sb has just suffered an ejection- which would be the first such event ever detected. Whether Sb will ultimately stay on a highly elliptical bound orbit or whether it will leave the system altogether will be known with about 5 more years of observations.*

23 Available at: http://esoads.eso.org/cgi-bin/nph-bib_query?bibcode=2003ApJ...587L..47L&db_key=AST&high=3ecb4b8cee27895

24 http://esoads.eso.org/cgi-bin/nph-bib_query?bibcode=2002AAS...20113602L&db_key=AST&high=3eae2aa83903082

2. The press release from *NRAO*:

NRAO

National Radio Astronomy Observatory
P.O. Box O
Socorro, NM 87801
http://www.nrao.edu

January 8, 2003

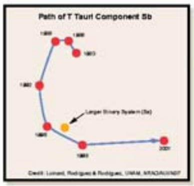
Contact:

Dave Finley, Public Information Officer
Socorro, NM
(505) 835-7302
dfinley@nrao.edu

Young Star Probably Ejected From Triple System

Astronomers analyzing nearly 20 years of data from the National Science Foundation's Very Large Array radio telescope have discovered that a small star in a multiple-star system in the constellation Taurus probably has been ejected from the system after a close encounter with one of the system's more-massive components, presumed to be a compact double star. This is the first time any such event has been observed.

"Our analysis shows a drastic change in the orbit of this young star after it made a close approach to another object in the system," said Luis Rodriguez of the Institute of Astronomy of the National Autonomous University of Mexico (UNAM).



"The young star was accelerated to a large velocity by the close approach, and certainly now is in a very different, more remote orbit, and may even completely escape its companions," said Laurent Loinard, leader of the research team that also included Monica Rodriguez in addition to Luis Rodriguez. The UNAM astronomers presented their findings at the American Astronomical Society's meeting in Seattle, WA.

The discovery of this chaotic event will be important for advancing our understanding of classical dynamic astronomy and of how stars evolve, including possibly providing an explanation for the production of the mysterious "brown dwarfs," the astronomers said.

The scientists analyzed VLA observations of T Tauri, a multiple system of young stars some 450 light-years from Earth. The observations were made from 1983 to 2001. The T Tauri system includes a "Northern" star, the famous star that gives its name to the class of young visible stars, and a "Southern" system of stars, all orbiting each other. The VLA data were used to track the orbit of the smaller Southern star around the larger Southern object, presumed to be a pair of stars orbiting each other closely.

The astronomers' plot of the smaller star's orbit shows that it followed an apparently elliptical orbit around its twin companions, moving at about 6 miles per second. Then, between 1995 and 1998, it came within about 200 million miles (about two times the distance between the Sun and the Earth) of its companions. Following that encounter, it changed its path, moving away from its companion at about 12 miles per second, double its previous speed.

"We clearly see that this star's orbit has changed dramatically after the encounter with its larger companions," said Luis Rodriguez. "By watching over the next five years or so, we should be able to tell if it will escape completely," he added.

"We are very lucky to have been able to observe this event," said Loinard. Though studies with computer simulations long have shown that such close approaches and stellar ejections are likely, the time scales for these events in the real Universe are long -- thousands of years. The chance to study an actual ejection of a star from a multiple system can provide a critical test for the dynamical theories.

If a young star is ejected from the system in which it was born, it would be cut off from the supply of gas and dust it needs to gain more mass, and thus its development would be abruptly halted. This process, the astronomers explain, could provide an explanation for the very-low-mass "failed stars" called brown dwarfs.

"A brown dwarf could have had its growth stopped by being ejected from its parent system," Loinard said.

The VLA observations were made at radio frequencies of 8 and 15 GHz.

T Tauri, the "Northern" star in this system, is a famous variable star, discovered in October of 1852 by J.R. Hind, a London astronomer using a 7-inch diameter telescope. At its brightest, it is some 40 times brighter than when at its faintest. It has been studied extensively as a nearby example of a young stellar system. While readily accessible with a small telescope, it is not visible to the naked eye. The observed orbital changes took place in the southern components of the system, displaced from the visible star by about one hundred times the distance between the Sun and the Earth.

The National Radio Astronomy Observatory is a facility of the National Science Foundation, operated under cooperative agreement by Associated Universities, Inc.

***Figure 13:** Press release for the "ejected star" story.*

3. The news article on *Sky & Telescope*'s website:

Sky&Telescope

A Tossed-Out Brown Dwarf?

January 9, 2003 | Astronomers may be witnessing the ejection of a very young starlike body out of a triple-star system. Dubbed T Tauri South (T Tau S), the system consists of a very tight binary (Sa) and a lower-mass companion (Sb). The trio is slowly orbiting T Tau North, the famous star that lends its name to a whole class of young stellar objects. Now, Laurent Loinard (Universidad Nacional Autónoma de México) claims that Sb is escaping the system after a close encounter with the Sa binary only about seven years ago. This remarkable claim is based on high-precision radio measurements made with the Very Large Array between 1983 and early 2001. If it is real, "this result is extremely significant for astronomy," comments Charles J. Lada (Smithsonian Astrophysical Observatory); it could shed light on the origin of the many free-floating brown dwarfs in star-forming regions. However, Mark J. Claussen (National Radio Astronomy Observatory) says another analysis of the VLA data fails to support the ejection scenario. Loinard does admit that it's extremely unlikely for such an ejection to be happening right now as we watch, but he believes Claussen is wrong because Claussen's analysis fails to incorporate the motion of T Tau Sa around T Tau North.

***Figure 14:** Article on the* Sky & Telescope *website for "ejected star".*

4. The article in *USA Today*:

Science

Three-star system ejects weakest link

Brown dwarf's ouster by gravity is first such sighting

By Dan Vergano
USA TODAY

SEATTLE — Astronomers report a first sighting of a round of *Survivor* set in space — a weakling brown dwarf star being booted out of a triple-star solar system.

Brown dwarfs are "failed" stars with relatively low mass. They are huge, but they lack the heft needed to light up with the nuclear fusion that powers true stars.

Numerous brown dwarfs have been spotted in recent decades, even in regions of space not associated with star formation. Seeing one ejected from a solar system suggests one explanation for their origin. And the find points to a new way to look at stars in their earliest development.

The phenomenon was reported at the American Astronomical Society meeting here by astronomer Laurent Loinard of the National Autonomous University of Mexico. The ejected star, called T Taurus South b, appears to have orbited a pair of larger stars, known as T Taurus South a, in the constellation Taurus for a good part of its less-than-1-million-year lifetime.

By using archival data from the U.S. National Science Foundation's Very Large Array radio telescope as far back as 1983, Loinard's team discovered that the smaller star apparently lost a game of gravitational chicken with its bigger brethren sometime around 1998.

Before then, T Taurus South b appears to have looped around the bigger pair of stars, traveling about 6 miles per second, a normal orbital speed. But by 2001, the star, about one-tenth the size of the sun, appeared headed out of the system at twice its original speed.

"The most likely explanation is we're actually seeing an ejection," Loinard says. Most likely, the two larger inner stars produced a very sharp tidal tug, just at the time the dwarf was at its closest approach.

Ejected from the system in which it was born, a young star could be cut off from the gas and dust it needs to gain mass.

The odds against randomly spotting a 20-year ejection event during the million-year adolescence of a young star suggest that such events "may be more common than we expected," says astronomer Charles Lada of the Smithsonian Astrophysical Observatory. Though Lada believes most brown dwarfs form on their own, he expressed "great confidence" in the ejection spotted by Loinard's team.

Some star nurseries have harsh climates

SEATTLE — A pair of star nurseries are turning up some oddball young solar systems that someday might form into planets, if they aren't blown away first.

In observations reported Wednesday at the American Astronomical Society meeting here, astronomers looked at two nebula regions, "starburst" hotbeds where normal and giant stars blossom into existence from collapsing clumps of hydrogen gas.

Images taken by the Keck II telescope in Hawaii of the Orion Nebula, which is located in the constellation Orion, show that teardrop-shaped flows of evaporating gas hundreds of millions of miles long surround the smaller stars in the region. Astronomers believe that radiation from larger stars is cooking the solar systems of their smaller cousins, evaporating the gas and dust surrounding them within as few as 100,000 years and making chances for planets to form less likely.

However, similar but even larger tadpole-shaped solar systems under siege turn up in a separate survey of the Carina Nebula, reported by Nathan Smith of the University of Colorado, and the small star systems there seem to be holding up under the assault of radiation from larger stars. Even though the Carina Nebula contains many more big, active stars than Orion, solar systems there seem to be hanging on, perhaps defying their bigger brethren to someday form planets.

Because most stars, and their solar systems, are thought to have origins in nebulas, determining whether planet formation is easy or hard in such regions is of great interest to astronomers.

USA Today and Dan Vergano

***Figure 15:** Article in the international newspaper* USA Today *about the "ejected star". USA TODAY 9 January 2003. Reprinted with Permission.*

It is interesting to see that as the story progressed and permeated into the more popular media it became simpler and the case for the ejection of the star became stronger. In this particular case it is notable that the word "ejected" is used in the original paper, although with a different meaning from the regular one of "thrown out" or "leaving". In fact, the scientists have not observed the system for long enough to show whether the star is still gravitationally bound to the system or whether it is "leaving". In the abstract of the peer reviewed paper the last sentence clearly states uncertainty, and thereby the somewhat (for layman and communicator) confusing use of the word "eject". This is a very clear-cut case of semantic confusion, but similar, though generally less obvious problems often occur.

The press release from *NRAO* is very clear on this point by using the word "probably" in the title.

The article on the *Sky & Telescope* (S&T) website treats the story in *Sky & Telescope*'s usual objective way, quoting "external" scientists, stating the pros and cons. The style of the article is not light, but the target group is also science attentive.

The article in *USA Today* is remarkable in the sense that it is one of relatively few science stories in this newspaper and also that it has received ample space. Seen in this light, it seems natural for the journalist, Dan Vergano, to choose a somewhat lighter angle. He has omitted — or played down — some of the scientific caveats, such as the "ejected" issue discussed above. The article still gives a good insight into the scientific result and is well targeted towards its audience.

Note that other scientists in 2004 found that the star system was stable (ie that the star was not leaving the system). In 2005 the original authors defended their original finding, so there is no final consensus on this issue yet.

9. PRODUCTION OF PRINTED PRODUCTS

The topic of layout and prepress is large and could easily justify a much deeper treatment here. The layout of printed products is partly an artistic discipline where text and images are combined into an aesthetically pleasing whole, and partly a more technical discipline that involves detailed knowledge of graphical rules, typefaces, software and colour spaces.

Two tips that can lead to better and faster results in the technical production of printed products:

1. Eliminate the use of offset films by using print shops that offer Computer-To-Plate (CTP) technology. Recent advances in print technology have moved printing away from offset printing with its tedious development and alignment of large sheets of films to digital printing. This makes the printing process faster, more reliable (reproducible on several occasions), better (better definition, sharper) and flexible (smaller volumes no longer have large start-up costs for films and manual labour). Print on Demand (PoD)[25] in this context has at least two meanings: Either the EPO office prints small volumes on demand with a digital print office externally or in house, or the end-user pulls digital material (e.g. print-ready PDF files) from a website and prints it himself on demand (with an external or in house print office). In both cases the advantages in terms of speed, availability and cost savings are great for both the EPO office and the end-user.

2. Use PDF files exclusively when shipping print-ready files to the printer. In this way it is possible to proof exactly what is sent to the printer calmly in the office on the screen or on a proofing printer. In addition some compatibility issues are eliminated, by removing the dependence on:

- operating systems (MAC/Windows);
- type of software;
- version of software;
- which fonts are installed.

9.1 CASE STUDY: THE INFRARED REVOLUTION BROCHURE

As an example of a brochure, take the *European Space Agency*'s *The Infrared Revolution*. The brochure tells the story of the birth of an entire field of astronomy and feasts on the great science exemplified by protoplanetary disks, solar systems under creation, dust, cold objects and much more. It introduces the great infrared observatories of the past and those to come.

The unusual feature of this brochure was the thematic approach that focused on the science of infrared astronomy rather than being purely a promotion or PR-oriented. The original brief from *ESA* requested a thematic brochure that discussed the history and science of one area of astronomy while mentioning the topics to be promoted such as Hubble, James Webb Space Telescope, Herschel etc as examples in passing. This

25 http://en.wikipedia.org/wiki/Print_on_demand

Figure 16: The cover of the European Space Agency (ESA) brochure, The Infrared Revolution.

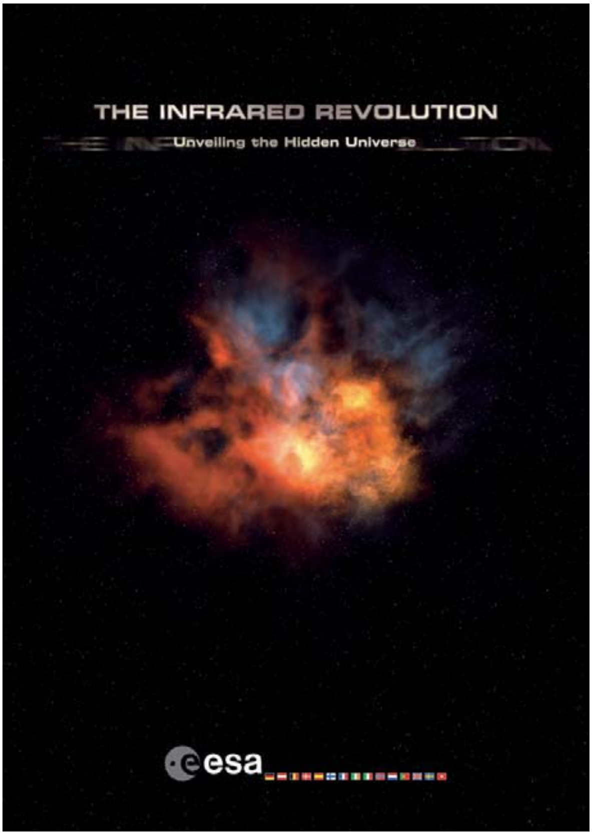


Figure 17 (opposite page): A spread from the brochure The Infrared Revolution *produced for* ESA. *It shows the graphical approach with many elements of texts and images spread over the pages in a non-traditional way.*

approach is well suited to the European environment where the media are more sceptical about PR than perhaps in the US.

The task of choosing the topic was not easy as many different requirements had to be satisfied:

- The science had to be interesting.
- It had to be a topic several *ESA* missions had in common (the thematic approach).
- Science had to be given a fair and objective treatment.
- The topic had to be one where *ESA* is global actor.
- The brochure had to be as interesting as possible and with an appeal to laypeople.

The brochure was produced in a highly efficient collaboration between Monica G. Salomone, a Spanish science journalist, myself and graphics designer Martin Kornmesser. The result is available in printed form and on the web[26].

26 http://www.spacetelescope.org/about/#readmore

THE COLD UNIVERSE

Astronomers have used several different properties of infrared light to reveal more about the Universe. Although our eyes cannot see infrared radiation we can sense it – as radiant heat.
Infrared radiation 'is' heat, and all objects, even the coldest ones – for example an ice-cube – emit a certain amount of heat. In fact, cold objects – up to temperatures of about 3,500°C – radiate most of their energy at infrared wavelengths. The cool Universe is therefore best studied in the infrared. Hotter objects like the Sun (which has a surface temperature of about 5,800°C) radiate strongly at more energetic (shorter) wavelengths. The Universe is full of cool objects, including aging stars, planets and dust, none of which generally shine brightly in the optical part of the spectrum and could not be observed directly until sensitive infrared detectors came along.

THE CHEMICAL UNIVERSE

The chemical make-up of dust clouds and other interesting regions can be probed by looking at the spectra of the molecules in the region (see box about Astronomical Tools). Very often the spectra can only be obtained by observing in the infrared. The reason is that most atoms and molecules emit radiation whose energy corresponds to the infrared range (emitted through rotations and vibrations). Besides, infrared radiation is typical of cooler regions, for instance dust clouds, where more complex compounds, such as organic molecules are often found. Infrared astronomy has made many interesting discoveries related to these more complex molecules in space.

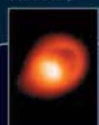
ASTRONOMICAL TOOLS

Astronomy is an unusual science in that it must rely only on observations of the radiation reaching us from celestial objects. Two different tools are used to observe the light and to extract the maximum amount of information: images and spectra.

Images are optical representations of objects. Two characteristics for a given image are the field of view and the resolution of the image (both measured in degrees or arc-seconds (1/3,600 degree). The field of view is a measure of how large a chunk of sky fits in one image. The resolution is a measure of the 'sharpness' of an image. Images are essential to give an idea of the different processes taking place in a given region.

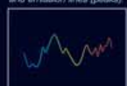
Light can be 'split' into its constituent colours using an instrument called a 'spectrograph'. A similar phenomenon happens when a rainbow is formed. When the light emitted or absorbed by atoms and molecules goes through a spectrograph the resulting pattern of 'coloured' lines is called a spectrum. Each compound produces a different spectrum, which can therefore be used as an identifier: a true 'chemical fingerprint'. Spectra are thus the astronomer's favourite tool to reveal the composition of objects in the Universe.

An image (showing organic molecules around a star)



ISO/ISOCAM

A spectrum showing absorption lines (troughs) and emission lines (peaks)



ESO & João Alves, Richard Hook and Bob Fosbury

A Cool Dusty Cloud Filled with Interesting Chemistry

The visible/near-infrared image of the dust cloud seen to the left illustrates three out of four main themes in infrared astronomy.
1. Dust: The dust in the cloud has blocked (scattered) almost all blue light and is letting only the reddest part of the starlight through. In fact only infrared light is allowed to pass, which is why the stars behind the cloud are coloured (infra)red in a rather dramatic way. The stars are not visible in optical images.
2. Cool temperatures: These dust clouds are cool objects and emit most of their light in the infrared. The red colour in the image corresponds to 2.2, the green to 0.8, and the blue to 0.4 micron.
3. Chemistry: The elements and compounds in cool clouds like this one are best studied with infrared telescopes and instruments.

ABOVE THE ATMOSPHERE

The Universe emits a tremendous amount of information in the form of different types of electromagnetic radiation. Only a small fraction of this is visible from the Earth (white areas) as the atmosphere absorbs the rest before it reaches the ground (black areas). Water vapour, ozone and carbon dioxide in the atmosphere absorb large parts of the infrared spectrum so most infrared astronomical observations have to be carried out at high altitude by instruments mounted below balloons or in rockets or spacecraft. The higher above the atmosphere an infrared telescope is, the better the observing conditions.
Apart from problems with atmospheric absorption, the atmosphere is itself also a source of infrared radiation, with a typical temperature of 10°C, making infrared observations of the coolest objects in the Universe difficult from the ground.

THE DUSTY UNIVERSE

Dust is the bane of the optical astronomers' life, blocking their view of many interesting objects. The Universe is full of dust, microscopic particles of varied composition – carbon, silicon, water ice, minerals, frozen carbon monoxide, organic compounds, silicates – the list is almost endless. The particles can be hard or soft and come in many different shapes, but the particle size is usually less than 1 micron. The wavelength of visible light is much the same size as many dust particles, so that visible light is very readily blocked (scattered) by the dust, whereas the longer wavelength infrared radiation passes through unhindered and the dust is therefore invisible to it.
However, the dust itself is also a source of infrared radiation that can be picked up by terrestrial detectors. For example, dust grains around a star absorb the starlight so that the dust begins to warm up and to radiate in the infrared. This absorption of energetic radiation and reemission at less energetic wavelengths is very efficient and dust clouds emit the majority of their energy at infrared wavelengths.

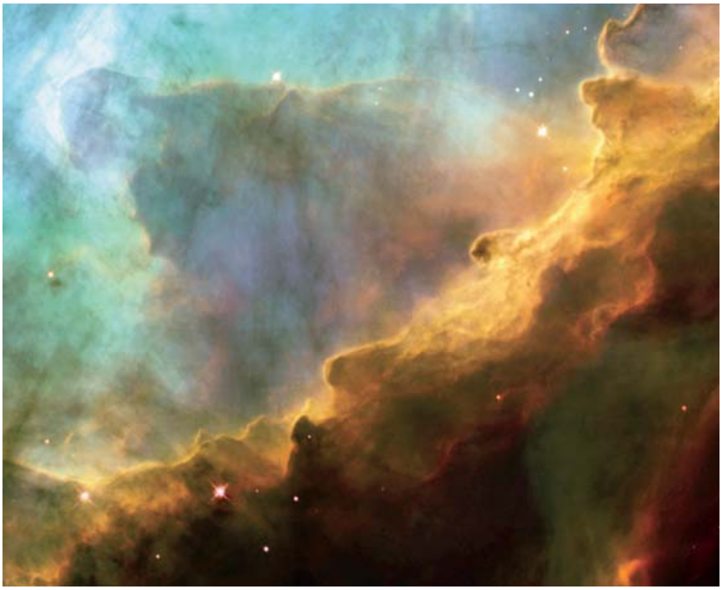
THE DISTANT UNIVERSE

Infrared radiation can help us to learn much more about the young, distant Universe. As a result of the Big Bang (the event that marks the beginning of our Universe), the Universe is expanding and most of the galaxies within it are moving away from each other. The more remote a galaxy is, the faster it is moving away from us. As an object moves away from us, the light that it emits is redshifted – the wavelength of the light is stretched and lengthened so that it is shifted towards the red part of the spectrum. The more distant the object, the greater the redshift. For distant galaxies this effect can be so large that they are only detectable in the infrared region.

10. VISUAL COMMUNICATION

Images, illustrations and visual design are key factors in successful science communication. The effort needed here can hardly be over-emphasised. It is true that all good science communication is based on good science, but without good visuals the chances of selling the products vanish. Images have always been an integral part of science, but two factors have contributed in particular to increase the impor-

Figure 18: *The famous "Pillars of Creation" image from the Hubble Space Telescope is the most famous Hubble photograph and also one of the most famous science images ever taken. The image shows part of the Eagle Nebula star nursery.*



NASA/ESA Hubble Space Telescope

Figure 19: *Like the fury of a raging sea, this image from the NASA/ESA Hubble Space Telescope combined from greyscale raw data shows a bubbly ocean of glowing hydrogen, oxygen, and sulphur gas in the massive and luminous molecular nebula Messier 17.*

tance of images: the advent of computers and the continuing decrease in the attention span of the average human.

Some visuals are easy for laypeople to interpret, others are harder to comprehend. At one end of the spectrum the mainstream scientific literature contains examples of advanced graphs that are so marvel-

ESA/Envisat

Figure 20: *A remote sensing image created from raw data from the* European Space Agency*'s Envisat. The image shows Mexico's Yucatan Peninsula extending into the Caribbean.*

IBM Almaden Research Center

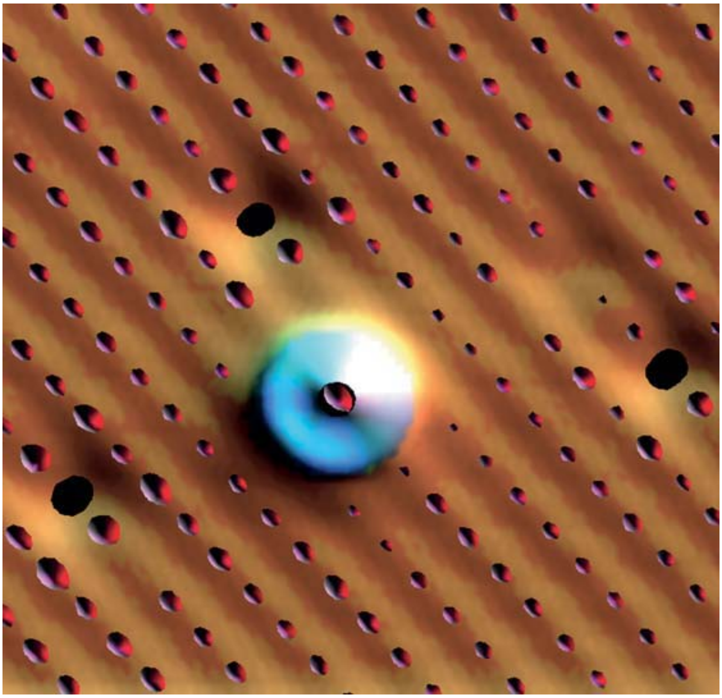


Figure 21: *Scientists from* IBM Almaden Research Center *have here overlayed two Scanning Tunneling Microscopy images on top of one another. One image with magenta-coloured nickel atoms poking up through the other image showing a xenon atom (the big light blue bump in the centre).*

lously complicated that they can literally take hours to understand fully. In science communication we exist to communicate to Everyman and work at the other end of the visual spectrum that is occupied by simple artist's impressions and aesthetic representations of real data.

10.1 CREATING IMAGES FROM RAW DATA

In some branches of science, such as astronomy or mathematics, there are plenty of chances to create images from real data. Work of this type, intended for scientific purposes, as opposed to communication purposes, is known as scientific visualisation and often involves advanced real-time interactions with the data, bright false colour schemes and an abundance of annotations, legends and scales. In science communication the challenge is use the data to convey only the relevant part of the message and keep things as simple and visually appealing as possible. This is often easier said than done and is almost an art form in itself.

In astronomy we are blessed with incredible photo opportunities of our Universe (see for instance figure 18 and figure 19). Even so, it still takes substantial resources to clean the images of the various artefacts from telescope and instrument. It may take anything from a couple of days to eight man weeks of work to process the raw data to produce one finished, polished EPO quality image. Appendix A is dedicated to a thorough hands-on treatment of how to produce EPO style images from raw astronomical data.

CERN

***Figure 22:** A so-called bubble chamber photo taken at* CERN *in 1973. This photo confirmed the electroweak theory, which had predicted that the weak force of nature and the electromagnetic force of nature were different facets of the same interaction.*

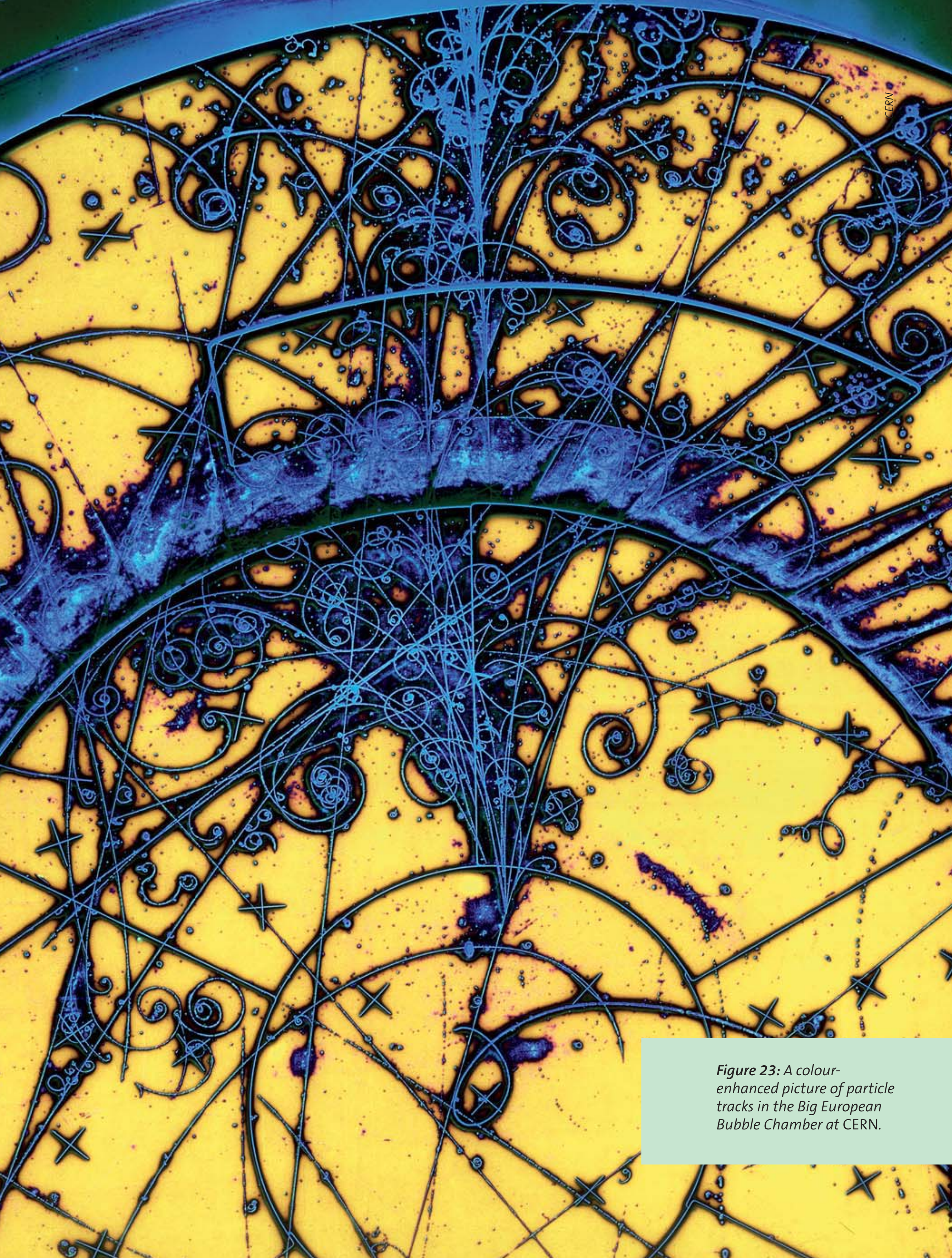


***Figure 23:** A colour-enhanced picture of particle tracks in the Big European Bubble Chamber at* CERN.

Much iteration between artist and scientists is necessary between the first draft and the final image.

In fields like remote sensing (figure 20), nanophysics (figure 21) or particle physics (figures 22 and 23) it is also necessary to extract and look at the raw data and before assembling individual "exposures" to colour images.

10.2 ARTIST'S IMPRESSIONS

The development of an artist's impression that is scientifically "correct" takes much longer than "free-fantasy" illustrations. Much iteration between artist and scientists is necessary between the first draft and the final image. An example can be seen in figure 24.

10.3 OTHER SCIENCE IMAGES WITHOUT DATA

Some branches of science may be less visually appealing, but may have other advantages. In some fields one can send a photographer to a lab or a facility to obtain photos for a press release instead of having to create all visuals on a computer. Each branch of science has its own challenges in producing EPO visuals, involving different approaches and techniques, though probably the effort involved in each case is comparable. What matters is the significance assigned to the task of producing (or buying) an EPO image for the next release, the website, the new brochure etc. It *does* take a significant investment to set up a technical and scientific image production pipeline that works for your particular field, and for your particular organisation. Some examples of science images without data are shown in figures 26 and 27.

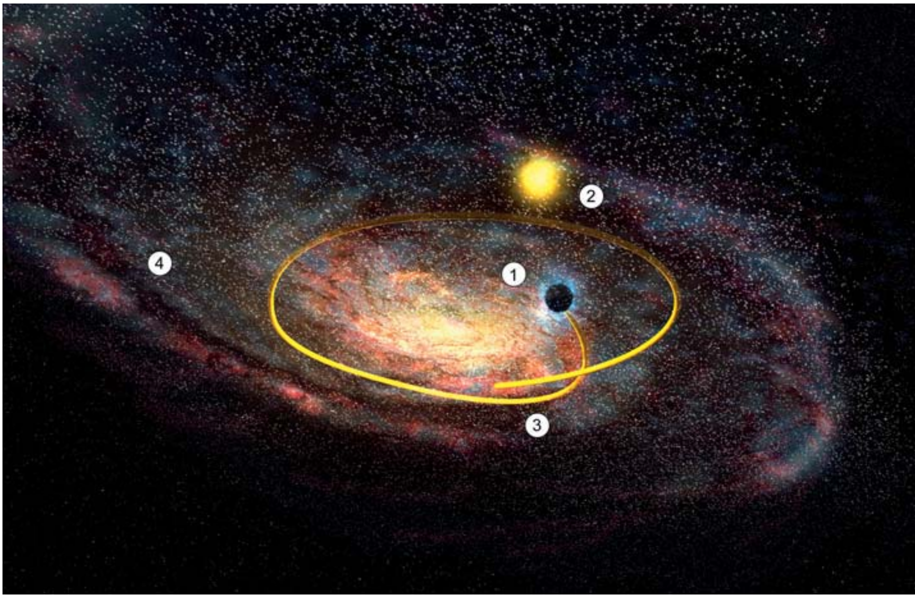
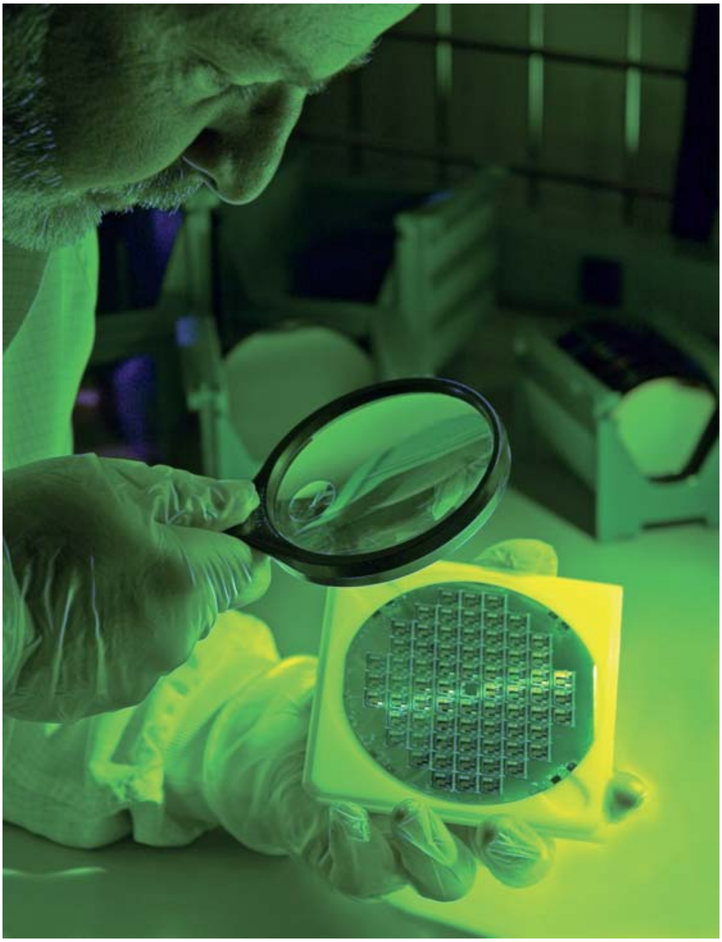


Figure 24: *This artist's impression example shows an oblique view of our Milky Way galaxy. The black-hole system GRO J1655-40 (1) is streaking through space at a rate of 400,000 kilometres per hour. The yellow star (2) is our Sun. The path of the black hole is shown in yellow, (3). The galaxy (4) is an ongoing 3D project, which is improved by each use. Realistic galaxies are one of the most difficult things to recreate in a 3D programme.*

Figure 25: *This artist's impression was created in* Adobe® Photoshop®, *mainly by drawing with a digitising tablet. Some components are copied from other images. This illustration has the following scientific components: (1) Quasar in the distant Universe about 900 million years after Big Bang. (2) Individual newly born stars. (3) The central part of the story: the iron gas dispersed by the first generation of stars. (4) Supernova remnants from the first supernovae. (5) Newly born star clusters. (6) Cavity carved by the fierce radiation from the new stars and (7) dust.*

bartproductions/Istockphoto.com

Figure 26: *Images created without data are relieved of the difficult issues of handling and manipulating the data, but may be less interesting. Here a pharmacologist scientist is performing an experiment in an image that shows different interesting aspects of the science.*



leezsnow/Istockphoto.com

Figure 27: *How does one illustrate the field of non-linear optics? A field that usually involves microscopic structures that are hard to see with the naked eye. One way to do it is by using interesting optical laboratories, lasers and the scientists themselves. Here a scientist is inspecting a silicon wafer through a magnifying glass in the lab.*

10.4 CORPORATE VISUAL IDENTITY

A strong corporate visual identity is not enough to create a strong brand. But a strong brand needs a strong corporate visual identity. Even in science communication it is necessary to have an elegant, simple and appealing branding of the organisation and of the products we are trying to “sell”. Branding of a science project calls for consistent design and consistent use of defining visuals such as logos and key images.

10.5 COLOURS

In science communication, the two main colour spaces are RGB and CMYK. Converting between the two colour spaces is a sensitive task that may cause unexpected problems. The two colour spaces have different gamuts (see below), so there is no unique way of converting between them.

10.5.1 RGB colours

The RGB colour model relates very closely to the way we perceive colour with the *r*, *g* and *b* receptors in our retinas. RGB uses additive colour mixing and is the basic colour model used in television or any other medium that projects colour with light, including computers and web graphics, but it cannot be used for professional print production.

The secondary colours of RGB — cyan, magenta, and yellow — are formed by mixing two of the primary colours (red, green or blue) and excluding the third colour. Red and green thus combine to make yellow, green and blue to make cyan, and blue and red form magenta. The combination of red, green, and blue at full intensity makes white.

Using the "screen mode" in *Adobe® Photoshop®* for the different layers in an image will make the colours mix together according to the additive colour mixing model. This is analogous to letting light beams of different colours overlap on a screen.

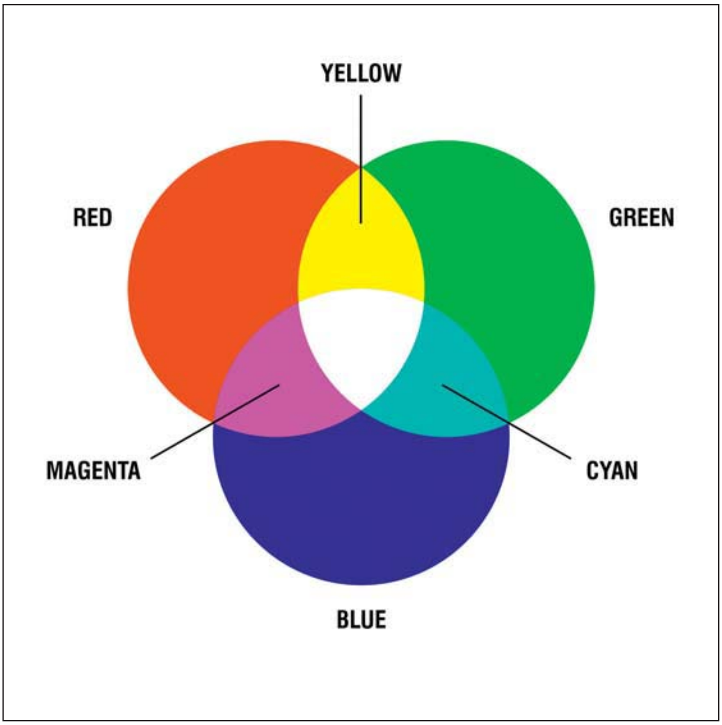


Figure 28: *The additive or RGB colour model relates very closely to the way we perceive colour with the r, g and b receptors in our retinas.*

10.5.2 CMYK colours

The CMYK model used in printing lays down overlapping layers of varying percentages of transparent cyan (C), magenta (M) and yellow (Y) inks. In practice, however, the combining of cyan, magenta, and yellow inks does not produce a pure black due to impurities in the inks. For this reason, black ink (K) is used in addition for deeper black in the print process, which is thus called four-colour printing or CMYK printing. The CMYK model uses the subtractive colour model, where a combination of 100% of each component yields black and 0% of each yields white.

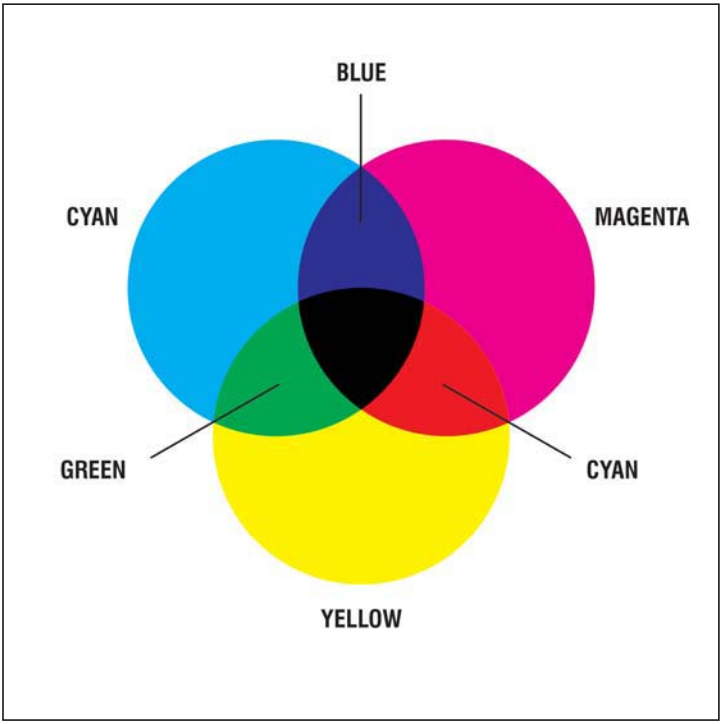


Figure 29: *The colours created by the subtractive model of CMYK do not look exactly like the colours created in the additive model of RGB. Most importantly, CMYK cannot reproduce the brightness of RGB colours. In addition, the CMYK gamut (colour range) is much smaller than the RGB gamut.*

10.5.3 Gamut

The range of colours the human eye can perceive is quite large. One describes such a range, or subset of colours, as a gamut[27]. The two colour spaces discussed above span only a fraction of the colours we can see with our eyes. Furthermore the two colour spaces do not have the same gamut. Some colours are included in the RGB space but not in the CMYK space, and vice versa, meaning that converting from one colour space to the other may cause problems for colours in the outer regions of the gamuts.

27 http://en.wikipedia.org/wiki/Gamut

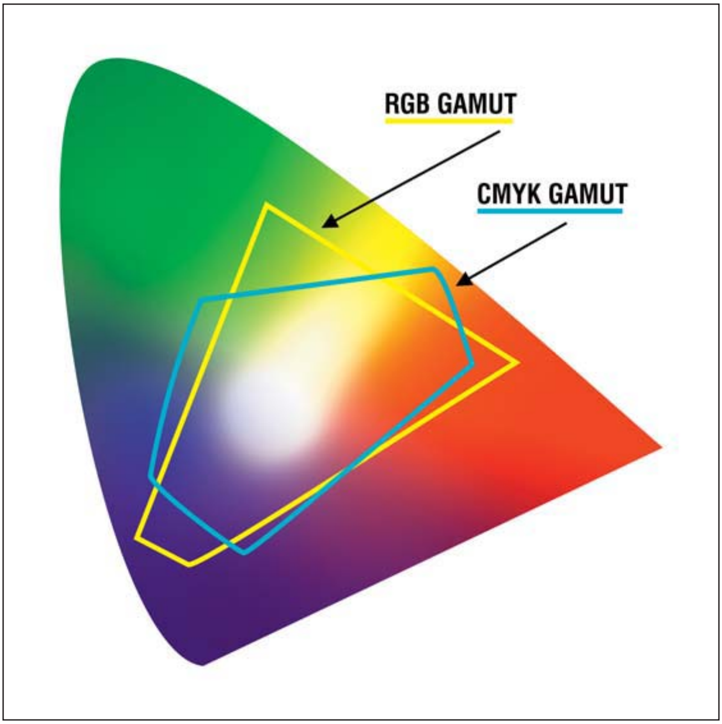


Figure 30: *This illustration shows the principle of the different gamuts of the RGB and CMYK colour spaces. The background is the CIE Chromaticity Diagram representing the entire colour range, or the whole gamut, of human colour perception.*

10.5.4 Colour management

No two output devices, monitors, printers will reproduce the same output colour from the same input colour. The primary goal of colour management[28] is to obtain a good match across the output devices and so increase the chance that what you see on your screen is what you get back from the printshop, or the same as most other people will see on their monitors.

This topic is enormous, and technically very demanding. It is really important to be in control of colour when producing high-quality graphical products for print or web use. In science communication it is especially important to have a colour calibrated monitor. The colour calibration can either be done by technically and graphically avid people on the team or by an external consultant. This work involves using a colourimeter that measures the output colours. These measurements can then be related to a standard colour space, and a colour profile for the output device can be calculated.

More information is available on the web[29] or in Fraser et al. (2004).

28 http://en.wikipedia.org/wiki/Colour_management

29 See for instance http://www.drycreekphoto.com/Learn/color_management.htm and http://www.normankoren.com/color_management.html

10.6 FILE TYPES

Be prepared to spend the necessary time creating stunning visuals — often longer than writing texts, etc.

There are two general groups of "images": vector graphics (or line art) and bitmaps (pixel-based). Some of the most common file formats are:

- **GIF**: Mostly used for web.
- **JPEG:** A very efficient format. Widely used, especially for web.
- **TIFF:** The standard publication bitmap format.
- **Postscript**: A standard vector format.

See the Glossary for more details.

11. TECHNICAL SET-UP

Having a strong technical skills base (section 3.4) and technical autonomy is absolutely mandatory if the communication office is to keep pace with the speed of the news flow and the demands of the press. This covers superficially simple, but often controversial issues, such as having administrative privileges for operating systems, having access to office supplies during off hours (printing paper, printing inks, stationery and so on) and purchasing printers that are not shared with other departments.

Having a strong technical skills base and technical autonomy is absolutely mandatory.

Technical autonomy means that the EPO office has full control over the technical equipment necessary in the production chain (see chapter 4). This often means investing in dedicated hardware that is available 24-7. Some examples of equipment that are extremely useful in a science communication office:

- **Fast computers** (for all staff): the communication office is likely to be the group in any organisation with the most "need for speed".
- **Market continuously operating systems:** that are market leaders and are updated to provide the newest and most advanced applications (for example, Windows-based or Mac OS-based). The more people use an operating system world-wide, the more applications will be available for the diverse needs of an EPO office.
- **B/W and colour laser printers**: for fast and flexible in-office production of hard copies, for archiving purposes and with low maintenance.
- **Large format printers**: for in-office production of posters and banners (see figure 31).

Figure 31: *A large format printer. Here a 42 inch (106 cm) HP 5000. It is worth setting a high premium on reliability, low maintenance and no essential expert knowledge. Once configured, calibrated and loaded with good paper, this device basically works as a normal desktop printer.*

***Figure 32:** A graphics workstation, here a combined 3D workstation and the graphic designer's personal computer. Note the dual monitor system allowing for a larger, cleaner workspace, and the digitising tablet to the right (for freehand drawing).*

- **Colour managed monitors**: colour calibration is really the only way to judge on-screen colours when producing images and graphics (see section 10.5.4).
- **Video editing equipment**: for in-office editing of Video News Releases (VNRs). A small full broadcast video editing system is shown in figure 63.
- **A 3D workstation**: allows modelling and rendering of animations and the like. This computer may double as the graphic designer's personal computer. See figure 32. Read more about the details of video editing (hardware and software) in chapter 15.
- **A render farm**: a (sometimes surprisingly simple and cheap) software solution that consists of a series of computers connected via the internal (for example, Ethernet) network that renders 3D or 2D animations[30]. The fast computers mentioned above could, for instance, double as a render farm.

30 For instance a reliable and cheap network rendering solution comes with the standard *Cinema 4D* software package. It even has an unlimited number of clients.

12. DISTRIBUTION

Many different methods for the distribution of science communication products can be chosen to fight the "battle to be heard" and several of them are often employed in parallel. Some of the most commonly used are:

- Direct mailing of physical materials.
- Email distribution lists: Create your own lists as well as using external ones.
- Web distribution (also discussed in sections 6.4 and 13.3): Nearly all products need to be available on the web. The web is unbeatable as a repository tool and offers 24-7 availability.
- Distribution via third-party partners: Such as press release portals, video portals (vortals) or external companies that sell your products (for the latter see section 20.1).
- Press conferences (see chapter 18).
- Networking: The personal contact between journalists and scientists/PIOs will always work better than more or less anonymously distributed paper and electronic products.

The preferred method in a given situation depends on the target groups, the products and past experience. Some means of distribution have a high cost per person reached, some lower costs. Some are very push-oriented, some rely more on the target group pulling material from the EPO office after the contact has been made. Some methods are under the full control of the EPO office, some methods rely on a third-party. Speed varies immensely between methods.

The preferred method of distribution in a given situation depends on the target groups, the products and past experience.

Mediators (see also chapter 5), including the news media, teachers, scientists and amateurs are vital for the distribution process as they help to disseminate communication products directly, thereby acting as a link between communicators and consumers. Communicators need these amplifying outlets to reach a larger audience. Apart from increasing the numbers reached, mediators can influence how much the communication can touch or teach the individual directly. Communicators can inspire interest and thereby raise public awareness about science, but *understanding* takes more effort and the time-consuming efforts of mediators such as teachers and lecturers are extremely valuable in this regard.

Distribution is — perhaps apart from the actual production process — the most important link in the production chain, but often not enough effort is put into this area. There may be many different reasons for this:

- It is fairly time consuming to build, and not least, to update, a large and consistent address database of recipients for the products.
- Distribution and promotion are rather close to what is known elsewhere in society as "selling", and it is perhaps difficult for an EPO office to accept that it is necessary to "sell" scientific results.

Figure 33: *If only a parcel could speak... This image illustrates some of the problems with distribution. The parcel came back somewhat the worse for wear from Egypt after 4 months (!) due to delivery problems. Handling mass mailing distribution of physical products certainly takes great effort.*

But it is! Today there is such fierce competition with other news and content providers that we have to follow suit.

- There may be internal obstacles in the organisation that prevent an effective and at times aggressive distribution.

12.1 THE PRESS RELEASE VISIBILITY SCALE

When publishing or distributing a given science result, an organisation can choose different "levels of effort" in the distribution process according to the importance of the given result. Here we illustrate this by listing the different distribution methods on a press release visibility scale consisting of seven steps with magnitude 7 being the highest level of effort an organisation can put into communicating a result (details below). If too high a level of effort is chosen relative to the story's science importance, credibility problems may occur (Nelkin, 1995, p. 161). The higher the level of effort the more solid the science case and the evidence have to be. Equally, the higher the level of effort the greater the need for a retraction if the science is later proven wrong — and the actual retraction should have a commensurate visibility (Nielsen et al, 2006). *NASA*'s guidelines and practices for media efforts follow a similar scale (Space Telescope Science Institute, 2005; Watzke & Arcand, 2005).

When publishing or distributing a given science result, an organisation can choose different "levels of effort" in the distribution process according to the importance of the given result.

It is important to note that the press release visibility scale only describes the level of effort *chosen* by PIOs to emphasise a given press release, and not the level of attention the given press release will actually *receive* in the media. However the level of communication efforts and the level of media attention are closely correlated — although not in a direct one to one relationship. A beautiful astronomical photo release (magnitude 2) may occasionally get just as much press attention

The Press Release Visibility Scale	
Magnitude 7:	Live televised press conference with presence of a high ranking political figure
Magnitude 6:	Live televised press conference
Magnitude 5:	Press conference
Magnitude 4:	Media teleconference
Magnitude 3:	Press release
Magnitude 2:	Photo release
Magnitude 1:	Web-only posting

***Figure 34:** The press release visibility scale.*

as a live televised press conference on something of a more technical nature (magnitude 6).

The number of images/animations in the press packs of press releases, together with distribution restrictions such as whether the given news is embargoed or not, can affect the visibility to a minor degree. Science news will not be broadcast on television unless the news is released with video clips. However, the size of the press package tends to grow the higher the release is on the press release visibility scale.

Magnitude 7 — Live televised press conference with presence of a high ranking political figure

A live televised press conference with the presence of or statements from a major political figure is the highest communication effort that can be put into a press release for major scientific discoveries. As an example, when (NASA, 1996) announced they had found *"evidence that strongly suggests primitive life may have existed on Mars"*, President Bill Clinton stated later the same day, that:

> *"If this discovery is confirmed, it will surely be one of the most stunning insights into our Universe that science has ever uncovered".*
>
> The White House (1996)

Only major scientific discoveries are endorsed by politicians, whose presence will pull the media in even more strongly. Normally the news will be based on an accepted peer reviewed paper to be published in a prominent science journal like *Science* or *Nature*.

Magnitude 6 — Live televised press conference

If a result is released via a live televised press conference this effort tells journalists that the scientific institution believes the scientific finding is of major importance.

Magnitude 5 — Press conference

Press conferences that are not televised live are likely to receive less attention than their live televised counterpart, mainly because they require journalists to gather in person in one place. As with the live televised press conferences, the science news will normally be based on a paper to be published in a prominent science journal: press conferences at scientific conferences are the exception.

Magnitude 4 — Media tele-conference

A media tele-conference releases science news representing major scientific discoveries to the press. A scientist will give a presentation and journalists may ask questions afterwards (similar to real press conferences, see chapter 18). The media tele-conference allows journalists to be in close contact with the scientist without having to travel. The news is also based on an accepted peer reviewed paper that will typically be published in a prominent science journal.

Magnitude 3 — Press release

Press releases are the most frequently used way of communicating science news that represents a scientific discovery of significant importance to the general public. Press releases are sent out via distribution lists that cover hundreds of journalists and news media. However journalists are flooded with press releases everyday, all competing to get page space, and this makes it important that a press release catches the attention of journalists in the headline. If a wire service picks up a press release many local newspapers will pick the up the story. Most often an accepted peer reviewed paper will back up the story.

Magnitude 2 — Photo release

Photo releases do not usually represent major scientific discoveries, but contain aesthetic images. Even though the scientific content is relatively low, a photo release of, for instance, Mars may still achieve considerable media attention, and appear on the front page of *New York Times* (Levay, 2005). Consequently, photo releases may attract more attention than live televised press conferences at times, despite the lack of a "proper" scientific finding. There is usually no scientific paper to back up a photo release.

Magnitude 1 — Web stories

Web stories, posted only on the scientific institution's website, contain news or information from the scientific institution that may only interest a smaller audience such as web visitors with political or technical interests. The news mostly concerns stories about the signing of agreements, new telescope openings, appointments etc. A key point is that the end-user needs to be active to "pull" the material from the scientific institution's website since there usually is no proactive distribution for this type of release. This makes the impact a lot smaller than that of methods higher up on the scale where the messages are pushed towards the end-user.

12.2 ADDRESS LISTS

One of the key elements in any distribution is address lists. The larger they are and the better maintained, the better tools they are. Address lists seem to be something that many organisations maintain on an individual basis, and it may be of mutual benefit to share such a resource between organisations.

An example of a relatively advanced media database is seen in figure 35. The database is Filemaker Pro, and the main fields for each record contain:

- **Institute/institution:** The name of the television station, newspaper or main contact point.
- **Postal address:** For distribution of physical material such as brochures and hard copies.
- **Telephone number:** For personal follow-up.
- **Email:** For emailing distribution.
- **Website:** To keep track of the record and to facilitate later updating.
- **Customer type** (see chapter 5): Media such as television stations or freelance journalists, educators such as teachers or science centres and decision-makers such as members of the European Commission or committee members.

To keep the database growing every person who requests material or information should end up in the distribution database. This can be done by printing the mailing labels from the database, thereby forcing the data into the system for future use.

12.3 EXTERNAL DISTRIBUTION PARTNERS

12.3.1 External mailing lists

In addition to the internal database, external partners may have access to other markets and other customer segments. It may be worthwhile considering using specialised external distribution lists. These lists usually specialise in their own science area. Two specific examples of good external distribution outlets in astronomy are:

- The *American Astronomical Society*'s press emailing distribution list: Currently has more than 1500 science journalists with a special interest in astronomy (Maran, 2005).
- The *Royal Astronomical Society*'s press emailing list: Has more than 200 members (Mitton, 2001).

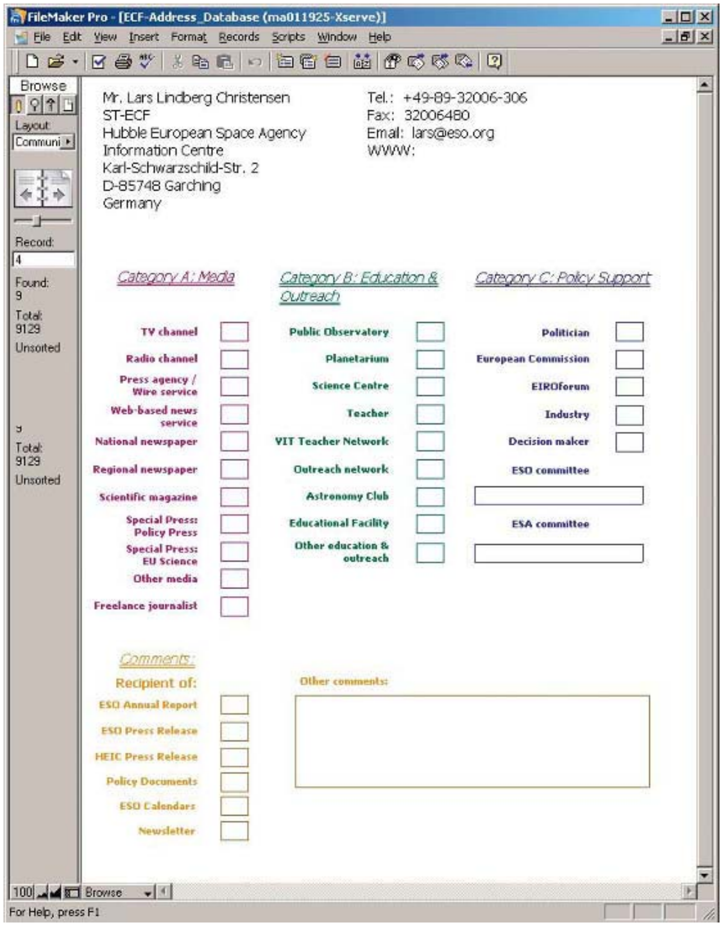


Figure 35: A fairly comprehensive distribution database. The coloured fields get a cross corresponding to the record's target group type. A comment field makes it possible to go back and check who was sent what at a later stage.

12.3.2 Press release portals

Recent years have seen a clear tendency for journalists and PIOs to rely more on syndicated press release portals such as *AAAS*'s[31] *EurekAlert*[32] and *AlphaGalileo*[33], originally supported by the European Commission. These portals offer a superb searchable overview of the available press releases to journalists. They also provide services such as access to embargoed stories, advance warning per email and more. For PIOs it may be worth considering registering with some of these portals and taking advantage of their services.

12.3.3 Video portals (vortals)

Video portals (or vortals) (analogous to press release portals) have also started to show up on the web. *AthenaWeb* is one such example (see figure 45). At the moment vortals seem to be less useful for media with

31 *American Association for the Advancement of Science*
32 http://www.eurekalert.org/
33 http://www.alphagalileo.org/

a short lead time such as daily news, while magazine programmes with weeks of lead time are better suited to take advantage of their offers.

12.3.4 Video on Demand (VoD)

Video on Demand is an up-and-coming concept. In a few years we may not see many more DVD rental shops in the street and we will exclusively rent and download movies online. Some Video on Demand (VoD)[34] companies already exist. These companies have descriptive pages on the web and a credit card payment option, from where the movie (prepaid) can be downloaded by the user directly via the Internet. The companies are naturally commercial, but may still be interested in taking (fully-fledged) scientific documentaries into their product portfolio and renting them out to both their and the EPO office's advantage. An example of such a company is the German *One 4 Movie*[35]. VoD websites may have access to a very different segment of the population than that normally targeted and addressed by an EPO office. VoD is sometimes known as Over IP Video or OIPV.

34 http://en.wikipedia.org/wiki/Video_on_demand

35 http://www.one4movie.de

13. EVALUATION AND ARCHIVING

A long-term communication strategy is necessary to secure a smooth production flow for the line of products in an education and public outreach office. Part of the strategy should be to clearly identify some success metrics and evaluate products after completion. But it is very difficult to quantify successful science communication. What defines a success? Is it the "importance" of the medium? The number of readers? The type of readers? The increase in the level of the reader's understanding of science and the scientific work process? Is it the number of web hits or the downloaded Gigabytes? Most often it is a complex mix of all these factors. Science communication is not an exact science, but this should not prevent us from seeking indications of our impact on the target groups.

A long-term communication strategy is necessary to secure a smooth production flow for the line of products in an education and public outreach office.

13.1 QUALITATIVE EVALUATION

When limited resources prevent a rigorous statistical investigation of the impact an intuitive/subjective understanding of the market response can also play an important role in evaluating success. Such a qualitative impact estimate can only be made if very close contact with the target groups is maintained. Sporadic monitoring of the impact in selected media, ideally spanning a few years, will foster an intuitive understanding of which products, approaches and angles are the most effective. This is naturally a method that requires years of personal experience among the EPO staff.

13.2 QUANTITATIVE EVALUATION

Obviously some sort of quantitative success metric such as gathering quantitative data concerning a product's or project's penetration into the target group is more satisfactory.

As an example, the number of times a given science result has been mentioned in the media will, to a first approximation, reflect the interest of the press and public in the product and the organisation and show whether the EPO office workflow has functioned well. However it is not possible to extract information about the content of the articles in large numbers: whether the articles were of a positive nature or whether the message actually came across to the public. Qualitative indications (see above) gained from daily contact with representatives of each target group (journalists, scientists, public etc) remain an important addition to quantitative metrics.

For the special case of quantitative evaluation of video productions, see section 15.5.3.

13.2.1 Press clippings

Some communication offices use press clippings as a success metric. These are a fairly accurate estimator if a good selection of the press is sampled. Press clipping agencies can check written and electronic press

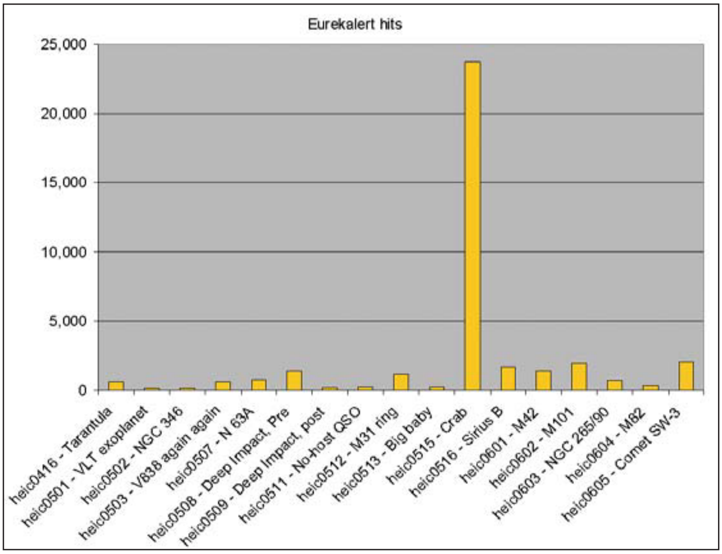


Figure 36: *An example of press release statistics from* EurekAlert.

for pre-specified keywords such as the name of the organisation or the project. This type of press clipping service costs real money, but can be a grand tool when justifying a continued or improved communication operation (provided the numbers come out in favour of the EPO office of course).

13.2.2 Press release portal stats

A relatively simple way to test a given press release's success with journalists is to check how many journalists look at it on press release portals such as *AlphaGalileo* or *EurekAlert*. Such portals often provide easy access to statistical information.

13.2.3 Google News

Another example of an impact estimator is *Google News* or similar services. *Google News* is a machine-generated list of the news items that appear on over 4500 news websites[36]. Apart from listing news coverage *Google News* also creates "clusters" of news coverage that have the same origin (for instance a press release).

The biggest political stories have a "Google News index" (number of websites carrying the story) of more than 1000. Good science stories

Google News

Figure 37: *A machine-generated* Google News *cluster with 28 related stories (other news websites covering this particular story) in the cluster.*

36 As of January 2006.

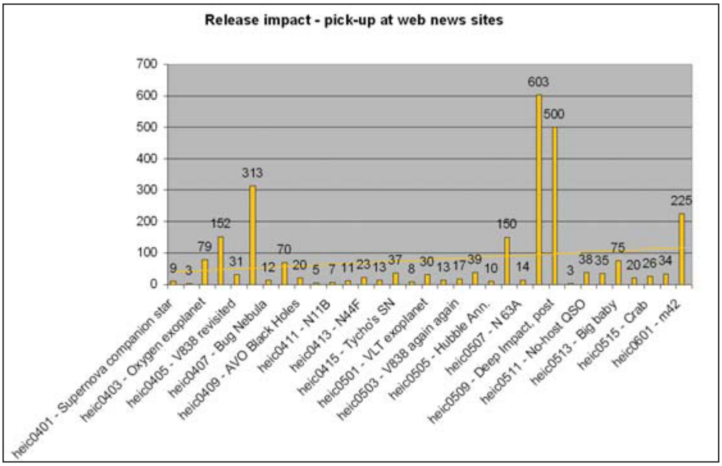


Figure 38: *Example Google news statistics for* ESA/Hubble. *The graph shows how many news websites picked up the individual releases in 2004 and 2005.*

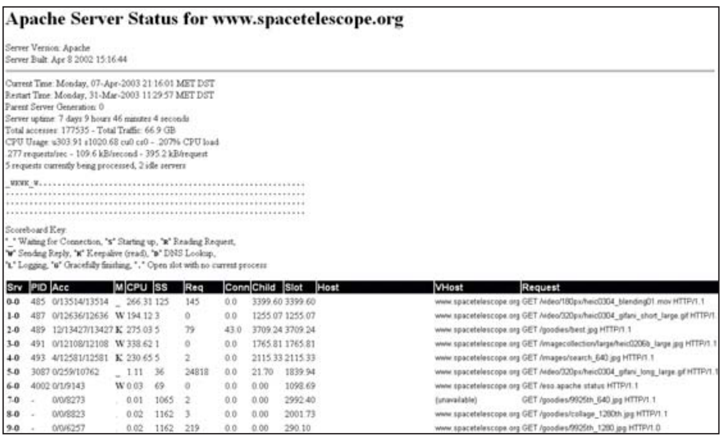
can make it above 100, and 20 can be considered quite satisfactory. *Google News* lists web articles for a consecutive 30-day period.

Using *Google News* it is possible to evaluate how successful individual releases are relative to each other. It is not always easy to understand why some releases fare better than others, although some of the effects may be attributed to random external factors.

13.2.4 Web statistics

A third way to estimate impact is to use web statistics.

Haigh and Megarity (1998) conclude that web statistics have to be taken with a pinch of salt as they often oversimplify the complex behaviour of users. However, as a minimum, web statistics can be used to



Apache Server Status for www.spacetelescope.org

Server Version: Apache
Server Built: Apr 8 2002 15:16:44

Current Time: Monday, 07-Apr-2003 21:16:01 MET DST
Restart Time: Monday, 31-Mar-2003 11:29:57 MET DST
Parent Server Generation: 0
Server uptime: 7 days 9 hours 46 minutes 4 seconds
Total accesses: 177535 - Total Traffic: 66.9 GB
CPU Usage: u303.91 s1020.68 cu0 cs0 - .207% CPU load
.277 requests/sec - 109.6 kB/second - 395.2 kB/request
5 requests currently being processed, 2 idle servers

_WKWK_W...

Scoreboard Key:
"_" Waiting for Connection, "S" Starting up, "R" Reading Request,
"W" Sending Reply, "K" Keepalive (read), "D" DNS Lookup,
"L" Logging, "G" Gracefully finishing, "." Open slot with no current process

Srv	PID	Acc	M	CPU	SS	Req	Conn	Child	Slot	Host	VHost	Request
0-0	485	0/13514/13514	_	266.31	125	145	0.0	3399.60	3399.60		www.spacetelescope.org	GET /video/180px/heic0304_blending01.mov HTTP/1.1
1-0	487	0/12636/12636	W	194.12	3	0	0.0	1255.07	1255.07		www.spacetelescope.org	GET /video/320px/heic0304_gifani_short_large.gif HTTP/1
2-0	489	12/13427/13427	K	275.03	5	79	43.0	3709.24	3709.24		www.spacetelescope.org	GET /goodies/best.jpg HTTP/1.1
3-0	491	0/12108/12108	W	338.62	1	0	0.0	1765.81	1765.81		www.spacetelescope.org	GET /imagecollection/large/heic0206b_large.jpg HTTP/1.1
4-0	493	4/12581/12581	K	230.65	5	2	0.0	2115.33	2115.33		www.spacetelescope.org	GET /images/search_640.jpg HTTP/1.1
5-0	3087	0/259/10762	_	1.11	36	24818	0.0	21.70	1839.94		www.spacetelescope.org	GET /video/320px/heic0304_gifani_long_large.gif HTTP/1.1
6-0	4002	0/1/9143	W	0.03	69	0	0.0	0.00	1098.69		www.spacetelescope.org	GET /eso.apache.status HTTP/1.1
7-0	-	0/0/8273	.	0.01	1065	2	0.0	0.00	2992.40		(unavailable)	GET /goodies/9925th_640.jpg HTTP/1.1
8-0	-	0/0/8823	.	0.02	1162	3	0.0	0.00	2001.73		www.spacetelescope.org	GET /goodies/collage_1280th.jpg HTTP/1.1
9-0	-	0/0/6257	.	0.02	1162	219	0.0	0.00	290.10		www.spacetelescope.org	GET /goodies/9925th_1280.jpg HTTP/1.0

Figure 39: *Web statistics in their purest form. The server (here for spacetelescope.org, one of* ESA/Hubble's *servers) can be monitored every second of the day via this status screen (lower half): the number of users, the download volume, the actual files being downloaded and also (top) some accumulated stats. These stats are stored in a text log file that can be summarised graphically with different web log analysis software tools.*

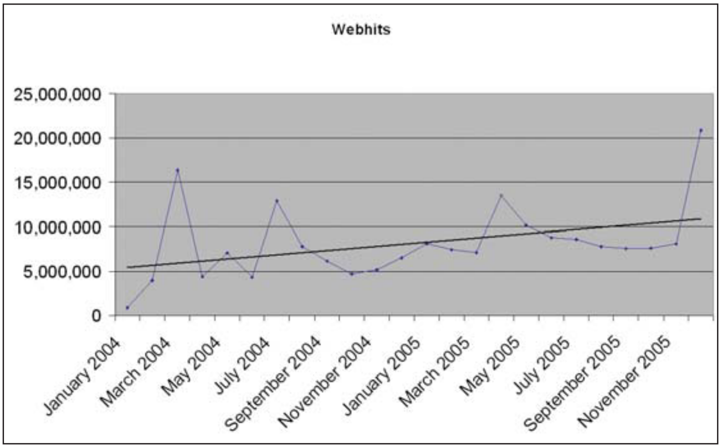


***Figure 40:** The number of web hits per month over a 2 year period for spacetelescope.org, one of* ESA/Hubble*'s servers.*

show the relative impact of web material. Comparisons may be drawn with previous similar work or with similar websites. Web stats include a number of parameters, but usually include the following three parameters: hits, visitors, and download traffic.

As the use of the Internet increases, web stats should move upwards on average over a reasonable sample period, for instance from month-to-month.

Hits

The number of hits represents the number of files downloaded (html pages, images etc).

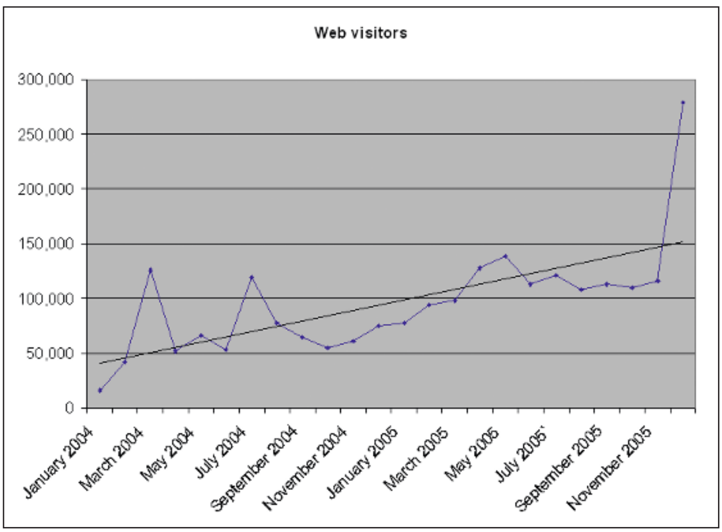


***Figure 41:** The number of web visitors per month over a 2 year period for spacetelescope.org, one of* ESA/Hubble*'s servers.*

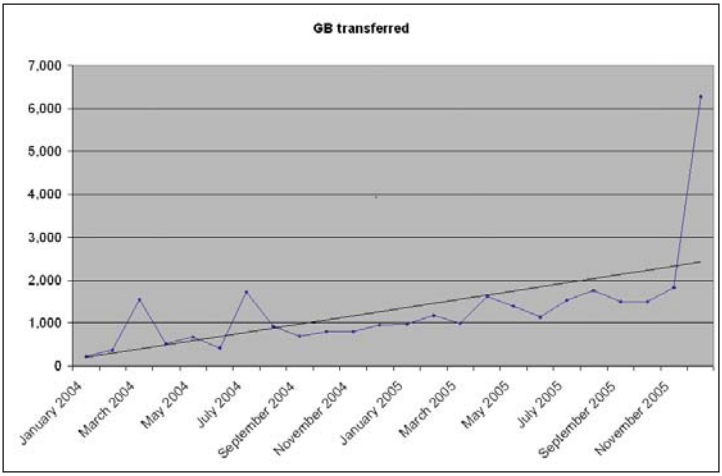


Figure 42: *The web traffic measured in Gigabytes per month over a 2 year period for spacetelescope.org, one of* ESA/Hubble*'s servers.*

Visitors

The number of visitors or sessions can be interpreted as the number of people visiting a website per month (it can also be "unique visitors" if repeat visitors are not counted).

Traffic

The traffic is a simply the measure of data transfer or traffic in units of kilobytes, megabytes or gigabytes per month.

Stickiness

Another useful estimator is the time per session, ie the average time a user spends on the website. This valuable number is an indicator of the "stickiness" of the content, that can be interpreted as the "quality" of the material itself, and not merely the quality of the advertising that got users to the site in the first place. There can be problems with this estimator as it not so easy to extract from the web server log by web server log analysis software tools. As Haigh and Megarity (1998) state, the extraction is usually based on two unsound assumptions:

- That a "host" corresponds to an individual user.
- That the user does not pause to go to another site or have a cup of coffee.

This makes the estimator a gross estimate at best for the real time per session, but is still useful for measuring the change in stickiness over time, or to compare with other sites that calculate time per session in the same way.

13.3 ARCHIVING

Good information management is one of the trademarks of a well-functioning education and public outreach office.

Good information management is one of the trademarks of a well-functioning education and public outreach office. This applies both internally within the group and externally towards the customers.

Being able to find information quickly when needed internally is the first step in any successful workflow and can be a real showstopper if neglected. Proper information management of the products offered to the outside world will decide whether customers can find what they are looking for or not.

The single most important concept in information management is archiving. Archiving splits naturally into two categories. One is fairly straightforward, namely archiving physical materials, whereas the other is more difficult, namely archiving electronic materials.

13.3.1 Archiving of physical materials

Proper archiving of physical materials is naturally highly desirable to smooth work internally within the group. The following production materials should be archived as a minimum:

- the raw material that went into the production of a product;
- copies of the actual finished product;
- material that relates to the evaluation of the product: press coverage, web articles, statistics etc.

An archive with easily accessible copies of the finished products makes distribution — especially later — much easier.

The best system is a matter of personal preference and working style. Do not underestimate the time saved by being able to find things instantly and so spend some strategic time setting up a proper archive as early as possible in an operation. For the author, hanging-file folder archives strike the right balance between "input time" (archiving the material) and "output time" (finding it again). It takes less than a

Figure 43: *A simple archive of raw material and finished press release copies in paper and glossy print form.*

NASA

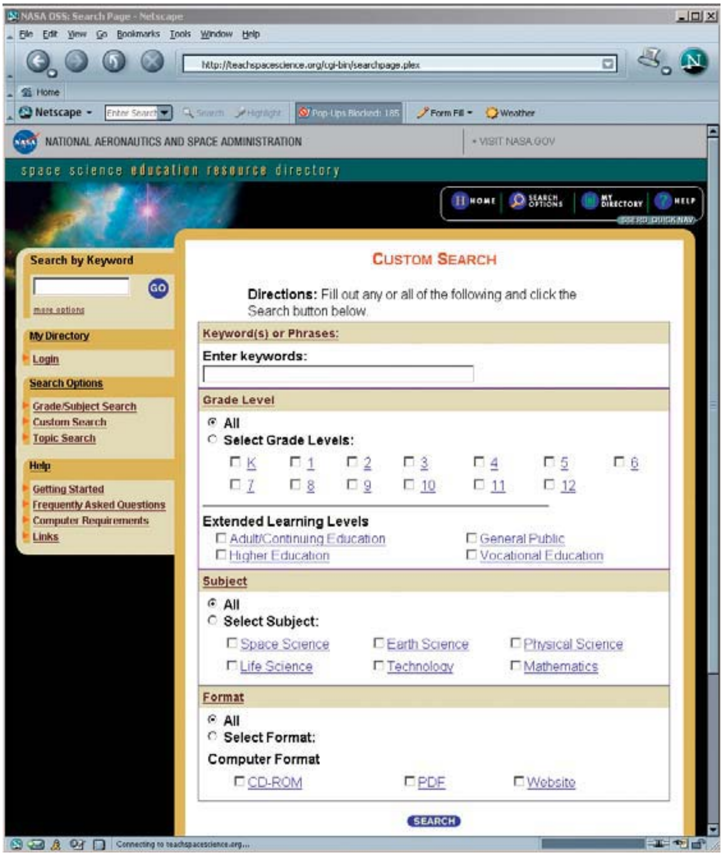


***Figure 44:** An example of a virtual archive:* NASA's *Space Science Education Resource Directory (http://teachspacescience.stsci.edu).* NASA's *Space Science educational products are entered into this service with a rich set of metadata describing content, target group (grade) and more. The service contains pointers to repositories such as websites that contain the data, except for educational material that is stored physically as PDFs and offered directly from the service.*

minute to set up a new case and to archive the material on the input side, and only a few seconds to find the materials again.

13.3.2 Archiving of electronic materials

Electronic information management is naturally a huge topic and is something that becomes ever more important as time passes.

Electronic information management is naturally a huge topic and is something that becomes ever more important as time passes. Generally an electronic archive consists of four components:

1. **Data:** The products or materials themselves (often consisting of pixels).
2. **Metadata:** Information that describes the data.
3. **Front-end:** Software that interacts with the user and allows him to "mine" the data.
4. **Look and feel:** Graphical interface that presents the information and the choices in a simple, appealing manner with a good overview.

See section 14.5.3 for an example of how this is implemented for a web archive system.

Figure 45: *An example of a physical archive: The EC's AthenaWeb. This archive is a repository of broadcast video clips from European research organisations and others. The decision to make this a physical archive, ie to transport all the data (the footage) to a centralised repository and control it from there accepts high manpower needs and costs.*

AthenaWeb/EC

There seem to be two different approaches to archiving electronic EPO materials: *physical* archives of data and *virtual* archives of data. In today's web-oriented age we have very little concern about the geographical location of electronic materials and this issue filters into the whole archiving discussion. What ultimately matters is whether an archive is kept up-to-date and not whether it contains direct links to the data (stored centrally) or pointers to the data that are stored in decentralised locations with the creators or publishers for practical reasons. The choice depends on the amount of data and other practical issues, but the magic question to ask is: what takes the most resources: porting the data to a centralised hold, or making sure that a decentralised virtual archive is kept up-to-date? In a virtual archive the creators or publishers often have a strong interest in making sure that their data are available, and therefore this responsibility can be transferred to them. The role of the virtual archive in this scenario becomes focused on the important task of devising and creating the system that connects the data and the metadata with the user through an appealing front-end.

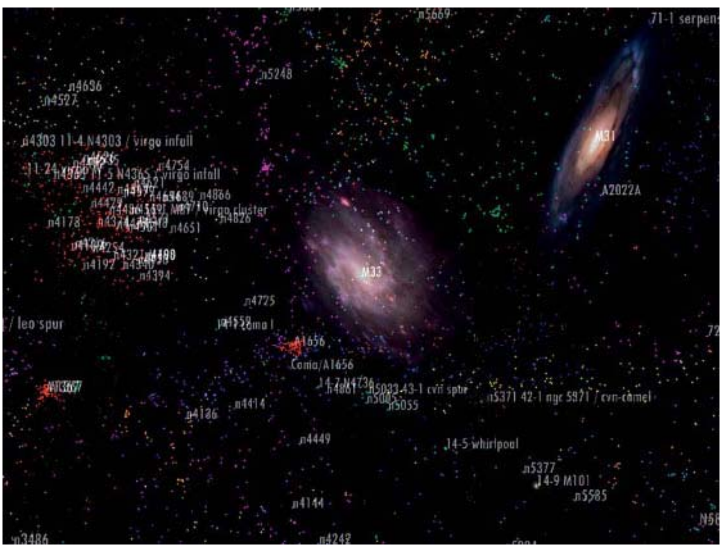
13.3.3 Case study: The Virtual Repository, a world-wide virtual archive

"An image is worth a thousand words, BUT only if you can find it!"

Paraphrase of an old Chinese proverb

The Internet and the web have been determining technologies in allowing efficient access to information and provide a fruitful environment for the creation of new information. Although innovative search tools, such as *Google*, have been developed to search the textual parts of the available information on the web, similarly *efficient* tools for searching audiovisual content such as images and videos stored in archives do not exist. There is some emphasis currently on the limited ability of these search engines to access and index archives of data. As yet there seem to be no global standards (like html for simple text and images) for accessing electronic archives of audiovisual content. A possible solution may be to set standards for how the data are metadata tagged, and allowing archives to agree to conform to some kind of standard for how they are accessed. This would allow the creation of a collective world-wide virtual archive of audiovisual content.

In astronomy the coordinated exploitation of astronomical science archive data through the *Virtual Observatory* (VO) will have a major effect on the way astronomers work. The exploding volume of incoming data and the emergence of technologies and tools to mine the archives will inevitably also have a knock-down effect and result in significant changes for outreach and education as well. There is undoubtedly a great potential for exploiting "VO-data" (meaning data in the VO era) and facilities in the educational and outreach context, but there is



Sciss AB Sweden/AMNH

Figure 46: *The dream of the Digital Universe is slowly becoming reality. Image from the* Uniview *application, property of* Sciss AB Sweden, *and the* Digital Universe database, *property of the* American Museum of Natural History.

Vast quantities of "clean" outreach material are available on the web today but it is next to impossible for the press and public to search these resources in a simple manner.

equally no doubt that this task is difficult and will need a coordinated worldwide effort.

At the same time as the scientists are experiencing a "data flood", we in the EPO world are also experiencing a similar parallel development. Larger and larger amounts of EPO audiovisual multimedia materials are being made available to press, educators and lay people on the web. The volume of digital products — outreach images, videos and news — is increasing all the time and the trend seems to be accelerating. Vast quantities of "clean" outreach material are available on the web today. The problem is that they are stored in individual archives with research organisations and are not linked systematically, so it is next to impossible for the press and public to search these resources in a simple manner.

Today's search engines work by searching and indexing the textual information in html text-pages on the web. Existing audiovisual search tools, such as *Google Images*, can only search textual information that is placed around embedded images on a webpage. This information consists largely of random pieces of text that often have little to do with the actual images and furthermore only images embedded in html pages can be searched. All audiovisual content in image or video archives, or databases, cannot be searched in this way and thus a large majority of existing audiovisual content is excluded. In addition, real archives are the preferred storage method for the highest quality content, ie the content closest to the scientific and cultural sources.

What is needed for astronomy EPO is a framework that enables seamless searching in archival databases on the web. One such idea is the *Virtual Repository*[37]. Here, as above, repository is used in the meaning of an archive, or a "place" where outreach and education resources are "collected" and "virtual" in the sense that no physical transport of data should take place — only a framework whereby the data can be accessed seamlessly in a sort of "Virtual Observatory-style" is required.

The search should be advanced, and allow users to specify search criteria such as quality, size, popularity and more. The *Virtual Repository* project is dedicated to improve the accessibility and usability of digital astronomical material in a multilingual environment. The project will coordinate collections in astronomical audiovisual archives worldwide and enhance the quality of the audiovisual material using well-defined metadata. It will reinforce cooperation between digital content stakeholders such as the existing image archives at the large observatories. The aim is to give access to the unique resource that is the sky — a vast laboratory of science that is always in operation and accessible at all times to everybody.

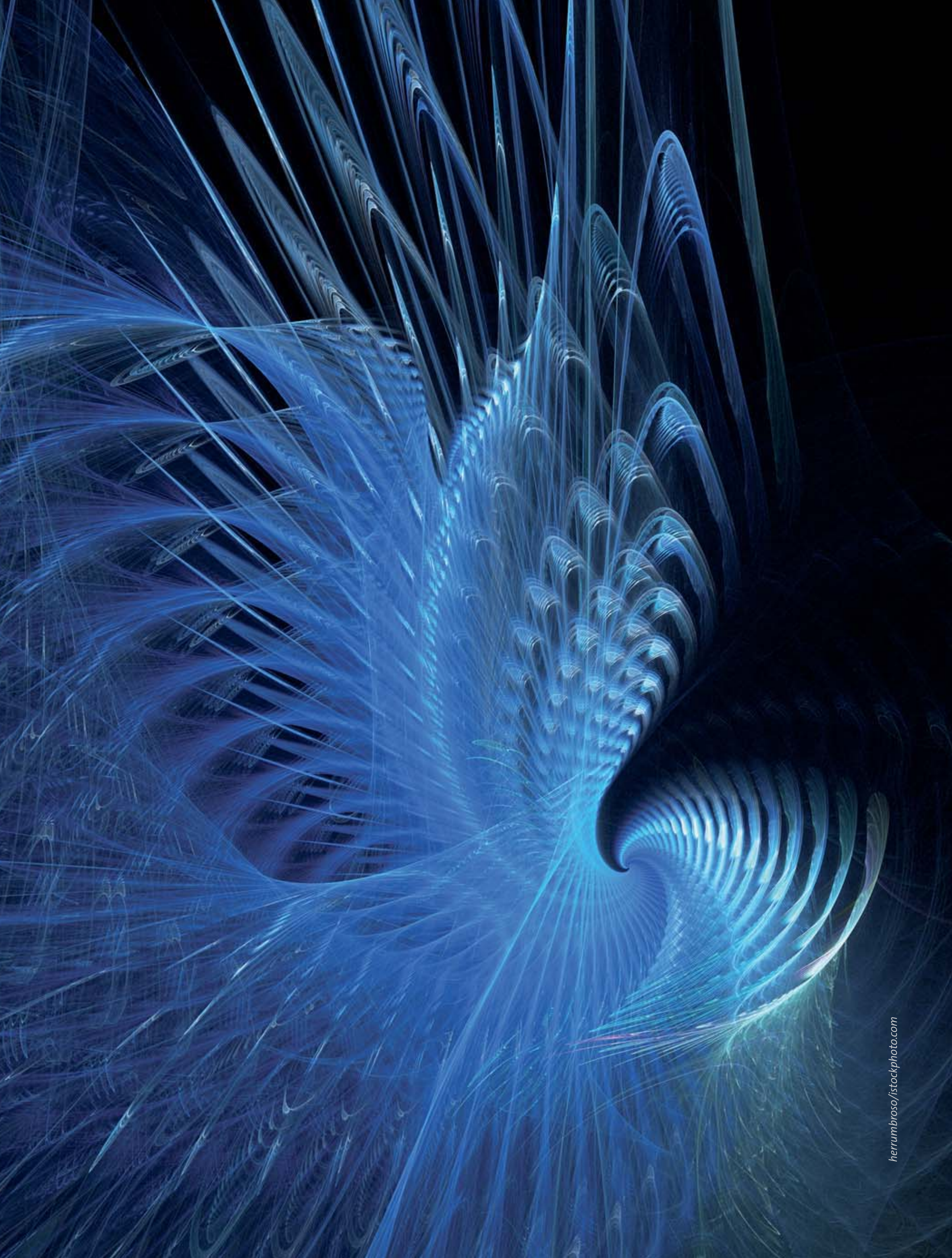
A few possible applications of such a *Virtual Repository* are:

1. Search engines (such as a hypothetical *Google Universe*).
2. Interactive click-and-point experiences in the planetarium dome ("let's look at the Orion Nebula in different wavelengths").

37 http://www.communicatingastronomy.org/repository/virtual_repository.html

3. The sky on your home desktop: Links with existing commercial planetarium software (*Redshift*, *Starry Night*, *The Sky* etc).
4. AstroKiosk (exhibition kiosks that automatically tap into, and exploit the daily stream of astro-news, provided they are coded with the right VR-metadata).
5. Educational material.

There are no limits to the potential applications when a *Virtual Repository* framework is in place, interlinking multi-wavelength images and videos and placing them in the right context.



herrumbroso/istockphoto.com

SELECTED TOPICS

PART III

14. MAKING WEBSITES[38]

A recent billboard advertisement read: "The web wasn't just a passing fad". Certainly no one would argue with that statement nowadays. In science communication the web is one of the most frequently used ways of distributing popular information about science to the media, the public and decision-makers today. As I argue in section 6.4 the web is becoming more and more a layman's tool. For several years the web has been the preferred tool for journalists to conduct story research (see Lederbogen & Trebbe, 2003, and section 7.3.2) and therefore a proper website must be a very high priority for any public information office. Webpages are today's business cards. The production of websites is a huge and specialised topic, but, without getting too technical, here are some rough guidelines on constructing science communication webpages.

In science communication the web is one of the most frequently used ways of distributing popular information about science to the media, the public and decision-makers today.

Lederbogen and Trebbe (2003) made an interesting study of a well-defined set of websites from scientific organisations in Germany. They find that most pages do not address their target groups properly and that they fail to disseminate the most interesting scientific information — the science results — effectively. Often the pages are not easy to understand and do not take advantage of the medium's excellent possibilities for displaying non-textual content such as multimedia.

Designing any website is far from trivial. Designing websites that are both user-friendly and easy to maintain is a real challenge.

Designing any website is far from trivial. Designing websites that are both user friendly and easy to maintain is a real challenge.

14.1 MAKING TRUSTWORTHY WEBSITES

Unfortunately the policy of uncontrolled self-publishing means there is no guarantee for the quality, credibility and reliability of web-based information. Everybody who thinks he has something important to say can publish his work or his opinion as proven facts on the Internet. This proliferation of self-publishing has decreased the value of net information and has resulted in some general bias against purely web-based information (Treise et al. 2003).

This trust issue is well-known and much discussed among more experienced users, and it is common knowledge that web information needs to be double-checked, for instance, against other webpages. This does not prevent problems from occurring, but since the web works so blindingly fast and has incredible amounts of information in comparison with other types of information search, it is fairly easy to work around this problem and to achieve a net gain when using the web. The issue of web trustworthiness has never been so much discussed as after the completely user-written web-based *Wikipedia*[39] became the largest encyclopaedia in the world in 2005 in just a few years of operation. Being from birth an open anarchic system largely policed by the community, it is an incredibly interesting system from an information science perspective. There is no doubt that the web — or at least

38 Discussions with, and inputs from, Anna-Lynn Wegener have been valuable for this chapter.

39 http://en.wikipedia.org/wiki/Wikipedia

respected subsets like *Wikipedia* — makes the retrieval of trustworthy information much quicker than before.

Since the Internet, apart from being used for serious science communication, is also a preferred communication tool for dubious pseudoscience, it is very important to design a science communication website so as to render it as credible as possible. Here are a few tips on how to accomplish this:

- **Be up-to-date**: Science moves quickly and you should make sure that the information you present is always new and up-to-date. To show this to the user you should state the date of your last update clearly on the website and avoid dead links to other websites that don't exist any longer.
- **Keep it simple**: Don't use too many or too bright colours and try to avoid fancy animations and sound effects. True information speaks for itself.
- **Have keywords**: Internet users judge the credibility of a website by comparing its contents with their background knowledge about a topic. This knowledge is generally acquired by education or through the media. Rogers and Marres (2000) suggest using the same keywords as media and education to facilitate the comparison between background knowledge and new information.
- **Link**: Referring and linking to other websites shows that your information conforms to that of other people and creates the impression that you are presenting commonly accepted facts. Be sure to link to acknowledged authorities like universities, governmental or international institutions or accredited experts to transfer some of their trustworthiness to your own webpage.
- **Be linked**: It is as important to be linked to as to link to other websites. If other institutions link to your homepage it means they acknowledge the information you are presenting. According to Rogers and Marres (2000) "non-linking is a sign of non-recognition, or, more radically, is an act of silencing through inaction", so be sure that you are linked to.
- **Use experts**: Mentioning acknowledged experts as a source of information on your website will make the information you are presenting more credible. People strongly believe in titles and credentials as they create an aura of authority. So rather than referring to Paul or Mr. Smith as a source, quote him with all his titles as Professor Paul Smith of the University of Edinburgh.
- **Be transparent**: Offer at least a minimum of information about the author of the website and state contact details for emerging questions. This conveys the impression that you aren't trying to hide anything.
- **Choose the right domain suffix**: Websites have different URL suffices to indicate the nature of their source. Governmental institutions are indicated by the URL suffix .gov, non-governmental organizations by .org, academic institutions by .ac (Brit-

ain) or .edu (USA) and all other providers by the collective suffix .com. Treise et al. (2003) state that the user's trust depends on the suffix domain of a website and that .ac and .edu are judged as more credible than .org and .gov, which again are considered more reliable than .com.

- **Be visible**: Even though search engines like *Google* do not rank the websites they find according to credibility, many Internet users still believe that the first webpage that comes up in *Google* is the most reliable. Therefore, by tagging many keywords, you can make sure that your website is ranked high in *Google* searches, which might help to increase people's trust in it. The more links that point to your site, the better ranking the site will have with *Google*.
- **Be open about your funding source**: Two crucial factors in judging the credibility of a website are: where the money for it comes from and whether you are pursuing a commercial agenda with the information you offer. Being open about your funding policies makes the website more transparent and trustworthy.
- **Be neutral**: People always try to judge your purpose in presenting certain information on the web. If you come across as having a personal agenda you will be judged less credible than somebody who presents the same information in a disinterested and neutral way. Therefore, it is advisable to use neutral rather than emotive language.

14.2 TO CMS OR NOT

Webpages can be constructed in different ways. Some of the most commonly used methods are:

- as simple manually constructed html pages;
- with a Content Management System (CMS);
- with your own backend system, for instance the *Simplicity* system, see section 14.5.

The web is a very important distribution tool (see chapter 12), but it is not unreasonable to assume that only a very few education and public outreach offices have their own full-time person (or persons) to deal with web issues. However, there is a huge step in the necessary manpower to go from a simple static html-page setup to a so-called Content Management Systems (CMS). CMS is a big buzz word for web management today.

A CMS is a large database driven tool that helps to structure information in the form of text, images and animations and place it on the web in a predefined way.

Static html-pages are simpler, low-tech solutions and are usually set up and maintained with the help of web editors such as *Adobe® Dreamweaver®* or *Microsoft Frontpage*. These editors offer templates that can replace some of the functions of a CMS, such as fixed design and the ability to change a design sitewide at a later time.

	CMS	Requirements for an Education and Public Outreach office	Result
Positive	Offers relatively easy maintenance by many people simultaneously.	Needs easy web maintenance by only a few people.	0
	Is reasonably easy to learn for non-technical people.	Needs a system easy to learn for reasonably technically oriented people.	+
	Offers reasonably easy creation of many new articles per day ('newspaper style').	Needs to create a only few new articles per day.	+
	Can be set up to make automated (and periodic) changes to the content, such as sitemap, lists, front page, glossary etc.	Some degree of automation is desirable.	+++
	Often includes workflow control (approval control by different people, status overviews).	No urgent need for workflow control.	0
	Has special features such as link checking, expert site options etc.	Link checking etc is needed.	+++
	Can often integrate small and simple image archives.	Needs a fully-fledged image archive with no restrictions due to file sizes, formats etc.	0
	Has automated search functions.	Needs automated search functions but this can be attached as an external package.	+++
	Has a cool, consistent design.	Needs a cool, consistent design.	+++
	Can change design sitewide relatively easily.	Needs to be able to change design every few years.	+++++
Negative	Usually has to be set up and programmed by an external company.	Needs full autonomous control of the system, its technical maintenance and its programming.	– – – – –
	Has bad performance and handling of large and huge image and video files.	Needs the web solution to work efficiently regardless of the type and size of the content.	– – – – –
	May have slow response for the users.	Needs lightning fast response for the user.	– – – – –
	Very little flexibility and little ability to adapt to new ideas, formats etc.	Needs high degree of freedom.	– – – – –
	Takes programming experience to make structural changes.	Needs the ability to implement new ideas fast and in a low-tech way.	– – – – –
	Has fixed templates similar to web forms => simple creation of articles, but slow and does not offer many degrees of freedom.	Nice in some ways, but slow and needs many degrees of freedom (within the design guidelines).	– – –

Table 8: *A quick and dirty comparison of the services offered by a Content Management System (CMS) and those needed by a communication office.*

The idea of a CMS seems to make most managers happy — at least in the implementation phase. Table 8 presents my (subjective) scorecard for how well a CMS fulfils the requirements of EPO offices based on personal experience.

My conclusion is that a CMS is overkill for all but perhaps the largest science communication outfits. There are indeed benefits in a CMS, but based on the relative slowness and inflexibility of such a system it does not fit very well into the daily grind of an EPO office. A CMS may however be a good idea for groups with less technical know-how. It is in this case important to choose a standard off-the-shelf solution that is in widespread use worldwide.

My conclusion is that a CMS is overkill for all but perhaps the largest science communication outfits.

14.3 CASE STUDY: FERMILAB'S WEBPAGES

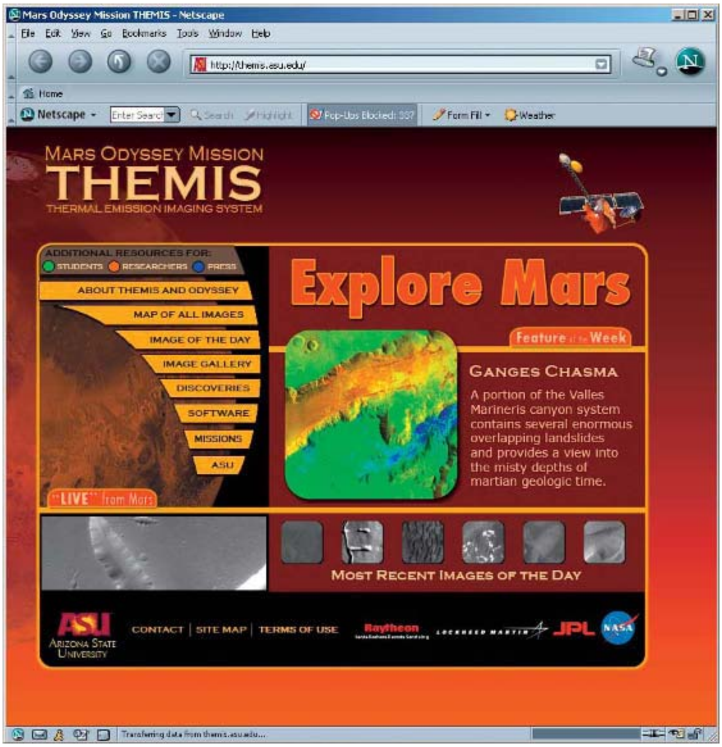
It is not difficult to find bad webpages, but a good example of a science communication webpage with all the essentials is *Fermilab*'s webpage (http://www.fnal.gov/). Some of the main features are:

- a clean design with:
  1. a clearly visible navigation structure;
  2. thumbnail photos to show some aspects of the organisation;
  3. a news area;
- fast response;
- clear overview of thousands of pages;

FermiLab

Figure 47: A well-designed organisational homepage: the homepage for Fermilab *in the US (2005)*

Figure 48: The Themis website is a textbook example of integration of science, graphics and technology.



NASA/JPL/Arizona State University

- quick access to the main information (addresses, staff phone numbers etc).

Read more about the development of (an earlier version of) the page at: http://www.nist.gov/public_affairs/Posters/fermilab.htm.

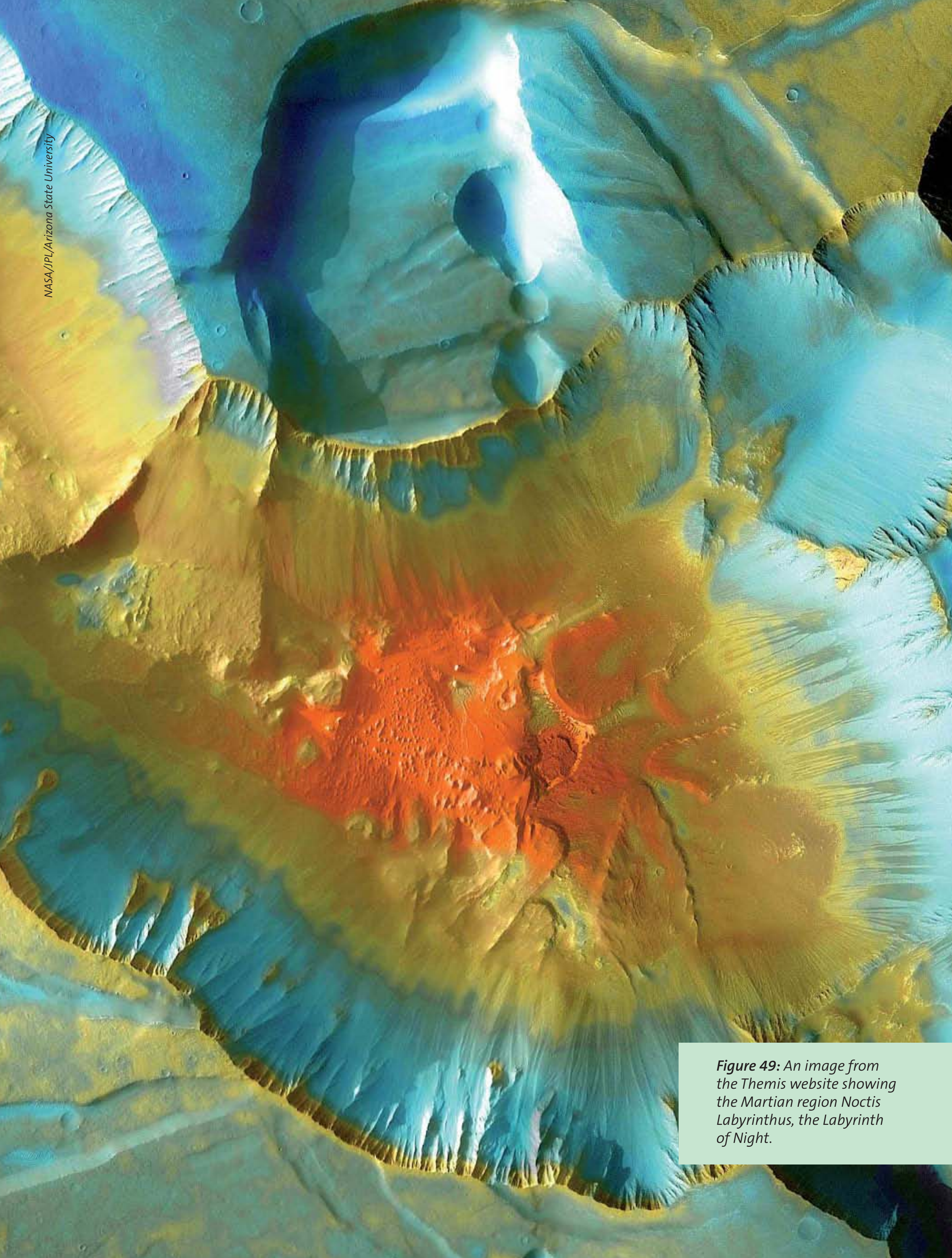
14.4 CASE STUDY: MARS ODYSSEY THEMIS WEBSITE

Apart from featuring the obvious text and image content the web can also be used for relatively simple interactive "applications" written in, for instance, Flash or Java. These range from simple pop-up windows to elaborate games exchanging information between users.

Very good examples of this are seen on the website for the Mars Odyssey Themis instrument (http://themis.asu.edu/). Themis is an infrared instrument on board NASA's Mars Odyssey spacecraft in orbit around Mars.

Some of the website's impressive features:

- interesting graphics with a modern inviting look;
- good overview;
- access to real data with simple web tools;
- multiple target groups: from laypeople to scientists working in other or related fields.



NASA/JPL/Arizona State University

Figure 49: *An image from the Themis website showing the Martian region Noctis Labyrinthus, the Labyrinth of Night.*

Overall the Themis website is a textbook example of the how the integration of science, graphics and technology elevates a somewhat difficult topic to an interesting level (cf, the skills triangle in section 3.4, figure 4).

14.5 CASE STUDY: DESIGNING AND PRODUCING A WEBSITE FOR ESA/HUBBLE[40]

Early in 2004 we began designing a new website for the Hubble Space Telescope in Europe. In this case study I would like to share some of the thoughts behind it, and the outcome.

We naturally wanted to exploit the advantages of the web as compared to other vehicles, and to produce a website that fulfilled particular needs for maintenance efficiency (due to very restricted available manpower). We quickly realised that the need to reduce manpower consumption for web maintenance was a general one in the science communication community and we extended our methodology into a general scheme for building efficient science communication websites. The results of our efforts are partly Spacetelescope.org, the public and press website for the NASA/ESA Hubble Space Telescope in Europe, and partly the web system *Simplicity* that combines ease of use for visitors with a simple and effective strategy for maintenance. *Simplicity* has also has been used to build the websites at *NASA* and at the *Instituto de Astrofísica de Canarias*.

For us, making the *Simplicity* system for organising information and serving the page provided an efficient alternative to existing commercial content management systems. A more detailed description and components for free download can be found at: http://www.spacetelescope.org/projects/web. A comprehensive users' manual (Nielsen et al., 2004) can be found in the same place.

14.5.1 Requirements for *Simplicity*

The most critical commodity we have in the field of science communication is time. We need to dedicate most of our time to producing material, and very little time to actually distributing it.

A website is an excellent tool for the distribution of outreach products and for product archiving in a repository, while also providing a searchable service that is available 24-7 thereby allowing rapid retrieval of relevant material. The most critical commodity we have in the field of science communication is time. We need to dedicate most of our time to *producing* material, and very little time to actually *distributing* it.

Spacetelescope.org was built to satisfy several requirements.

Firstly it had to be a user-friendly website that is easy to navigate and extremely responsive to the customers' needs with a consistent, attractive design. In today's information overloaded society it is crucial to provide search capabilities that enable the user to sift through vast amounts of information swiftly and to receive an instant response to each query.

40 This section was written with valuable inputs from Lars Holm Nielsen & Erik Nordström Andersen.

Secondly the technology behind the site should be able to juggle huge data files — images and videos (up to GBs in size) — in archives unrestricted in size, containing thousands of items each represented in up to 15-20 different display formats (e.g., thumbnails, wallpaper, originals etc for the images), without impeding function or requiring maintenance. It should be able to handle all existing file formats (JPEG, GIF, TIFF, MPEG, QuickTime®, Flash etc) as well as being easily adjusted to accommodate future file formats.

Thirdly the maintenance of the web system (daily updates) should be extremely easy and fast. Design changes should be implemented in just one place, so that the webmaster is not forced to update hundreds of pages manually. Structural changes such as the addition of new archives should also be possible with relatively small changes to the system.

Finally, the website should be relatively "CPU light" and be able to handle many hits, many concurrent visitors and many downloads on standard server hardware.

14.5.2 Planning

For Spacetelescope.org there were five main areas of focus in the planning phase. Firstly, the **functionality** of the website, then the **sitemap** — ie the structure (files and directories) — the **front page** and finally the **file formats and sizes for the data**, ie images and videos and **the structure of the metadata** (data about the images and videos).

Figure 50: front page of the Spacetelescope.org, built with the Simplicity *backend. The page is a result of trying to analyse the needs of different target groups in a front page significance matrix.*

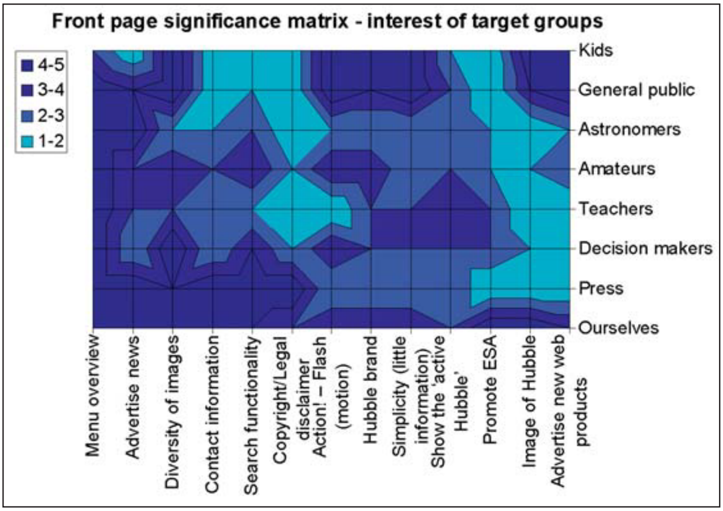


Figure 51: *A front page significance matrix showing the significance of the different functional or graphical components on the front page.*

Planning the front page

Targeting a website to its customers is essential to make it successful, and the front page of a website is undoubtedly the most important page of all. In our preparations for an effective front page we devised what we call a front page significance matrix consisting of two steps:

1. List a sample of different target groups and assign each of them effective weights calculated from how big a target group they represent and their individual "importance" (as judged by our own particular subjective criteria, table 9).
2. In the absence of a proper user survey we simulated the results by putting ourselves in the place of every target group in the weighting scheme and assigning a significance from 1 (unimportant) to 5 (important) to the different functional or graphical components on the front page, such as Menu overview, Action (moving elements) or Hubble branding (PR). The result of this exercise is depicted graphically in figure 51. Note that this is at best a simulation derived from educated guesswork based on real experience with the target groups, rather than scientifically collected data from a properly framed survey.

The result was multiplied with the effective weight of the target group and organised as a prioritised list of the importance of the different front page components (seen in table 10).

The following conclusions were drawn from this:

1. A **simple page overview** is the most important.
2. **News** must have top priority.
3. **Hubble images** have to be prominent.
4. Excessive space for **flash animations** cannot be allocated, but they are necessary.
5. Excessive space for design components cannot be allocated, but an **appealing design** is mandatory.

The actual final design for the front page is seen in figure 50. For us this represents a compromise between efficiency, searchability, science, visual appeal, "action" and overview that we think caters to the needs of most target groups and the most important users.

14.5.3 Components of the web scheme

Simplicity consists of four main components:

1. **Data**: The actual data (images, videos, news stories, brochures etc). In figure 50 the round images and the five lines of news story texts are data.
2. **Metadata**: Metadata is information about the data (ie image ID, Title, Object name etc, see figure 52). These are stored in "comma separated text files" editable with *Microsoft Excel*. *Excel*, although not traditionally used for this type of work, has maintenance-friendly features such as spell checking and is familiar and easy to use. Each archive object (an image, a news story, a video, a poster etc) has a line of metadata stored in a text file.
3. **Front-end:** Query scripts to execute various search and display queries, either in dynamic form (interacting with user), or pre-generated static queries (for content that does not change and for which on-the-fly CPU intensive queries are not necessary). Instead of using off-the-shelf database solutions that have problems dealing with huge files, a large maintenance overhead and a potentially slow response time, the choice for *Simplicity* fell on lightweight *Perl* scripts as the "engine" to create the dynamic web content.
4. **Look and feel:** *Adobe® Dreamweaver®* templates are used for the 'wrapping' of the design around the query outputs. *Dreamweaver*[41] is a simple and visual commercial html editor that allows webpages to be edited easily, and also provides a template scheme. The templates define the editable areas of a webpage, making it possible to keep a consistent design on all webpages.

	Us	Press	Decision-makers	Teachers	Amateurs	Astronomers	General public	Kids	Total
Number of visitors		15%	1%	5%	11%	20%	43%	5%	100%
Weight		75	250	25	10	3	1	5	369
Effective weight	**13**	**11.25**	**2.5**	**1.25**	**1.1**	**0.6**	**0.43**	**0.25**	**30**

Table 9: *Weighting scheme for the Spacetelescope.org front page: Effective weights of a sample of target groups according to their estimated number and importance for us. Note that we had to add ourselves as a target group as we realised that we had certain requirements that were of little or no interest to the real target groups (of a more PR specific nature).*

41 Web editor: Dreamweaver — http://www.macromedia.com

Table 10: *Prioritised list of the importance of the different front page components.*

Menu overview	151
Advertise news	138
Diversity of images	135
Contact information	134
Search functionality	128
Copyright/Legal disclaimer	105
Action! — Flash (motion)	95
Hubble brand	94
Simplicity	93
Show the 'active Hubble'	92
Promote ESA	92
Image of Hubble	88
Advertise new web products	77

Any changes made to a template will cascade to all webpages that are based on it, and so design changes need only to be made in one place. Nested templates — templates themselves based on other templates — are used to ease the maintenance load further. This makes it possible to define the global design of the website in one template and create templates for the different sections based on this global template to hold the individual section design items and menus.

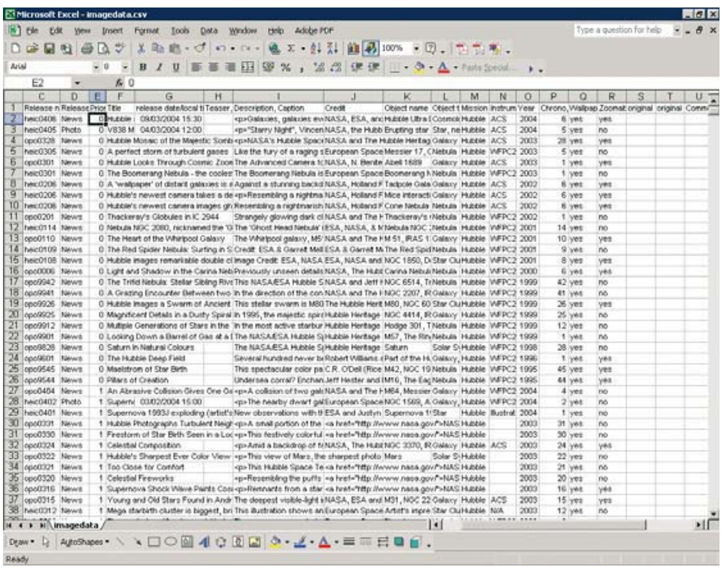


Figure 52: *A Metadata text file opened in* Excel. *Each line corresponds to an image and contains information such as ID, Title, Description, Object name and more.*

14.5.4 Archives

One of the pillars of the *Simplicity* scheme is the concept of "archives". An archive can be any collection of data and metadata. The content of an archive can be shown in any way needed, and in different ways in different parts of the website.

In *Simplicity* the *Perl* scripts search and show excerpts of the archive metadata that are stored in the *Excel* files, along with the necessary data (images, videos ...). The *Perl* scripts can format the data/metadata content of the archives in many different ways and also make refined searches possible. They can also publish content at a pre-determined time. The *Perl* scripts are run from a homemade Administration web interface where individual IDs in individual archives can be generated at will.

14.5.5 Pros and cons

Why choose a "home-made" low-tech solution over one of the many content management systems (CMS, see section 14.2) on the market? A CMS can certainly be adapted to most common user demands, such as ease of maintenance and a consistent design, but when it comes to performance and handling of huge image files, we believe most CMSes fail.

In science communication there is an intense need for flexibility, and this implies the fully autonomous control of a web scheme and its technical maintenance and the flexibility to adapt quickly to new ideas. Most CMSes do not provide this. In addition most CMSes do not provide the lighting fast response needed.

In science communication there is an intense need for flexibility, and this implies the fully autonomous control of a web scheme and its technical maintenance and the flexibility to adapt quickly to new ideas.

On the down side, *Simplicity* is not a foolproof scheme. No web system is ever 100% foolproof, but our scheme is probably more open to error, especially when used by non-technical staff. *Simplicity* is not a multi-user system; in the sense that only one person can edit the page design, or update the individual metadata files at a time. In a normal outreach office none of these issues should present major worries as it is usually staffed with technically competent personnel and there is no need for workflow control, approval control and version tracking.

As a happy side effect, the construction of *Simplicity* (including the implementation of *Spacetelescope.org* with all its data and metadata) only required three man-months of work, compared to an estimated two or three times longer for an off-the-shelf CMS (with less functionality). Some of this time was naturally invested in an integral knowledge of the scheme that will contribute towards a reduced total cost of ownership in the long run. The total implementation costs were roughly 13 k€.

Simplicity's low-tech solution has proven its performance capability. *Spacetelescope.org* runs on a single standard *Apache SUN* web server and has coped with more than 2 million hits per day (50-60 requests/sec peak load) and the delivery of up to 1 Terabyte of data per day.

15. VIDEO PRODUCTION

The production of video material is an extensive topic and is treated separately from the "production flow" chapters above, although this type of production necessarily has to be an integral part of the daily operations. Video productions usually have to be planned even further in advance than other products and some of the most important aspects of the process are discussed below. More good advice can be sought in Kalbfeld (2001).

15.1 TELEVISION

As stated earlier, television is one of the most powerful news media we have access to, and its importance has tended to increase over the past few years. Some of the main reasons for its success as a news medium:

- The public's increasing need for quick access to news about world events.
- A given news topic can be described on screen by means of animations, illustrative footage, sound bytes from experts very quickly.
- The media works almost exclusively by pushing information towards the user. The user only has to turn on the television set, sit back and relax.

For these reasons television is one of the most attractive media to use for distributing news oriented products. Television is also one of great challenges. As Taylor (2003) writes: *"Television is a medium of great power and vast limitations"*. The medium is very simplistic and there is great (economic) pressure to make science programmes less "in-depth" and more "edutaining". But, as Taylor continues:

Television is one of the most attractive media to use for distributing news oriented products.

> *"On the positive side, if you use Television's visual power effectively you can create images that stay in the mind."*

The typical way for an EPO office to distribute video material related to a press release is by issuing a Video News Release (a VNR). Television is "expensive" in more ways than one. VNRs are relatively costly to produce (both for technical and for manpower reasons). The entire broadcasting system is expensive, meaning that competition for airtime is fierce. Therefore, a communication office should only use television for the very best news stories and take great pride in producing the best possible VNRs.

A communication office should only use television for the very best news stories and take great pride in producing the best possible VNRs.

15.2 THE VIDEO NEWS RELEASE

A Video News Release (VNR) is a press release in video form designed for use on broadcast television — as a news item or feature story. VNRs translate the printed word into the sound and pictures television newsrooms need. A Video News Release usually consists of an A-roll and a B-roll.

***Figure 53:** Television is one of the most powerful news media we have access to. Do not let technical worries stop you.*

The A-roll is a 2-5 minute produced “programme” that tells the story in an appealing and journalistic way. It is edited and has voice-over (speak). This will give broadcasters (producers and news directors) a quick introduction to your story that will help them decide whether it is worth running or not. A B-roll follows the A-roll, and contains all the A-roll sequences (unedited) and additional background material, stock footage and such. The B-roll has no narration and sound. It may be useful to have “slates” with the name and duration of each B-roll sequence.

15.3 ISN’T IT TOO DIFFICULT TO PRODUCE VIDEO MATERIAL?

A word about the production of video material in general: if you think you or your group has the talent to produce useful material in a reasonable time, do not let technical worries stop you from trying. It may seem like a dauntingly high-tech branch of science communication, and to some degree it is, but with a feel for formats and an editing system up and running (or just use an outside company) it is not so difficult. And the outcome may be well worth the extra effort. For an example of an "all-you-need" system see chapter 10.

15.4 PRODUCTION OF VIDEO MATERIAL

A video is just one of many product types, or vehicles, at our disposal and, as such, the production should follow the steps in the usual production chain (see chapter 4). It is, however, also normal to describe video productions with a model consisting of three main phases that exclude some standard links in the production chain such as distribution (see also section 15.5). The three phases are:

1. **Preproduction**: The phase of a project spent preparing, researching, planning, writing the script, preparing for the audio, developing a shotlist and making a storyboard.
2. **Production**: The phase of a project spent producing video footage and the audio.
3. **Postproduction**: The phase of a project spent editing the footage and compositing the footage into a finished video.

Some basic advice and examples for these phases are given below. Much more information can be found in the literature and on the web (see for instance the excellent *Digital Video Curriculum Guide* from *Adobe®* [42]).

15.4.1 Preproduction

Preproduction is the preparatory phase of a project spent researching, planning, writing the script, preparing for the audio, developing a shotlist and making a storyboard. So preproduction defines the "big picture" of the production, setting the resource budget, target groups, level, duration and style, and then planning things in detail. Read more about the general concept of planning in sections 4.1 and 4.2.

The storyboard

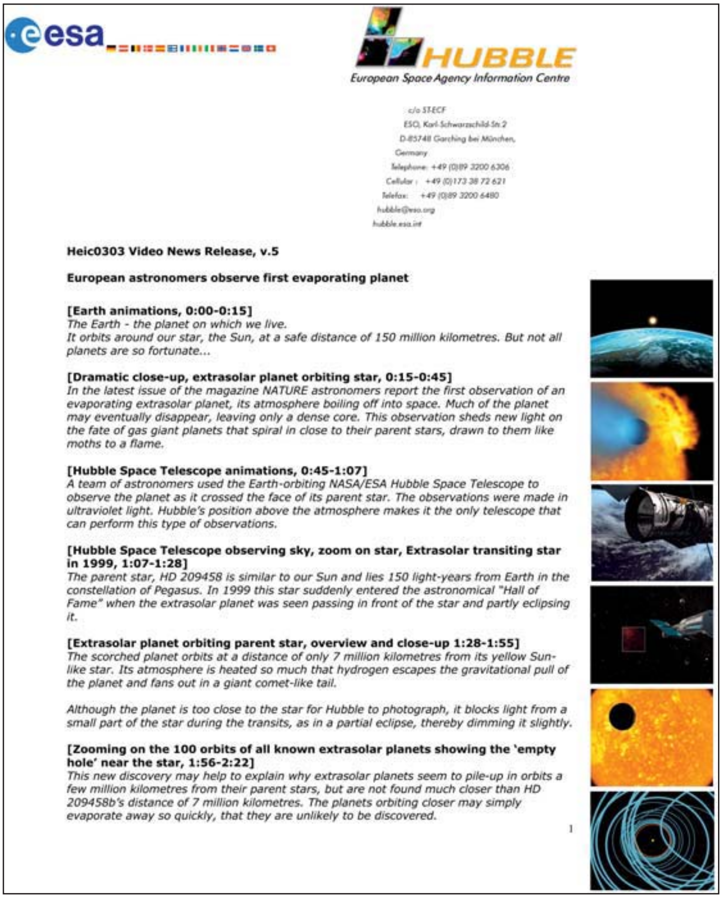
The most important component of the preproduction is the storyboard. A storyboard is a schedule with visual indications and should put all collaborators in a movie project on the same footing. As *Adobe®* states on their website[43]:

> *"Feature films, animated movies, and commercials have one thing in common: They begin as storyboards. Before a camera is picked up or a tape is taken out of shrink-wrap, the blueprint for the project has already been designed. That blueprint is the storyboard. It is a visual outline for the video. Storyboards are not usually fancy — stick-figure drawings will do. But they save time. For professional producers, time is money [...] Storyboarding is an important skill to learn."*

42 http://www.adobe.com/education/instruction/curriculum/dv_curriculum.html

43 http://www.adobe.com/education/digkids/lessons/storyboards.html

Figure 54: The first part of an elaborate VNR storyboard: the script and the thumbnails (here even partly rendered).



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Heic0303 Video News Release, v.5

European astronomers observe first evaporating planet

[Earth animations, 0:00-0:15]
The Earth - the planet on which we live.
It orbits around our star, the Sun, at a safe distance of 150 million kilometres. But not all planets are so fortunate...

[Dramatic close-up, extrasolar planet orbiting star, 0:15-0:45]
In the latest issue of the magazine NATURE astronomers report the first observation of an evaporating extrasolar planet, its atmosphere boiling off into space. Much of the planet may eventually disappear, leaving only a dense core. This observation sheds new light on the fate of gas giant planets that spiral in close to their parent stars, drawn to them like moths to a flame.

[Hubble Space Telescope animations, 0:45-1:07]
A team of astronomers used the Earth-orbiting NASA/ESA Hubble Space Telescope to observe the planet as it crossed the face of its parent star. The observations were made in ultraviolet light. Hubble's position above the atmosphere makes it the only telescope that can perform this type of observations.

[Hubble Space Telescope observing sky, zoom on star, Extrasolar transiting star in 1999, 1:07-1:28]
The parent star, HD 209458 is similar to our Sun and lies 150 light-years from Earth in the constellation of Pegasus. In 1999 this star suddenly entered the astronomical "Hall of Fame" when the extrasolar planet was seen passing in front of the star and partly eclipsing it.

[Extrasolar planet orbiting parent star, overview and close-up 1:28-1:55]
The scorched planet orbits at a distance of only 7 million kilometres from its yellow Sun-like star. Its atmosphere is heated so much that hydrogen escapes the gravitational pull of the planet and fans out in a giant comet-like tail.

Although the planet is too close to the star for Hubble to photograph, it blocks light from a small part of the star during the transits, as in a partial eclipse, thereby dimming it slightly.

[Zooming on the 100 orbits of all known extrasolar planets showing the 'empty hole' near the star, 1:56-2:22]
This new discovery may help to explain why extrasolar planets seem to pile-up in orbits a few million kilometres from their parent stars, but are not found much closer than HD 209458b's distance of 7 million kilometres. The planets orbiting closer may simply evaporate away so quickly, that they are unlikely to be discovered.

1

Below is an example of a simple storyboard for a Video News Release[44]. The storyboard consists of the script for the A-roll (in italics) with time-code, thumbnails indicating the visual content, and a "shotlist" giving the overview of the content of the entire tape. The visuals do not need to be as elaborate as here.

15.4.2 Production

The production phase of a project is spent producing or acquiring the raw components: the video footage and the audio.

Audio

Naturally the video footage is normally the most important part of the production, but even the most superb footage will not appear outstanding unless the audio, and especially the music, is not up to scratch. The overall quality of a product is often improved tremendously when the final music is added to a project. It is possible to find free music on

44 From http://www.spacetelescope.org/videos/scripts/heic0303.pdf

Shotlist

TIMECODE	DESCRIPTION
	A-ROLL
10:00:40	Sunset over Earth
10:00:47	Earth rotating, Brazil covered in clouds
10:00:58	Dramatic close-up, extrasolar planet passing by in its deadly 7 million kilometre orbit over the hot parent star
10:01:11	Zooming on parent star, scorching hot gas streams up
10:01:22	Hubble Space Telescope (HST) animations
10:01:37	HST observes the constellation Pegasus, 2.5 degree field from the ground-based Digitized Sky Survey 2 zooms up, centred on parent star HD 209458.
10:01:50	Crossfade to animation of parent star, zooming in
10:01:58	Extrasolar transit from 1999
10:02:06	Planet orbiting star, comet-like gas tail
10:02:17	Following planet behind star
10:02:27	Planet + tail passing in front of star
10:02:35	Zooming on orbits of 100 known extrasolar planets, showing the central 7 million kilometre 'zone of avoidance'.
10:03:02	**END A-ROLL**
	B-ROLL
10:03:12	A-roll animations: • Dramatic extrasolar planet close-up • Zooming on parent star • HST observing, zoom on parent star HD 209458 • Crossfade to animation of parent star • Extrasolar transit from 1999 • Planet w. tail orbiting star • Following planet behind star • Planet + tail passing in front of star • Zooming on orbits of 100 known extrasolar planets
10:05:09	HST receives light from space, instruments and mirror inside of HST visible
10:05:31	HST transmits observations to the ground
10:05:51	Miscellaneous HST animations
10:08:41	Miscellaneous Earth animation
10:09:35	**END B-ROLL**

Figure 55: *The second part of a video storyboard — the shotlist.*

the web and there are also compilations of copyrighted "pay-per-use" stock music available. The best solution is to join forces with some talented and relatively unknown (read "affordable") artists who can compose and record music in collaboration with you.

Even with a detailed storyboard prepared, whether you produce the audio or the footage first is a classic chicken and egg dilemma. These two components influence each other heavily. There is no clear solution, but flexibility in both the different productions is a must. In general the integration of the two productions is an iterative process and the "leading" component is the one that is the most inflexible. It makes sense to give composers a raw footage clip with as much content as possible to work from and take it from there.

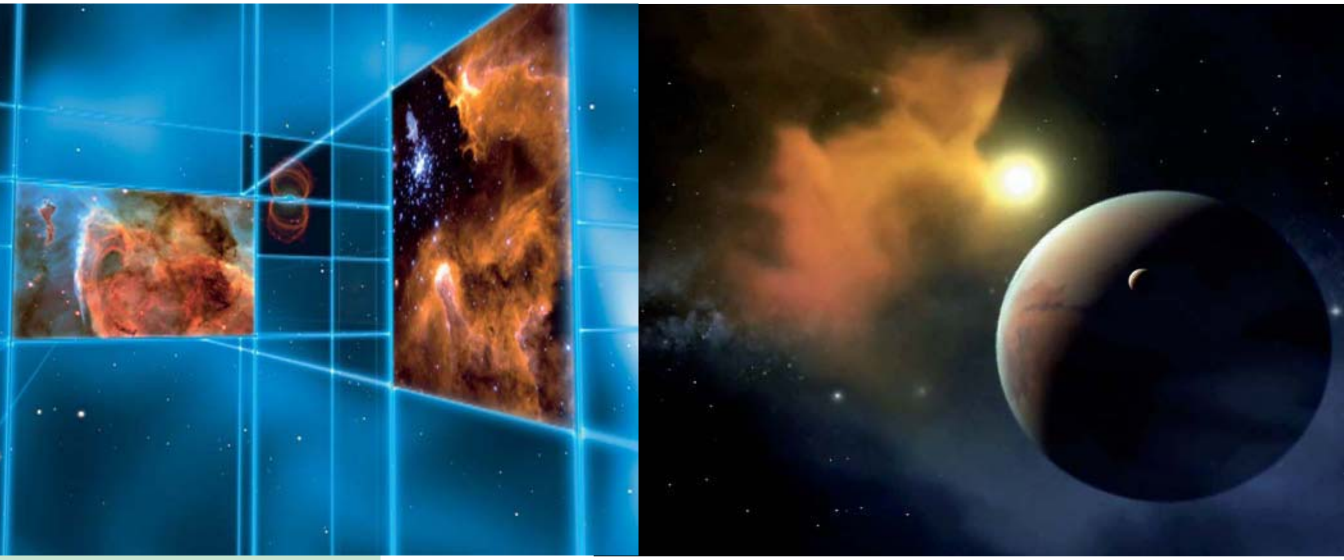


Figure 56: *Examples of 3D animations: to the left, a journey in music and images through the Universe. To the right, an imaginary extrasolar planet.*

Video footage

The raw video footage can consist either of real footage recorded with a camcorder and digitised, or animations, or a combination of both. The latter has become a very important part of science communication and this development is likely to continue as we see real and virtual scenes melt together to an indistinguishable whole. This issue will be described in more detail in section 15.4.3.

2D or 3D animations can enhance the visualisation, explanation and presentation of scientific issues significantly. Below are some examples of 3D animations:

2D animations, produced in, for instance Adobe® After Effects®, are any producer's dream as they are a very *cost-effective way of producing* footage simply. 2D animations do not have to be boring or less informative than real 3D animations if care is taken in the production. Above is an example of a 2D animation.

Real footage is recorded with a camcorder either with an in-house camcorder or with the assistance of a small hired camera team. The latter is recommended if the production needs to be more high-end.

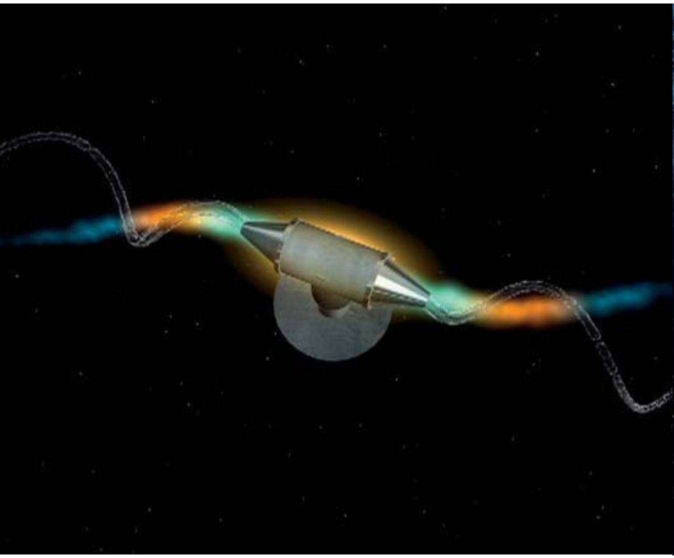


Figure 57: To the left a visual analogy for the workings of a precessing garden-sprinkler "nozzle"mechanism, embedded in the planetary nebula Henize 3-1475. To the right, the supernova explosion that created the Crab Nebula.

***Figure 58:** A 2D animation can look almost as good as a real 3D animation: A black hole "eating"material from its surroundings.*

***Figure 59:** Outdoor shooting scene for the project described in section 15.9 below.*

15.4.3 Postproduction

Postproduction is the phase of a project spent editing the footage and compositing the footage into the finished video. Postproduction consists of:

- video editing;
- compositing and other video effects;
- audio editing;
- adding audio effects.

Video editing

The video editing process consists roughly of the following steps:

- Organising footage: Most editing software, like *Adobe® Premiere®*, has an archive that gives an overview of the clips in your project. Most software works with these archives on a project

Adobe® Premiere®

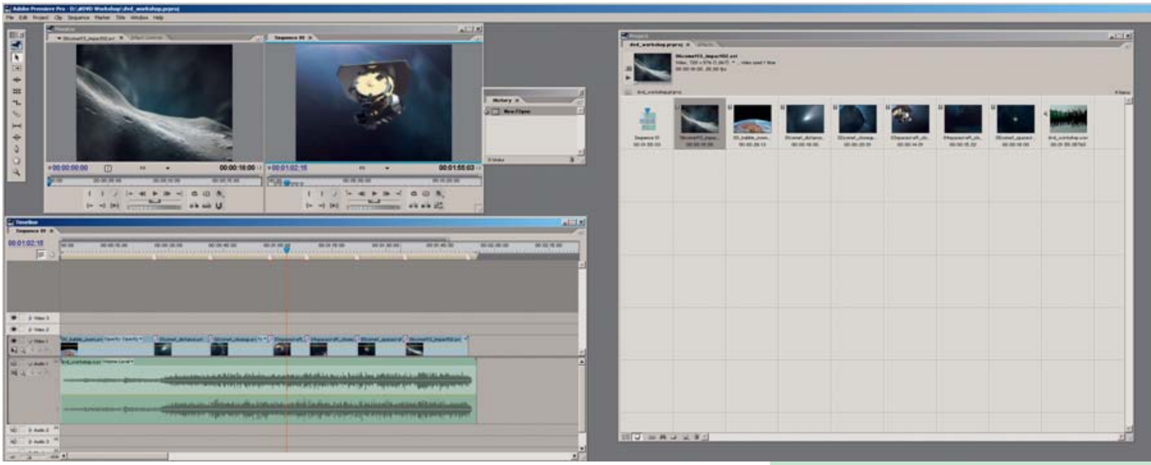


***Figure 60:** Video editing in* Adobe® Premiere® *from* Adobe's Video Collection.

by project basis, meaning that it is difficult to get a complete overview of all of the footage you have in your video archive. This is partly due to the fact that video clips are rather large and were, in the past, not meant to be permanently online.

- previewing clips;
- trimming clips to remove unwanted parts;
- adding clips to timeline;
- adding audio;
- adjusting;
- colour-correcting;
- making transitions;
- adding supers and titles.

Here we have dealt exclusively with non-linear video editing as opposed to (old-fashioned) linear editing from tape to tape. Rough editing is something everyone can do. Artistic editing may not be achievable by most, but on the other hand we are in the business of science communication and not producing Hollywood blockbusters like *Blade Runner*, so we can make do with less.

What matters is the right mix of visuals and speak and the right speed of cuts and dissolves to create a balanced whole. Try to avoid fancy effects if they are not necessary for the story.

Compositing

Compositing means combining different digital clips, for instance by superimposing layers on top of each other to create scenes that could not be created in one piece (or were not economically feasible). There are four main methods of compositing:

- Reducing the opacity of a top layer to allow another layer to show through (like a "sandwich" of two pieces of slide film).

- Using a clip's alpha channel to "cut" part of a clip out, for instance when superimposing supers or titles onto other footage.
- Using a matte to let other clips show through.
- Using bluescreen effects, also known as keying, to "cut" out an element recorded on real footage.

The combination of animations and real footage using bluescreening in compositing is an exciting possibility that gives a whole palette of different possibilities for human interaction with scientific phenomena that are normally out of reach — from quarks to colliding galaxies. The technical setup is slightly more complicated and requires a studio with a bluescreen. This is still far from rocket science and does not have to incur unrealistic costs. The only function of the bluescreen is to create a background surface that is "a uniformly monochromatic blank" (most often blue or green) that can be deleted digitally from the footage later on using video editing software such as *Adobe® Premiere®*. Make sure the subject in the foreground does not wear any clothes that are the same colour as the screen.

After compositing the finished sequence is exported as a file in the format that is needed in the distribution link. Read more about compositing in Brinkmann (1999).

15.5 DISTRIBUTION OF VIDEO MATERIAL

15.5.1 Video distribution methods

There different ways of distributing video. Some are, in order of effectiveness:

- via satellite uplink;

Bob Fosbury (ESA)

Figure 61: *The author (left) directing Bob Fosbury (right) for a scene filmed with a small bluescreen setup for the project described in section 15.9 below. The bluescreen can also be green as long as its colour does not appear anywhere else in the final product.*

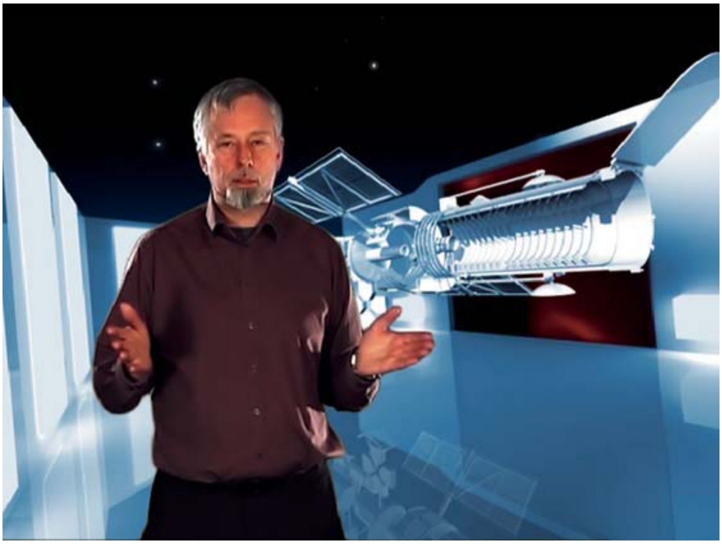


Figure 62: *The result of the bluescreen shooting with the set-up in figure 61. Note the colour-correction of the real footage. This is the outcome of a composition of real footage with 3D animation where the Bob Fosbury is placed in an interesting virtual studio environment.*

- via web (large files with broadcast quality video);
- postal shipping of Betacam tapes.

Help from external companies, such as *MediaLink*[45], is recommended for the uplink via satellite. Companies like this one may also help in other stages of a video production, such as tracking (see below).

Distribution via web takes some know-how about the right video formats, and also — since the individual clips can easily be a few hundred megabytes — some investments in hardware: storage space and Internet bandwidth.

Shipping via postal mail is too slow and is not recommended for news-oriented products like VNRs.

15.5.2 VNR Media Advisory

In addition to the actual uplink, a media advisory (media alert) should be issued to warn broadcasters about the time and technical details of your distribution.

15.5.3 VNR Evaluation

Since VNRs are costly productions, it may be worth investing in some resources that track the use of your material (impact statistics or usage monitoring). In order to track the VNR an invisible code is placed on it, so that when the footage is used, the station, airtime, and story length can be determined.

Some methods for tracking are:

- *NewsIQ*;

45 http://www.medialink.com

- *Teletrax*;
- *Sigma*;
- *Vericheck*.

15.6 TECHNICAL SPECIFICATIONS FOR DIGITAL VIDEO MATERIAL

An in-depth discussion of the production of video material requires much technical detail, so only some of the most important topics are treated here. For more information, *Adobe's Digital Video Technical Guides*[46] is to be recommended.

15.6.1 Video tape media

The standard used today to exchange video footage with television broadcasters is Betacam SP tapes. While many do use the more expensive and lossless Digital Betacam, SP is still the most widely acceptable tape format. For consumers, the DVD format has now superseded VHS tapes almost completely and is the most used consumer video format. The semi-professional Super-VHS (S-VHS) is still used occasionally. Recently digital tape formats such as Digital Video (DV), miniDV (for consumers), DVCAM and DVCPRO have become very popular.

15.6.2 Frame Sizes

Different parts of the world use different sizes of frames for broadcast videos, so this is an area that may take a little investment of time and effort to get right. The standard formats are:

- **NTSC**: Typically digital NTSC frames are 720 x 486 pixels (with a 0.9 pixel aspect ratio, also known as D1). The frame rate is 29.97 frames/second. NTSC is interlaced with two fields displayed per frame (roughly one field per cycle of the alternating current which is 60 cycles per second). NTSC is used in the United States, Canada, Japan and some parts of South America.
- **PAL**: Typically digital PAL frames are 720 x 576 pixels. The frame rate is 25 frames/second. PAL is interlaced with two fields displayed per frame (one field per cycle of the alternating current which is 50 cycles per second). PAL is used in Europe, Australia, and large parts of Asia and Africa.
- **SECAM**: Typically digital SECAM frames are 720 x 576 pixels. The frame rate is 25 frames/second. SECAM is interlaced with two fields displayed per frame (one field per cycle of the alternating current which is 50 cycles per second). SECAM is used in France, Russia and parts of the Middle East.

The NTSC format is somewhat smaller and gives lower quality per frame than PAL and SECAM, but there are more frames/second, in principle giving less "flicker". Flicker is more visible on modern digital televisions as the picture elements ("pixels") on older (Cathode Ray Tube) televisions have a certain afterglow time making flicker less pronounced.

46 http://www.adobe.com/uk/education/instruction/curriculum/dv_curriculum.html

15.6.3 Data volume

Since the frames are in true-colour (16 million colours = 3 bytes of information per pixel), we can calculate the storage space needed for one frame:

- USA: 640 pixels x 480 pixels x 3 bytes/pixel = 921,600 bytes = ~1 MB/frame => ~28 MB/second.
- Europe: 720 pixels x 576 pixels x 3 bytes/pixel = 1,244,160 bytes = ~1.2 MB/frame => ~31 MB/second.

So, for both PAL and NTSC formats the full bandwidth needed to "transport" uncompressed video from apparatus A to apparatus B is roughly 30 megabytes. Only large and costly computer and hard disk systems can sustain this kind of I/O (input/output) rate ("sustain" here really means *never* dropping below this rate and causing frames do drop out). Although "normal" PC/hard disk systems typically deliver at least 10 MB/second (without RAID), it is difficult to achieve the necessary threefold increase in sustained rate to show every byte of information in the video frames. It is possible to do this in practice, but it is virtually never done. The answer lies in compression of the frames — really *smart* compression.

Before discussing compression it is perhaps worthwhile considering whether real-time playback of broadcast video is actually needed. Some users may be perfectly happy handling broadcast video in a non-real-time environment. If the footage is produced completely on a computer (ie does not need to be digitised from tape) and never needs to be recorded in real-time on eg a Betacam recorder (but for instance distributed via the web) it is possible to produce video on slower computer systems. However it is difficult to evaluate the production fully as the footage can never be displayed without jerking motions, but it can certainly be considered as a worthy low-budget solution.

15.6.4 Compression

In theory each frame can be compressed, or packed, with the help of smart algorithms that group the information. This is done in two ways: without losing information and quality (non-destructive or lossless compression), or with a certain well-controlled loss of quality (destructive or lossy compression). The compressed information is later decompressed, or unpacked, to be displayed on the screen.

The amount of disk space saved, the compression ratio, depends on the content of the footage (what is actually filmed) and on how quickly the content changes. As an example, a few stars on a dark background can easily compress by a factor of 10 times non-destructively, whereas a monkey moving in a complex natural background may only compress by a factor of two or less.

Since a factor of 3 in the input/output rate has to be saved to playback the footage on normal computers, destructive compression is nearly always used. Some very clever algorithms have been invented to handle the compression and decompression called codecs (compressor-decompressor). When compressing, a codec looks at each frame and finds similarities within the frame (the spatial domain) and also in the temporal domain by comparing the frame with one or more frames to store only information that describes the differences between frames. Sometimes compression is visible to the untrained eye as compression artefacts ("chunky blocks") in the picture when there is a lot of (temporal) action (e.g. a fast explosion). In such cases the "informational differences" between the frames are large, so to keep the information below the allowed ceiling of the playing device or the network a higher, and more destructive, compression is applied in that sequence of the film. Video codecs have names like motion-jpeg (MJPEG), MPEG-1, MPEG-2, H.264/MPEG-4 etc. Note that some of these formats are mainly for editing and some mainly for distribution to the end-user.

15.6.5 Technical Specifications for VNRs

Typical technical specifications for a VNR are:

- Colour bars: Start of tape, duration 1 min 30 sec;
- Black burst: After colour bars, 30 sec;
- A-roll material starts at 10:00:00:00;
- Split audio tracks: Natural sound and effect on track 1, speak on track 2;
- No "supers" (names and titles of people interviewed in or speaking on the video) on top of the A-roll footage. Present the information on slates at the start of the VNR instead.

15.7 A TYPICAL SET-UP FOR A SMALL VIDEO EDITING SUITE

A small video-editing set-up typically consists of:

- computer (typically a medium to powerful PC);
- video board with dedicated processing chips for compressing and uncompressing video frames in real-time;
- 1-2 computer monitors;
- television monitor;
- betacam SP tape recorder;
- computer loudspeakers;
- normal "monitor" loudspeakers attached to the video board;
- break-out box with audio and video connection from and to the different components.

A small full broadcast video-editing system is shown in figure 63:

1. Television monitor showing an accurate representation of the footage.
2. Break-out box with audio and video connections to and from the different components.
3. Two computer monitors running on the same graphics card in the PC (the box below the second monitor) .
4. Microphone for recording of live speak.
5. S-VHS recorder.
6. Betacam SP recorder (the television industry's adopted standard).

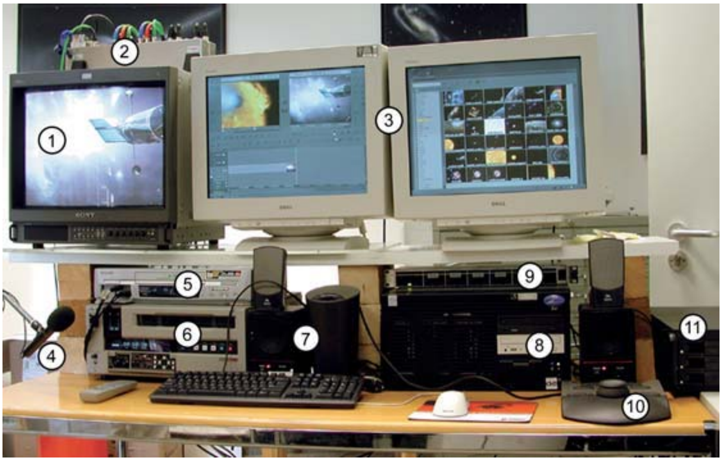


Figure 63: A quick and dirty, small (but highly capable and professional) video editing system. For numbers please refer to the text.

7. Loudspeakers.
8. Computer with a special video board with dedicated processing chips for compressing and uncompressing video frames in real-time.
9. Audio mixer.
10. Jog-shuttle wheel (for remote control of the Betacam during digitisation of footage).
11. RAID hard disk array.

Many different types of optional hardware are also available, such as Jog-shuttle wheels, special keyboards etc.

This type of set-up is typically referred to as a non-linear video editing system. The term non-linear means that all parts of the video material can be accessed fully at all times (unlike a video tape which is linear and the different parts of the tape cannot be accessed at will).

When editing video material, most of the calculation work is taken care of by a special video board that employs fairly sophisticated technology. The calculation power needed by the PC itself is not too demanding, and the main function of the PC is to act as an interface between the hard disks and the video board. The processing power of the PC becomes important when doing post-processing work, for example when combining layers, adding transitions, filters or changing colours, sizes and so on.

At the time of writing (December 2005) the all-inclusive price for a good complete system with installation and initial training is between 10,000 and 30,000 €.

15.8 PRODUCTION OF MOVIE DVDS

The DVD medium[47] (short for "Digital Versatile Disc" or "Digital Video Disc") for storage and playback of high-quality hour-long movies emerged in the mid-1990s and has since steadily gained in popularity.

47 Read more in the excellent article at: http://en.wikipedia.org/wiki/Dvd

The movie DVD is an excellent medium for bringing high-impact science communication directly to the end-users.

The movie DVD (more correctly known as DVD-video) is an excellent medium for bringing high-impact science communication directly to the end-users. It stores large volumes of high-quality film material, but is very portable and thus easy to distribute (see also section 15.9).

The concept movie DVDs discussed here are different from the data DVDs used for storing and transporting data (known as DVD-data). The actual medium may be the same, but the content is "packaged" in a different way on a movie DVD and involves a full navigation system for the user. The latter means that when an end-user puts a DVD in a player (either connected to a TV, or on a computer) "things" happen instantly. If produced properly, a DVD can hurl the spectator on an interesting journey into the subterranean lives of earthworms or on a journey to distant stars and planets almost instantly.

15.8.1 The overall workflow of DVD production

As for other video productions, the typical workflow for DVD production has three phases: preproduction, production and postproduction.

Preproduction

1. *Technical Preparation*: Installing the right technical setup (hardware, software) for production, editing and authoring. This includes a video board with high signal processing capability for the real-time editing (see 15.7) and a computer system capable of sustaining the necessary high rate of I/O. A good and affordable solution for the software is, for instance, *Adobe*'s *Video Collection*[48].
2. *Organising* thoughts and ideas about the production:
    a. fix content;
    b. define aim;
    c. set style;
    d. allocate budget;
    e. produce storyboard (see section 15.4.1);
    f. plan menu structure (see section 15.8.4).

Production

3. *Production* of:
    a. footage;
    b. music and sound effects;
    c. subtitles.

Postproduction

4. *Organising* all elements.
5. *Editing* the movie and bonus material (see section 15.4.1).
6. *Compositing* (see section 15.4.1).
7. *Encoding* the footage into the final MPEG-2 movies (see section 15.8.3).
8. *Authoring* (see section 15.8.4):
    a. Produce and implement menu structure.
    b. Import all elements: MPEG-2 movies, sound and subtitles.

48 http://www.adobe.com/products/dvcoll/main.html

c. Encode sound.
d. Link all elements.
e. Test all links and functions.
f. Export the final DVD.

15.8.2 Different movie DVD formats

The DVD footage format follows the television standards (see 15.6.2 and 15.6.3), so a DVD will be either in PAL, NTSC or SECAM format. There will also be region codes added to control distribution. This enables distribution companies to acquire the rights for the distribution of a commercial (e.g. Hollywood or similar) DVD in a smaller area, so saving costs. The region codes are:

0. Informal term meaning "playable in all regions".
1. Bermuda, Canada, United States.
2. Most of Europe, the Middle East, Egypt, Greenland, Japan, Lesotho, South Africa, Swaziland.
3. Southeast Asia, Hong Kong, Macau, South Korea, Taiwan.
4. Central America, Oceania, South America, Mexico, Australia.
5. The rest of Africa, Former Soviet Union, the Indian subcontinent, Mongolia, North Korea, Russia.
6. Mainland China.
7. Reserved for future use.
8. International venues such as aircraft, cruise ships, etc.

15.8.3 Encoding

The DVD standard incorporates a clever compression and decompression method that uses MPEG-2 encoding (performed offline during production) and decoding (performed during playback without the user noticing) to "package" the information. The encoding can be done either in hard- or software with different resulting qualities. The costs involved span the entire range from 0 € (with freeware), to 25,000 € for a high quality hardware encoding system. Very good software encoders, such as the *Cinema Craft Encoder* (CCE) SP, can be purchased for roughly 1-2000 €. There seems to be a good relation between the price and quality of encoders, although the incremental quality improvement per € is much less for the more expensive encoders.

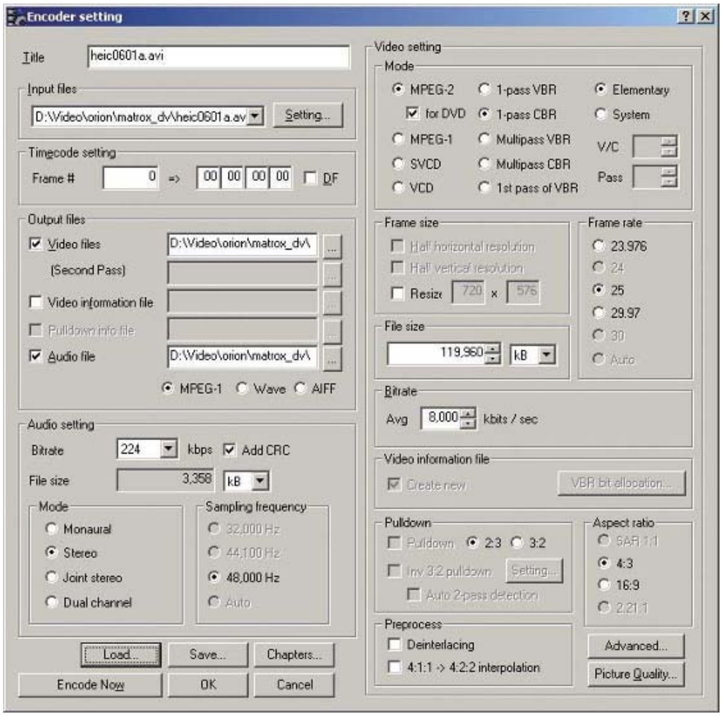
When encoding it is, as usual, a balance between size and quality. There are currently two typical types of DVDs[49]: DVD-5 which contains up to 4.7 GB and DVD-9 which contains up to 8.5 GB. If less than roughly 150 minutes of movie material is to be packed onto a DVD-9 there should be few problems in achieving very high quality encoded footage. As the amount of footage increases, the more difficult and sensitive the encoding becomes and the quality of the encoder becomes much more important.

15.8.4 DVD authoring

Authoring is the final stage of producing a DVD: implementing a menu structure and merging all the components into the standard format

49 The current state of technology in December 2005.

Figure 64: *Screenshot from* Cinema Craft Encoder SP. *There are a multitude of settings and options, but once a good compromise between quality and size is found the settings can be saved in a preferences file and need not be changed again.*



Cinema Craft Encoder SP

readable by DVD players. Software for authoring ranges from Freeware to Sonic's Scenarist Professional with a price of roughly 4000 €.

When preparing a DVD keep a clear idea of the functions of the menu tree of navigational choices presented to users. The individual menu screens can be produced in *Adobe® Photoshop®* as layered PSD files in either PAL (720x576 pixels) or NTSC format (720x480 pixels). Buttons etc have their own layers.

In authoring software, such as *Adobe® Encore®* from *Adobe's Video Collection®*, the following elements are imported:

- menu PSD files;
- encoded MPEG-2 movies (called Timelines in *Encore*);
- sound files (in wave format);
- subtitles (as unicoded text files, see the example below).

The sound files are compressed to AC-3 format. The timelines are then aligned with the corresponding sound and subtitle tracks. The next step is to produce the actual navigation by linking all buttons to the actions they should perform (e.g. play Timeline X with subtitle Y).

Extensive testing should then be carried out, both within the authoring programme as well as on real burned DVDs in a variety of hard- and software DVD players.

Adobe® Encore®

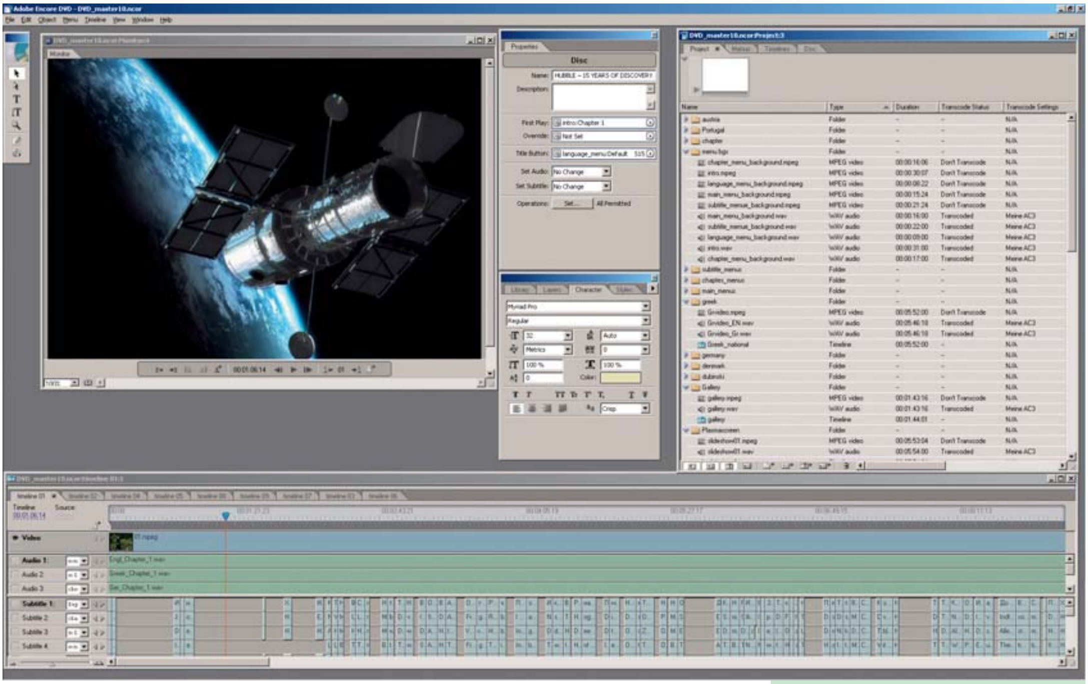


Figure 65: *Screenshot from* Adobe® Encore® *for the project described in section 15.9.*

Once the DVD is ready for export it can be sent for replication. Until recently the export could only be done to DLT tapes (old-fashioned magnetic tapes for storage, two tapes for a DVD-9) as the break between the two DVD-9 layers needed to be recorded in a special way. Replication companies will now also accept dual layer DVD-9s as masters for the replication. A typical price for a DVD replication copy is roughly 0.30 € (depending on the volume as the start-up costs are not included).

15.8.5 The future of DVDs

In the future DVDs will most likely have larger storage capability, higher quality and new smart compression methods. High-Definition DVD formats (*HD DVD* and *Blu-Ray*) with up to 1920 x 1080 pixels interlaced (1080i), or 1280 x 720 pixels progressive (720p, non-interlaced), should

```
1 00:00:00:00 00:00:02:12 This film takes you on a
  journey…
2 00:00:02:12 00:00:05:00 …a journey through time
  and space.
3 00:00:37:03 00:00:41:07 I want to tell you the
  story of an instrument that has vastly improved
  our view of the skies,
4 00:00:41:07 00:00:43:19 sharpening our perception
  of the Universe,
5 00:00:43:19 00:00:49:01 and penetrating ever deep
  er toward the furthest edges of space and time
```

Figure 66: *This example shows a subtitle text file that can be imported directly into* Adobe® Encore®. *This has significant advantages when dealing with subtitles in many different languages.*

In the future DVDs will most likely have larger storage capability, higher quality and new smart compression methods.

be within reach in the near future. For science communicators this will improve the artistic capabilities, enable more details in the frames (eg, more text), large projection surfaces and in general improve the "Wow! factor" significantly.

The actual production of HD formats will naturally be more demanding for the obvious reason that a higher I/O rate is necessary, and also because data storage needs to be increased by up to a factor of 5. Solutions to these issues are being actively developed by hard- and software companies looking to exploit the huge commercial potential.

15.9 CASE STUDY: THE ESA HUBBLE 15TH ANNIVERSARY DVD

15.9.1 Background

24 April 2005 marked the 15th anniversary of the launch of the NASA/ESA Hubble Space Telescope. As an observatory in space, Hubble is a major project that has made an enormous impact both in terms of scientific output and in its immediate public appeal (see chapter 20).

The 15th anniversary of Hubble's launch presented the ideal opportunity for a dramatic and dynamic project[50] to grab the attention of the public, with a special emphasis on the younger generation, and to further the knowledge of science in general and astronomy in particular. In this project, Hubble is presented as a "science superstar" to make the possible largest impact and reach as many different target groups as possible, including that section of the general population whose interest does not usually include science.

15.9.2 Products

The project consisted of a number of activities, or products. The full-length documentary movie *Hubble — 15 Years of Discovery*, issued on DVD and broadcast on television, was the most important. The movie covers all aspects of the Hubble Space Telescope project — a journey through the history, the troubled early life and the ultimate scientific successes of Hubble. More than 700,000 copies of the DVD have been distributed, making it possibly the most widely available science documentary ever. Dr. Bob Fosbury, a scientist from the European Space Agency, who has frequently used Hubble for his own research, presents the movie. Through the movie Bob Fosbury explains various astronomical phenomena and describes the workings of a major telescope such as Hubble. As an active, but approachable scientist himself, he brings an added depth and insight to the material while simultaneously helping to demystify the image of scientists.

The other products were events, press meetings, large 3-metre anniversary images, exhibitions, talks by scientists, educational material, a coffee-table book, a movie poster, a movie soundtrack and a planetarium show package for planetarium show production.

50 Read more about the individual activities on the Anniversary webpage: http://www.spacetelescope.org/projects/anniversary/

__Figure 67:__ The Australian DVD label print. Note the co-branding with the appearance of the logo of the local distributor that creates a co-ownership and increases the win-win effect.

15.9.3 Production of the DVD

Preproduction

In the planning phase budget and manpower were allocated. The level and scope were discussed, decided on and the research started. *Microsoft Word* was used as the scripting tool during the six week script-writing period. Due to the large size of the production (the movie is 80 minutes long) and the very small team, it was not possible to make a proper storyboard. However detailed comments about the visual content were included in the script.

Production

The main part of the footage was produced with *Cinema 4D*. An important part of the movie consisted of studio bluescreen shots and some scenes were also shot outdoors with the scientist to add variation. For the real shots a camera team was hired.

Subtitles in 16 languages were made with *Microsoft Word* and directly imported into *Adobe® Encore®*.

See photos from the actual production in section 15.4.2.

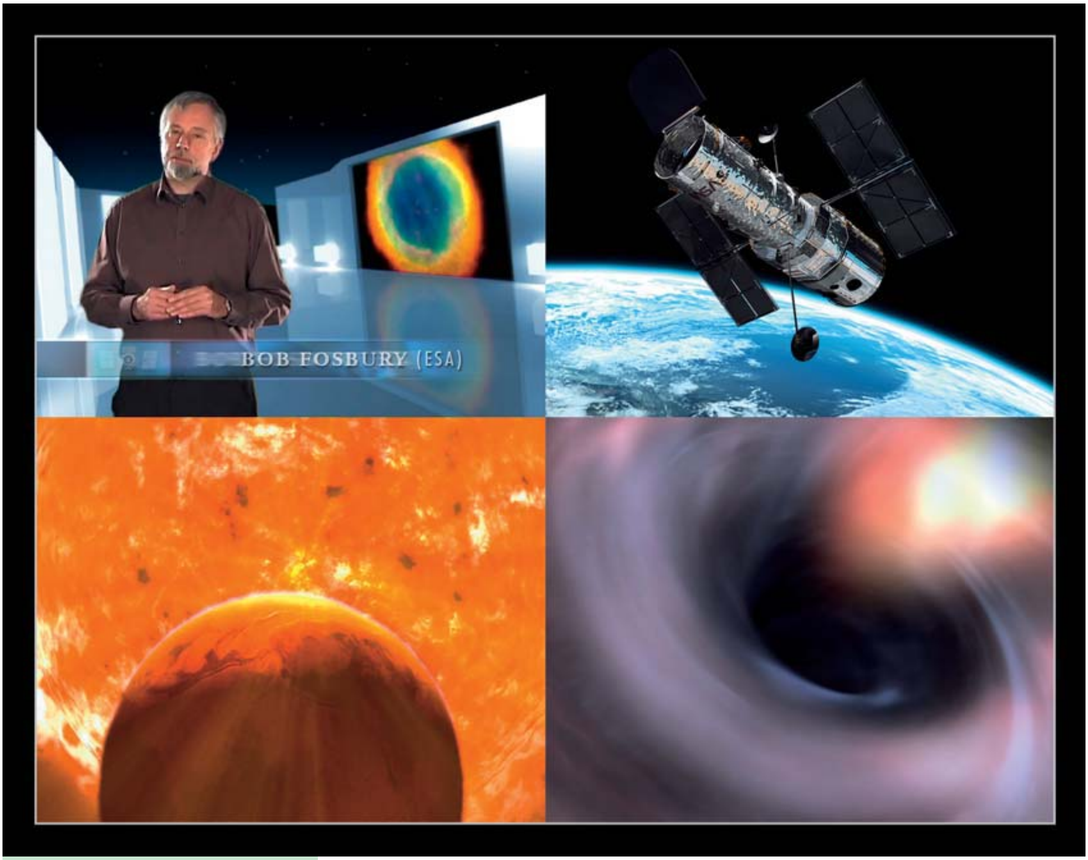


***Figure 68**: Scenes from the* Hubble – 15 years of Discovery *DVD.*

Postproduction

Adobe® Premiere Pro® 1.5 was used for the video editing and *Adobe® After Effects®* 6.5 Production Bundle for compositing. *Adobe® Photoshop®* was used to produce menus. *Adobe® Encore®* 1.5 was used for authoring.

15.9.4 An alternative business model

Collaborators and partners from more than 20 EU member states and third party countries joined in the Hubble anniversary celebration and collaboration on subtitles etc. This truly unique multinational initiative created a multiple win-win situation for everyone involved from the participants in the production to the national partners and the end-users. Eventually a "snowball" effect brought enough interested distribution partners such as magazines and newspapers into the col-

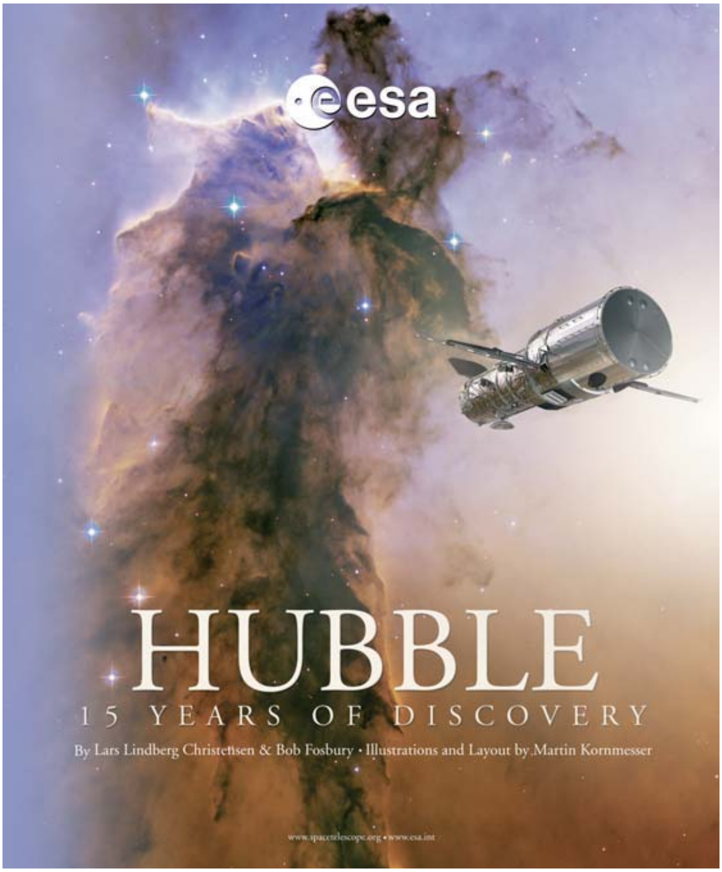


__Figure 69:__ Cover of the accompanying Hubble 15th Anniversary book (Christensen & Fosbury, 2006).

laboration so that the production costs of the physical DVD were minimised to the advantage of all involved. Some of the partners even took out advertisements in large national newspapers and magazines for the DVD, thereby promoting Hubble and ESA in a way not otherwise possible. Only the enormous power of a multinational collaboration made this project possible.

15.9.5 Results

More than 700,000 copies of the DVD movie were distributed through more than 80 delivery points all over Europe (magazines, newspapers, science centres etc). This makes it probably the most widely distributed science documentary ever. Nearly 30 different DVD packages were made in different languages and quality to cater to the different needs of the partners. An estimated 10-20 million viewers or more have watched the movie through various TV channels. The movie has been shown at numerous venues such as planetaria, science centres, public observatories etc. Searching on the title of the DVD movie on *Google* gives many thousands hits.

Figure 70: The Bulgarian cover of the Hubble – 15 Years of Discovery *DVD.*

16. CRISIS COMMUNICATION

16.1 CRISIS COMMUNICATION IN GENERAL

Crisis communication is a discipline well-known to all companies and commercial enterprises, but "corporate" crises are something that even we as science communicators cannot avoid. Here follows a condensed overview of crisis communication, and I recommend Ogrizek & Guillery (1999) and Byrne (2002) if further reading is required.

"Corporate" crises are something that even we as science communicators cannot avoid.

Although everyone has a clear understanding of the concept of a "crisis", a formal definition is elusive, and a few examples of crises will serve to illustrate possible scenarios:

- An **accident** happens at a production plant and the entire production of a product has to be withdrawn. The classic example is the "Perrier crisis"[51] in 1990 when 160 million bottles of Perrier mineral water were withdrawn around the world when minute traces of benzene were detected in Perrier bottles.
- **Boycotts:** Often caused by moral, political, religious or ecological issues. Although boycotts of scientific institutions are rarely seen, one example is the public demonstrations in the last half of the nineties stemming from the launch and fly-by of NASA's Cassini spacecraft carrying a plutonium reactor[52].
- **Rumours:** Uncontrollable unofficial "underground" thoughts and comments shared by large numbers of people in a particular stratum of society. According to Ogrizek & Guillery (1999) it is quite common for rumours to be well-founded (contrary to popular belief).
- **Financial crises:** Deficits, lack of funding, rumours of poor financial health etc.
- **Major technological accidents**. For example, the crash of El Al cargo flight 1862 in Amsterdam, the Netherlands, in 1992, the loss of a rocket like the Arianespace Ariane 501 explosion in 1996, the Space Shuttle Challenger and Columbia accidents in 1986 and 2003 or the oil spill of Exxon Valdez in Prince William Sound in Alaska in 1989. One could also mention the fire that destroyed LZ-129 Hindenburg in New Jersey, USA, in 1937, the sinking Titanic off the coast of New Foundland in 1912, the vibrations that broke Tacoma Bridge in Washington 1940, the methyl isocyanate gas leakage in Bhopal, India, or the nuclear power plant accidents in Three Mile Island, Pennsylvania, 1979, and Chernobyl Ukraine, 1986.
- **Natural disasters**. An example could be the "Black Saturday" in 2003 where a bushfire almost completely burnt down the Mount Stromlo Observatory in Australia.

Crises usually have some features in common:

- **Extreme time pressure.**

51 http://en.wikipedia.org/wiki/Perrier

52 http://en.wikipedia.org/wiki/Cassini_probe#Plutonium_power_source_and_controversy

Figure 71: *A major technological accident. The explosion of the Arianespace Ariane 501 launcher carrying the European Space Agency's Cluster satellites.*

- **Other pressure:** Both internally, from management, employees, colleagues etc, and externally, from the press, shareholders, public ...
- **Confusion.**
- **Emotions:** Severe emotional involvements with the victims of the crisis or internally in the organisation.
- **Lack of reliable information**: Often due to time restraints, geographical restraints, the nature of the situation, confusion and other unpredictable factors, it is hard to figure out the basic questions about the crisis at hand: what, how, where, who, why and when?
- **Need for quick management decisions.**
- **Media interest**: As Byrne (2002) puts it "*you are carrying out decisions in a gold-fish bowl*".
- **Urgent need of internal and external communication.**

Crisis communication is therefore becoming increasingly important.

According to Ogrizek & Guillery (1999) crises are more likely to occur today than in the past due to changes in social values (environment, sexual harassment are some examples), changes in economic structure and changes in the extent and speed of media coverage. Crisis communication is therefore becoming increasingly important.

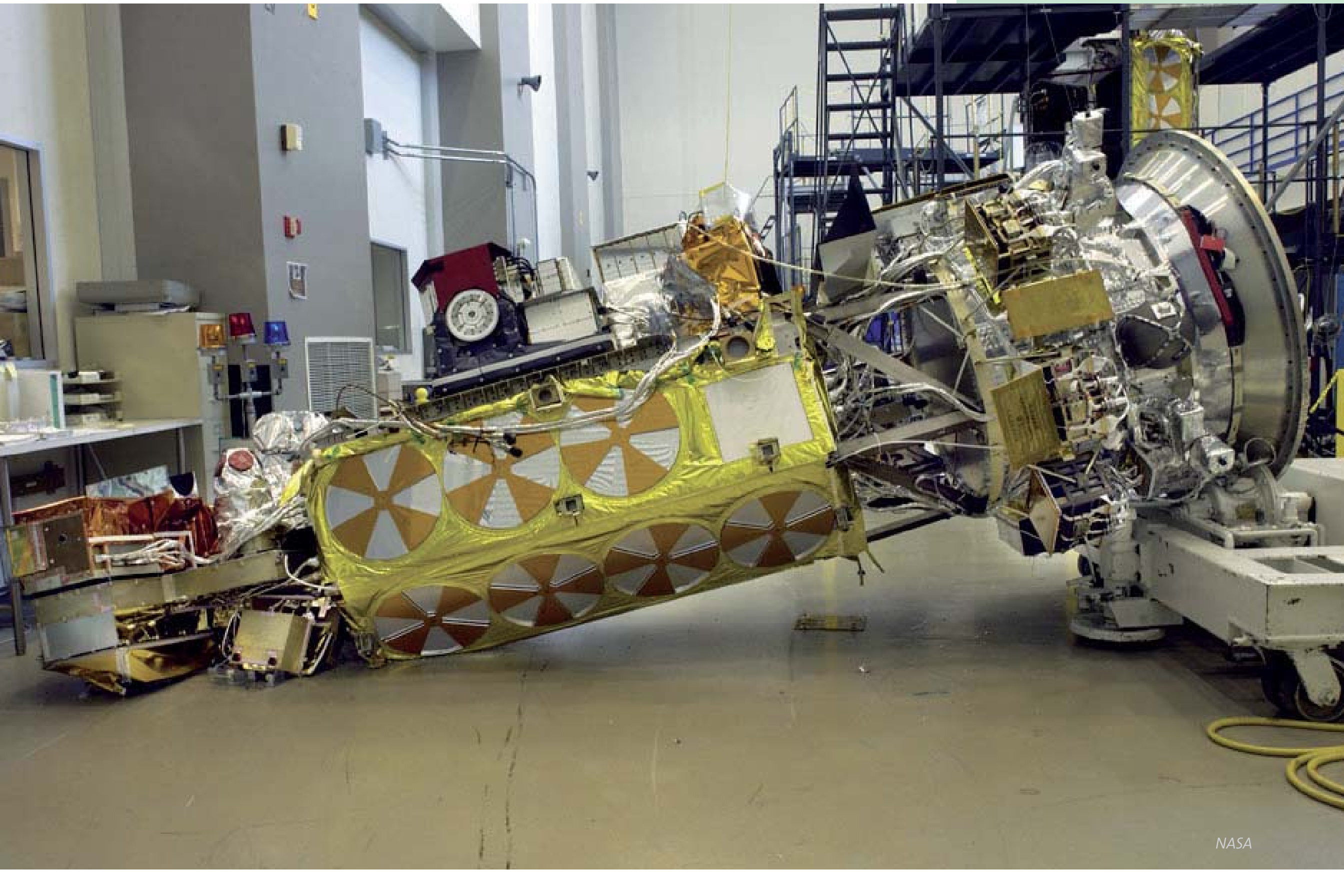
16.2 CRISIS MEASURES

So, what can be done to "survive" a crisis successfully? The essential tool to cope with a crisis situation is *communication*.

16.2.1 Basic rules of crisis communication

- **Communicate internally first:** Although the media play the major role, it is vital to make sure that organisation, especially the key internal stakeholders, is informed about the situation, who takes the decisions, who the spokespersons are and what measures are being taken.
- **Follow the five "c"s**: Ogrizek & Guillery (1999) state: *"When communicating with the media the five Cs offer a desirable course to follow: Concern, Clarity, Control, Confidence, and Competence."*
- Crisis communication **does not depend on secret recipes**, but on known concepts and methods.
- Crisis communication requires **planning** before the crisis occurs: contingency plans, gathering a "crisis task force" of trusted employees, preparation of management, media training etc.
- Crisis communication is **not a one-man task**. It is a team effort, the success of which does not depend on a spokesperson's ability to "spin" the situation or to conjure up media tricks.

Figure 72: *NASA's NOAA-N' spacecraft was accidentaly dropped 1 metre to the floor. An example of a technological accident in 2003.*



- Crisis communication **spans a period longer** than the few days around the most critical events. It includes the planning period before and the "post-crisis" aftermath.
- **Availability**: This point can hardly be stressed enough. If all the major players in the organisation are available within a short time of the beginning of the crisis and can reach what information is available to start assessing the situation and act on the basis of this, then you are off to a very good start.
- **React quickly!** Detect the situation and address it! Communicate the basic information internally and externally (media, government officials, locals, industrial partners etc) very quickly! At least within the first two hours of the crisis. The right preparations (see below) are vital here.
- **Compromise**: It is important to realise that the extreme nature of a crisis situation inhibits perfection in any communication that is released internally and externally. The speed of the actions required is far too high. The full overview of the situation will only come later, and the legal consequences will not be visible when the first press release is issued.
- **Balance the communication**: Avoid overly reassuring messages, or the announcement of unrealistic measures.
- **No denials**: A simple denial of, for instance, a false rumour is often ineffective.
- **Do not blame the media**: Although the media thrive on crises, they are not the cause of the crisis. Furthermore their behaviour follows certain well-defined patterns and can be predicted and to some degree steered in the right direction. This guide presents some of the basic insights into the *modus operandi* of the media. Friedman, Dunwoody and Rogers (1986) give more details.
- **Credibility**: Be credible. Do not lose the trust of the media and the public.
- **Rational arguments are often not effective**: Rational arguments often do not work as the issues involved are normally of a complex or technical nature. Take the example of contamination with minute traces of a contaminant (as benzene in the case of Perrier). Even completely statistically harmless "one-in-billions" traces will not convince the public.
- **Acknowledge the pain**: Acknowledging to the public and the possible victims that their loss is known is a way to gain some sympathy.
- **Analytic and disciplined working methods**: A crisis calls for overview, balanced decision-making, procedures, short meetings and brief discussions.
- **Evaluate**: Make sure that both the good and bad lessons of a crisis are never lost. Evaluate and prepare for the next crisis.
- **Transparency**: It is no longer believed that best practise involves telling: "the truth, the whole truth, and nothing but the truth". According to Ogrizek & Guillery (1999) the norm is now "controlled transparency" and "everything you say must be true".

16.2.2 Management

Avoid letting the management process become subservient to the communication process itself. This is difficult in a crisis, but the old adage still applies: *Decide first, communicate after*.

Following Ogrizek & Guillery (1999), it is important to ask these crucial questions:

1. What is the real risk and what kind of risk is it?
2. What is the prioritised list of the organisation's medium to long-term objectives: what is to be protected at all costs, and what compromises can be made?

There is no time for hesitation and the necessary delegation of emergency decision-making power in a crisis situation is needed. Time is too short for a complex reporting line.

There is no time for hesitation and the necessary delegation of emergency decision-making power in a crisis situation is needed. Time is too short for a complex reporting line.

16.2.3 Planning

One of the necessary components to successfully "survive" a crisis is meticulous planning. In the perfect world case the planning components are:

- Make sure that the "public faces" of the organisation get the appropriate **media training**: including managers, experts, and spokespersons.
- Creation of a **dedicated crisis team** that spans departments, groups, experiences and so on. The role as a crisis team member should be seen as an additional duty on top of the unit member's normal work. The team should think up crisis scenarios and contingency plans in advance, prepare lists of worst case questions from the media (and their answers) and find the best ways of coping with the most likely situations (and be prepared to adjust this when a real crisis happens). The mission for a crisis team is to provide the foundation for management decisions, prepare internal and external crisis communication and coordinate logistical and technical issues. The team should, as a minimum, consist of:
  - **Crisis unit head**: Manages the crisis unit, makes decisions and plans strategies.
  - **Logistics responsible**: Takes care of all equipment needed by the unit and logistics issues at the crisis site.
  - **Internal communications responsible**: Handles the internal communication.
  - **External communications responsible**: Handles external communication.
  - **Secretary**: Has the global overview of procedures, lists, maintains notes of meetings, a timeline of events and other documents and necessary information.

- Creation of a **dedicated emergency room** with the necessary infrastructure:
  - a number of phone lines;
  - dedicated telephone "hotline";
  - mobile communication: cell phones etc;
  - wireless Internet connections (for email, press coverage, information search, video conferences etc);
  - fax;
  - photocopier;
  - adjacent individual working/meeting rooms;
  - boards for posting and structuring large information sheets, graphs etc;
  - catering, coffee machines, microwave oven etc;
  - TV, radio, DVD and a video beamer;
  - video conferencing;
  - Paperwork and procedures (see below).
- **Precise procedures and checklists** for a well-oiled internal crisis communication set-up must be prepared well in advance, with the aim of creating a fast response to crisis situations. This set-up includes central messages for the organisation, emergency crisis approval procedures, procedures and formats of the crisis team meetings, procedures for how to assemble the team (also outside office hours, during vacations etc).
- **Distribution lists** need to be collected and ready to use (in printed form and on crisis team intranet pages): Crisis team list, media distribution lists, email lists of the internal people that need to be called in for the crisis. Lists of internal and external experts who can be contacted in different crisis situations: high-level management, engineers, scientists etc. A dedicated person (secretary) is needed who can handle the mechanics of the information stream.
- **Telephone chains** of the relevant contacts need to be set up. This is a chain of communication initiated very quickly and where each link in the chain passes on the message to the next available person on the list. Especially useful at night and weekends. The last person in each chain segment should report back to the initiator as a check.

17. GUIDELINES FOR SCIENTISTS AND COMMUNICATORS

As discussed in section 2.4, the interaction between scientists, PIOs and the media is often a rich source of tension. A good collaboration starts with information and an openness to understand the work of the other actors. A few checklists for scientists and PIOs that might help smooth the interaction follow here.

The interaction between scientists, PIOs and the media is often a rich source of tension. A good collaboration starts with information and an openness to understand the work of the other actors.

The "scientist's checklist" given below may be copied and distributed directly to scientists to be used if the scientists: a) are contacted by the media, b) have results that may be suitable for a wider audience (as for a press release perhaps) or c) give talks aimed at laypeople. If this material is used (even in translated form), please refer to this source. The checklists have been compiled with input from various sources, most notably: Funsten (2004), Villard (1991), Tips (Anon, 1985), Jones (2002), U2Media (2002) and General (Anon, 1985).

For further reading on how to deal with the media, here are some suggestions for general books: Blum et al. (1997), Nelkin (1995), Anton & McCourt (1995), Gregory & Miller (1998), Gastel (1983), Rodgers & Adams (1994), and Byrne (2002). Montgomery (2003) holds advice for scientists in a broad range of science communication disciplines from writing to giving presentations.

17.1 A SCIENTIST'S CHECKLIST FOR INTERVIEWS

17.1.1 Background

Some scientists dislike the lack of control they have in interviews and there *are* reasons to be cautious, while still being as helpful and cooperative as possible. Some are insecure about the media, their intentions and their ways of working. Some of the reasons why scientists should participate in science communication are listed in section 2.4.

The best way for a scientist to improve science communication skills is to get some proper media training. Different private companies offer this (one example is *U2Media*[53]), and also some of the larger institutions such as the *Royal Society* in the UK[54]. Make sure the trainers are active science communicators as the field changes so rapidly.

The best way for a scientist to improve science communication skills is to get some proper media training.

Second best is to read the advice in the list below. It may help scientists to prepare to meet journalists and give some insight into why the media work the way they do.

53 http://www.u2media.org/

54 http://www.royalsoc.ac.uk/page.asp?id=1151

17.1.2 Checklist

- ☐ **First contact**: When contacted by a reporter return the call/answer the email as soon as possible and make sure you have the facts: What is the topic, the level, where will it be used and what is the deadline? Often a delay of a few hours may mean that the journalist misses a deadline. The media typically work on timescales of minutes and hours. Journalists have many constraints (time, editorial policies, financial etc) and this simply creates the boundary conditions for the "media game" that we all have to respect.
- ☐ **Involve the PIO**: If possible, contact the public information officer (at the local information or media relations office) before the interview. Maybe the communicators there can produce illustrations or background material to send to journalists or help with expertise about the relevant medium. The communication office may also brief journalists about the main content of your work if you are short on time.
- ☐ **Practical info**: Make sure journalists have all the necessary practical information: contact info, addresses etc. Make arrangements so that you are available, at least per cell phone or email for, the first 48 hours after a press release is issued.
- ☐ **Be helpful, and do not control**: You cannot control the media. The best you can do is to provide accurate information, discuss sensitive topics with care and provide fact checking assistance or even assistance checking the final text if the journalist asks for this (most however won't due to lack of time or due to editorial policies). Do not demand to see the text before publication, but instead offer your help. It is often a good idea to ask journalists to include the education and public outreach office in the loop as they may be able to help in checking for mistakes if you are unavailable. It is important to leave the actual writing to journalists. They know how best to get the job done within their given framework. You share a common goal: to communicate a science result to as broad an audience as possible, in as exciting a way as possible without losing contact with the ground. You may not agree on the actual way this is done, but commenting on the style/angle of a piece is 'bad karma' as this is a direct attack on one of the core abilities of a journalist (just as when a less knowledgeable scientist says your work is wrong). As Mitton (2001) writes about the relationship between journalist and scientist: *"Each needs the other for their own different purposes so there is a symbiotic relationship between them"*. By collaborating with journalists you increase the chance of accurate news reporting.
- ☐ **Do not worry about your colleagues**: The press is not a place to communicate with your peers. If your peers fail to understand this point, explain it to them. Often negative criticism from colleagues about a media appearance means that the job was well done (yes, the topics do have to be explained *that* simply). The press has many inherent limitations and is working against

the clock under many conflicting demands to bring your story out.

- ☐ **Hit the right level**: Do not underestimate the intelligence of journalists, but be aware that most journalists are general journalists who write about anything from politics to sports. Be prepared for simple questions — sometimes more than one.
- ☐ **Prepare**: Plan what you would like to say in advance. If you are caught at a bad time ask to postpone the interview for 15 or 30 minutes and use the time to prepare. Make sure you have a full overview of the field (including other people's work). Memorise the most important facts and figures. Remember that you need to prepare more to talk to a journalist than when talking to your peers. Rehearse your explanation with anyone who will listen. In the words of Villard (1991): *"Do not think you can just 'wing' it."*
- ☐ **Minimise scientific caveats**.
- ☐ **Be confident**: You are the expert in your field, act it.
- ☐ **On television, look at the reporter and not at the camera.**
- ☐ **Style**: In some ways science communication is exactly the opposite of communication with your peers. In a journal the style is rigorous, exact, precise, dry and detailed. In public communication simplicity and excitement are the main issues. Science communication is a form of translation and simplification. Often there is no room for details, caveats, references to similar results etc. That does not mean that this type of communication is inaccurate or erroneous.
- ☐ **Select the right material**: Reduce the number of core messages to a maximum of three. Remember that the attention span of the typical layman is short and that you are competing with a flood of other much more dramatic news items (wars, disasters, pollution, health and so on). Select the best and most interesting topics. When selecting points, think about what makes an interesting angle (use the education and public outreach office for advice). In general, there are a number of simple criteria that make a story newsworthy (see section 8.2). Ask yourself: What is the main issue? Why is it important? What are the implications of your discovery? Repeat your messages if necessary.
- ☐ **Simplify**: Provide simple explanations — the simpler, the better. Simple explanations leave less room for error in the final product. Use analogies, metaphors and examples wherever possible. Avoid jargon and abbreviations. Use simple everyday conversational language.
- ☐ **Be brief and concise**: Typically science stories are "briefs" in the newspapers (max. 500 words) and only achieve 30 seconds or a few minutes on air on television or radio. Speak in self-consistent "sound bites" where possible since this leaves the most room for subsequent editing. Repeat your messages more than once during the interview. Be ready to accept that only 30 seconds out of a 20 minutes interview will be actually used on television or on the radio. Remember, even though your research took years you have published just three pages in *Nature*...

- ☐ **Some speculation is ok**: Journalists will often ask for wider "perspectives" or "implications". Going a bit "beyond" your result is fine, but emphasise where the facts end and speculation begins.
- ☐ **Think before you talk**: Take your time before answering.
- ☐ **Admit your limitations**: Admit it if you do not know the answer to a question. Say that you can check up on it if necessary.
- ☐ **Bridge, hook and flag:** If the topic is touchy three techniques may be applied with good results (Linke, 2005):
  1. Bridging: Make a transition from one question to the next, eg "Yes, and in addition to that ...".
  2. Hooking: Force a follow-up question that sets the stage for a key message, eg "That's just one of the benefits of ...".
  3. Flagging: Use a cue to underscore the importance of a point, eg "The take-home message would be ...".
- ☐ **You are on the record**: Never make off the record remarks. The exception to this excellent rule is if you know the journalist well and can trust him or her.
- ☐ **Enthusiasm fascinates**: Be enthusiastic about your work. Pay attention to your body language if you are on television. Relax and enjoy the experience.
- ☐ **Your core messages will be edited**: Be aware that only a small fraction of your already very condensed messages will ever reach the public.
- ☐ **Educate a bit**: Despite the previous advice, take the opportunity to add a few comments about the scientific process. How research takes long hours and hard work and much fumbling trial-and-error. Explain how surprising some results can be, and how scientific advances often come in incremental advances rather than as great breakthroughs. It may all help to give a slightly more accurate picture of science in the long run.
- ☐ **Be prepared to accept a less than perfect result**: News coverage often falls short of the level of detail, breadth and accuracy that most scientists would prefer (Nelkin, 1995). To some extent this is something you have to accept, but do your best to avoid errors by following the advice above. The final press product may:
  - Contain scientific inaccuracies, or even errors, especially if the journalist did not have time to check back with you. It is a myth that science journalism is often inaccurate and sensationalist — especially for more "traditional" and non-controversial science fields such as astronomy or physics. Madsen (2001 & 2003) supports this picture and concludes that overall the investigated science reporting is reasonably correct.
  - Be too short and condensed to give the full picture.
  - Contain inaccurate quotes.
  - Have a misleading headline. Headlines are often written by specialist headline writers who typically do not fully understand the story.
  - Ignore previous efforts in the field.
  - Have the weight in a wrong place, eg on some quirky detail rather than on the facts.

- Simply not be published, which means your time was wasted. The space for science stories is very limited and last minute changes happen all the time. If it is any consolation this is however at least as great a loss to the journalist.

Read more about interview situations in Funsten (2004), Shortland & Gregory (1991) and Wilson (1998).

17.2 A SCIENTIST'S CHECKLIST FOR PRESS RELEASES

17.2.1 Background

Press releases (see chapter 8) are one of the most common ways to place science news in the media. There are standard ways of producing and distributing them. If you have a local education and public outreach office it is best to liaise with them if you have discovered something that may be of potential interest to the public.

17.2.2 Checklist

- [ ] **Hot or Not?**: If you think you have a good science result, check with the list of News Criteria (see section 8.2) to see if your result is likely to interest the press and the public.
- [ ] **Be proactive**: If your science fulfils one or more of these news criteria, do not hesitate to tell your local public information officer (PIO) about it. If the PIO considers your story "hot" he/she can help you in many ways:
    - Help evaluate the "newsworthiness" of a given science result.
    - Prepare texts for a press release.
    - Prepare visuals: illustrations, images, video.
    - Prepare webpages etc.
    - Distribute the material to the press and the public via specialised media lists etc.
    - Arrange press conferences etc.
- [ ] **Participate in the process**: Work with the PIO to prepare a press release. Be prepared to spend some time explaining the science and to make the proper information available to the science communicators there.
- [ ] **Involve other institutions**: The PIO will interface with PIOs of other institutions that have participated in the work, possibly proposing a simultaneous co-release.
- [ ] **Create images**: Some sort of eye-catching image or illustration to accompany the press release is practically mandatory. Work with the EPO office to create appealing and correct imagery.
- [ ] **Add value**: Many scientists like to make a more specialised webpage containing additional information, translations of the press release into other languages, additional images, graphs, technical movies etc. Scientists are sometimes in a better position to interface with local media and often have a much more detailed knowledge about them than the PIO.

17.2.3 AGU's tip sheet for scientists in interview situations

This tip sheet is courtesy of the American Geophysical Union's public information office (from Funsten, 2004). Photocopy it, and keep it handy in your office.

Prepare your message: A checklist

What are the primary points that you want to communicate?

1) ____

2) ____

3) ____

How do they affect the public's interest, health, safety, and quality of life?

1) ____

2) ____

3) ____

What everyday analogies will help communicate your message?

1) ____

2) ____

3) ____

Two "pithy" phrases that you would like to use to help communicate your message:

1) ____

2) ____

Web material: Graphics, movies, supporting material, and background information:

____

Quick tips

- **Return that reporter's call immediately!** Reporters work to rigid deadlines. A "hot" topic can turn "cold" in less than a day.
- **Be enthusiastic!** If you are not excited about your own research, then nobody else will be.
- **Keep it simple!** Assume your audience knows nothing about your message. Talk at the level of your intended audience (no acronyms, technical terms, etc).
- **Be clear and accurate!** Take the time to explain your message clearly and accurately and you will probably not be misquoted. Take cues of misunderstanding from the reporter: Is a question repeated or rephrased? Does a question deviate from your message?
- **Educate!** Use the opportunity to educate the public on scientific method and scientific debate; avoid personal attacks on other scientists.
- **You are on the record!** Assume that everything you say will be quoted and attributed to you. Don't say anything, even in obvious jest, that you would not want to read in tomorrow's newspaper. Don't go "off the record" unless you have agreed with the reporter what it means.

Point of contact:

Your Institution's PIO and phone number:

____

17.3 A SCIENTIST'S CHECKLIST FOR PUBLIC PRESENTATIONS

17.3.1 Background

Verbal presentations are different from the written in many respects. When writing we carefully prepare, write and edit. We discuss the product with colleagues and re-write until we are perfectly happy with the result. But with verbal presentations the situation is normally very different. No referee or editor checks what we are going to say and after the presentation we never usually receive any negative criticism. This list may help to improve the quality of your presentations and to direct your attention towards some critical points. Find more good advice in Shortland & Gregory (1991), Kenny (1982) and Wilson (1998). For more scientific audiences good advice is found in Alley (2003).

17.3.2 Checklist

- ☐ **Expectations**: First check on expectations with the organiser:
  - Which target group are you addressing?
  - What level should the presentation be?
  - How long should the presentation last?
  - Suggest a topic, and discuss what the best approach is.
- ☐ **Prepare**: Prepare your presentation well in advance. Investigations have shown (Kenny, 1982) that fear of public speaking is the single most common fear amongst people in general. And nothing is better at removing this fear than preparation and practice.
- ☐ **Practise**: Read the full presentation to yourself, time it and make sure you use no more than the allocated time. A full dress rehearsal at the actual venue is even better and will make for a much more pleasant experience when the real presentation happens.
- ☐ **Think positive**:
  - The fear of public speaking is desirable to some degree. Adrenaline is good for improving performance.
  - The audience will see you as an expert, have a friendly attitude and want you to succeed.
  - The following four pieces of advice are adapted from Kenny (1982):
    - By preparing well the risk of making mistakes is reasonably small.
    - You are most likely to know more about the topic than anyone else in the audience.
    - Even if you make mistakes, it will be much less noticeable to the audience than to yourself.
    - If you have difficulties, there are escape routes:
      - Read from your manuscript
      - Skip to the end
      - Pour some water
      - Ask if there are any questions so far

- ☐ **Check venue:** Check out the venue well in advance of the presentation:
  - How is the room arranged?
  - How large is the screen?
  - Where is the pointer?
  - Where can you stand?
  - Where can the computer/projector stand?
  - Where are the light switches?
- ☐ **Film slides:** If you use 35 mm slides:
  - Sort the slides in advance.
  - Make sure you have 15 minutes to put them in a different tray at the venue.
  - Walk through the slides in advance and change the orientation of the ones that are wrong.
- ☐ **Selection**: Be selective in what material to present:
  - Simplify.
  - Choose the most interesting and sexy aspects of your work.
  - Carefully decide on your core messages. Start and end the presentation with these.
  - Minimise (or omit) equations.
  - Use a slightly shorter time than your audience expects.
- ☐ **Questions**: Allow plenty of time for questions.
- ☐ **Engage the audience**: If possible try to involve the audience:
  - Be enthusiastic about your work (or ask someone else to make the presentation)!
  - Encourage questions during the presentation.
  - Try to get smaller (relevant) dialogues going.
  - Ask the audience questions, eg "What do you think is going on in this picture?" or "How would you solve this problem?" Often the answers are clever, surprising and even thought-provoking.
  - Involve cases or circumstances that are recent and has relevance to the audience.
- ☐ **Visuals**: Have pleasant and friendly visuals: Viewgraphs, flipchart, slides, whiteboard, animations, images ...
  - Do not clutter the viewgraphs.
  - Use large lettering commensurate with the size of the room, the screen and the audience.
  - A rule of thumb is to have one viewgraph or slide per minute.
- ☐ **Speed**: do not exceed 100 words/minute (Kenny, 1982). Write down your presentation and count the words.
- ☐ **The scientific method**: Involve the scientific work process/tradition in your presentation if possible. Underline that science is not easy, but has great rewards in the form of acquired insight.

17.4 A PIO'S CHECKLIST FOR DEALING WITH SCIENTISTS

17.4.1 Background

Just as there may be conflicts in the relationship between scientists and journalists (see section 2.4), it is well-known in communicator circles that the scientist and the communicator do not always pull in the same direction in putting together a communication. Although scientists and PIOs are in "the same boat" in principle and have every reason to collaborate, natural differences in the background and the goals of the two actors may cause problems. The problems often arise from the fact that the scientist is afraid of giving control of the communication to someone who naturally knows less about his science than himself. The communicator — based on past experience — may assume that the scientist is either not very interested in the communication process or lacking in ability in this area. What often happens is that the scientist shoots down communication ideas and ideas for simplification.

It is well-known in communicator circles that the scientist and the communicator do not always pull in the same direction in putting together a communication.

Some possible problem areas (over and above those listed in section 2.4):

- Any scientific result can be communicated in a thousand different ways (Principle of a Thousand Ways). The answer to what works best is not cast in stone. Scientists live to discuss and to doubt, and often like to see firm quantitative arguments for why the communication is put together in a particular way. But science communication is not an exact science and depends on personal experience. Quantitative arguments are hard to come up with.
- Scientists are not always aware of how much work is done in science communication to preserve credibility (delivering an interesting, newsworthy and understandable science message while avoiding "hype", see chapter 21).
- Not all scientists know enough about science communication in general and do not consider the details of the communication process important.
- Not all PIOs pay enough attention to the credibility balance.
- Mistakes in science communication *are* made.
- When scientists have not experienced how useful a well-oiled communication process can be when performed in a controlled and balanced manner, it is (understandably) difficult for the communicator to get the necessary support.

Principle of a Thousand Ways: any scientific result can be communicated in a thousand different ways

17.4.2 Checklist

- ☐ **Gather experience**: Science communication is a sensitive, resource-driven balancing act and experience, not rigorous argument, shows what works best in a given communication situation.
- ☐ **Control the communication process**: Limited manpower and time make it crucial that the PIO decides what and how to communicate in order to maximise the outcome (while best respecting the mission statement). The PIO needs to dedicate the necessary time to choose the right path by finding the most suitable products, target groups and angles and then stick out his/her neck to defend them from the participating scientists.
- ☐ **Success does not come easy**: In the first months of operation of a new communication office it may be very difficult to get the backing and trust of scientists. Once the communication process gets going and the media coverage pour in, the relationship gets easier.
- ☐ **Gain experience with the science**: The more one knows about the science being communicated the better one stands in discussions with scientists. It helps to have a science degree, but an intensive study of the relevant topics can be sufficient.
- ☐ **Be sensitive**: A scientist's science is his "baby", and too many discussions can trigger his protective instincts.

18. HOW TO HOST A PRESS CONFERENCE

A press conference is an effective way of getting the attention of the media and is a statement that a story is "hot news". Press conferences rank at the top of the press release visibility scale (Section 12.1) with visibility magnitudes from 5 to 7 depending on the type of conference. Mitton (2001) urges *"extreme caution over calling press briefings outside scientific meetings"*, due to experiences with poor attendances. Today press conferences have, to some extent, been replaced by media teleconferences that involve much smaller logistical challenges for the journalists.

Naturally there are some basic rules to follow for press conferences:

- Make sure the story reflects the visibility magnitude — that the story is truly newsworthy or that the scientist is outstanding (Nobel Prize material) to avoid subsequent problems with credibility (consult the list in section 8.2).
- Pick a time that suits media deadlines, ie morning.
- Invite the press at least a week in advance with an indication of the topic: "*We will have a press conference highlighting a major discovery in extrasolar planet research*". A more detailed invitation should be issued two to three days in advance.
- Provide the attendees with a press pack (see chapter 5).
- Give the reporters a chance to get individual interviews with the scientists afterwards.
- Provide quiet rooms for these interviews.
- Brief scientists before the press conference.
- Rehearse the scientist's presentation.
- Provide audio feeds for radio/TV journalists.
- Use microphones during the Q&A session.

Press conferences have a more or less standard format:

- The PIO welcomes and introduces the organisation very briefly. He then introduces the scientist(s) and explains very briefly why the press conference was called.
- The scientist briefs the meeting about his/her result.
- Often an independent scientist, carefully selected in advance by the PIO, is called in to give his/her endorsement of the story.
- Q&A session. Allow plenty of time for questions and discussions. The PIO may also ask questions or clarify important points.
- The PIO closes the Q&A session when it seems appropriate — not too early, not too late.
- Individual interviews are held.

For the scientist's presentation the usual checklist applies (see section 17.3). A few additional pieces of advice:

- The briefing should really be very short — 5-10 minutes.
- This is *not* a science talk: The conclusion has to come first, the explanation, observations and theory afterwards.
- Some clear messages — sound bites — should be prominent.

- Use even simpler and more appealing graphics than for public talks.
- Be sure to stress why this discovery is particularly important and any implications it may have.
- Be prepared to rehearse the presentation with the PIO in advance.

For the individual interviews afterwards please refer to section 17.1.

Read more about this topic in NASW (2003), Byrne (2002) and Maran (2003).

19. OVERCOMING NATIONAL BARRIERS

In Europe we are currently facing a huge problem: media and public interest in science and technology is waning and the number of students pursuing science at higher educational institutions is decreasing. Investigations have shown that articles on a topic like astronomy and space occupy only 0.1% of the leading European newspapers today (Madsen, 2001).

There is a great need to improve the awareness and understanding of science in Europe and a huge effort in science communication is essential to maintain and increase the level of scientific funding.

Including science communication as an integral part of every research institution is a concept that is emerging all over Europe. Efficient and effective science communication has long been a tradition in the US where there is a direct feedback loop between scientific funding and the visible presentation of results. In general European institutions still lag behind the US in this field and much can be done to improve the situation.

In general European institutions still lag behind the US in this field and much can be done to improve the situation.

Because of the "direct" or even "aggressive" methods, "the American way" of communicating science is very often criticised in Europe, but the American results are undeniably much better than those achieved elsewhere. This is not to say that everything American is 100% correct or that American methods would transfer successfully directly to Europe, but there are many good things to learn.

The European media today often favour American results and institutions, for instance by using results from NASA instead of ESA. There may be several reasons for this. Perhaps part of the reason is merely habit with journalists and editors? After all, the Americans have had many years to build up a good relationship with the media, and the media know what they are getting from the US. Perhaps American science stories are more digestible and of a higher standard? Or there are more of them and they are simply more accessible and visible? I believe that all of the above apply, and the best strategy to improve the situation is to consistently produce interesting and high quality communication products in Europe.

19.1 THE LANGUAGE BARRIER

One of the most prominent differences between Europe and America is the existence of many different European countries each with different traditions and languages that a European communicator has to target. The many different languages in everyday use on our continent make it difficult to target all of Europe with the same product and are an inherent disadvantage to European communicators. Most scientifically literate Europeans master English, but, especially in the southern part of the continent, English is less used. The end-users (often the public at large) prefer material in their own language, and often the mediators (media, teachers) will also need translated material. The translation and editing of multiple versions of each product is a substantial task, both in terms of time and manpower.

19.2 THE CULTURAL BARRIER

Often hidden behind it, and much trickier to deal with, is the cultural barrier. One does not present things in the same way to Europeans as to Americans. Or in the same way to Italians or Chinese as to Chileans or Pakistani for that matter.

Different countries have different religions, political systems, technological and scientific levels, and levels of general knowledge. All these cultural differences will manifest themselves in different ways, for instance in different news criteria (see section 8.2) and favoured distribution mechanisms. The cultural differences should, in the perfect world, influence the way we communicate, as we can target the different cultures better when we know them and take then into account.

19.3 ATTITUDE

The largest problem faced by communicators outside the US is the lack of what could be called a real professional attitude or culture within the organisations.

The largest problem faced by communicators outside the US is the lack of what could be called a real professional attitude or culture within the organisations. Attitudes in Europe are slowly shifting from a situation where talented volunteer scientists act as science communicators in scientific organisations, often as a part time adjunct to another job, to a situation where full-time professional science communicators are taking the leading role.

The most important point about science communication is that it should be professional. As an example, many scientific organisations outside the US have not even reached a stage where communication efforts are evaluated rigorously, or even semi-rigorously. Although it is notoriously difficult to do, it can certainly be done and should not be neglected (see chapter 13).

19.4 CENTRALISED VS DECENTRALISED SCIENCE COMMUNICATION

How do we best go about communicating science in Europe?

The cultural and language barriers make it relevant for many large organisations, like the *European Space Agency*, to discuss whether science communication should be centralised or decentralised. A better infrastructure for production can be set up in a centralised environment and more can be produced with the same resources. However a decentralised operation can be set up close to the scientific action where the flow of information is better, and where each local office is better placed to deal with the local media in their own language.

Naturally the solution to the centralised/decentralised question depends on the organisation's individual circumstances, but I believe that "both" may often be the correct answer. The optimal situation is probably a combination of a centralised and a decentralised operation. The central unit defines the mission, the strategy, the general framework (corporate visual identity etc) and coordinates the work actively with the decentralised units. The centralised unit does not necessarily enforce full control over the local unit. This kind of micromanagement over distance is counterproductive in science communication where events unfold on very short timescales and where a reasonably high degree of autonomy is necessary (see section 3.5). It may also be advantageous to have some degree of free competition between the different units to promote high quality and distinctive products. The local units should have the specialised know-how in science and science communication that enables them to carry out their particular task. For this kind of hybrid scheme to work it is necessary to have a high level of internal communication between the centralised and decentralised units and a common respect for their mutual responsibilities and areas of expertise.

19.4.1 National press offices

As an example we can look at the problem that large pan-European organisations such as the *European Space Agency*, ESA, and the *European Southern Observatory*, ESO, have in dispersing their excellent results effectively across borders. As each organisation has different operational environments and different goals, they operate largely independently, often duplicating resources. While this is largely this is unavoidable, one could imagine a great deal of synergy if the organisations each had access to a local (decentralised) national press office in each country, or area, that could act as a “focal point” and “information exchange” between the centralised head offices of the international organisations and the local media and scientists for a particular scientific field. *ESA* has taken steps in this direction by setting up a network of contact points called “country desks”, but it is difficult for one organisation to get above the critical mass of 3-4 persons or more in such an office. In a perfect world one could imagine several large research organisations, pooling their resources to establish national science communication offices that serve several organisations and so reach a size that enables an efficient production in each individual local office.

The implementation of such a national press office should probably be a collaborative project between international organisations, national organisations and the local national ministries. There are obvious advantages to such a setup, but it may not be so easy to convince potential members of the clear benefits. A national office in a country can:

- Be a central engine for communicating a particular branch of science.
- Nationalise, eg translate and adapt news releases from international organisations.
- Be the point of contact for the media.
- Be the coordinating entity both internally for national organisations and externally for international organisations.
- Coordinate international events such as Science Days.

- Maintain the national database of press contacts (for all organisations to use).
- Feed know-how about science communication back into the scientific circles through talks, media training and graduate courses.
- Maintain a catalogue of scientists with standard pre-cooked talks about current scientific topics ready for schools etc.
- Help national and international organisations establish a brand and public profile.
- Participate in the training of high-school teachers.
- Establish contacts between international research organisations and local industry.

20. GOING COMMERCIAL[55]

The two terms "science communication" and "commercial" don't immediately seem to belong together, but science communication in non-profit research organisations is exposed to exactly the same forces as anyone else operating in the global marketplace. The big difference is that everyone else "out there" is subject to standard economic rules such as "supply and demand" and must make a profit to survive. These profits enable the investments that create a continuous development of the product portfolio and the company itself. By ignoring all commercial methods science communicators put themselves at a significant disadvantage.

Science communication in non-profit research organisations is exposed to exactly the same forces as anyone else operating in the global marketplace.

Finding funding for science communication is often mentioned as the biggest obstacle to doing a good job. Carefully adding some commercial facets to an education and public outreach office can add alternative strategies otherwise impossible within a strictly non-commercial operation. These might include: joining forces with commercial companies, selling outreach products on the web (known as e-Commerce) at cost price, sponsorships and applying for grants from funding organisations.

But should non-profit research organisations, which are often funded by taxpayers' money, really charge for their products? There is no clear answer as each case depends heavily on the individual circumstances and rules. However by following a basic "moral code" it should be possible to convince others that commercial aspects can be both of great benefit and "morally correct".

20.0.1 Moral code for commercial science communication

For non-profit research organisations the following points may serve as guidelines for conducting a "morally correct" trade with science communication products:

1. Commercial aspects are not introduced into the workflow to make a real profit. The revenue should only cover costs: production, handling and shipping costs.
2. If some products do create a small profit, the profits should be invested in improving the product portfolio (both quality and number).
3. Deals with commercial companies, for instance distribution rights for a certain product, should be on a non-exclusive basis.

20.0.2 Copyrights

When dealing with external users of EPO products one may group copyrights into two different types:

1. Copyright: The right to copy, or use, often at a cost per use.
2. Copyright-free: The opposite of copyright. The product may be used freely, modified, and also redistributed. There are usually no particular terms imposed apart from a source credit (eg a

55 This chapter was written with substantial input from Sylvie Wieland (Germany) who conducted a six week internship at *ESA/Hubble* in the autumn of 2005.

credit line, logo etc). Copyright-free is related to CopyLeft[56] and public domain. Sometimes a product can be used after prior approval. Additional terms can be built into this such as mentioning the source, credit oversight and approval of how the product is used (graphics, advertisements etc).

20.1 PARTNERING WITH COMMERCIAL COMPANIES

It may sometimes make good sense to team up with commercial companies who can take over partial ownership of a product.

EPO offices will never be more than dwarfs when it comes to marketing, advertising and distribution in the global market place. So it may sometimes make good sense to team up with commercial companies who can take over partial ownership of a product. This can create a win-win effect whereby both sides gain advantages. Ownership can involve advertising and sales of a product produced by the EPO office or even in some cases the production itself.
The advantages for the EPO office are:

- **Visibility**: A commercial company is market driven and owes its existence to making a profit. Marketing a product is no longer a "nice to have" but an existential "must". For this reason companies will often have full-time professionals handling marketing and advertising issues (ie more marketing "muscle" than an EPO office). The EPO product becomes "one of many" in a standard commercial company portfolio so that standard advertising such as catalogues, web presence and the like is automatically taken care of in a professional manner and the product gains much greater visibility — one of the main aims of an EPO office.
- **Quantity**: A commercial company's sale and distribution network is much larger and more elaborate than any an EPO office can set up, enabling much greater numbers of the EPO product to be distributed.
- **Branding**: When granting usage rights for a product to an external company, it is common to impose the condition that a source credit line or a logo for the scientific organisation is shown, increasing exposure of the organisation or product.
- **Access to other segments**: An external company's marketing and sale set-up is typically aimed at different market segments from those targeted by the EPO office. Accessing these segments is a valuable addition to the EPO portfolio as they are likely to be less exposed to scientific products than the normal "customers" of an EPO office.
- **Special knowledge**: Commercial partners often have special expertise for a particular market, eg a country, an area, a market segment or a particular product type.

Collaborating with a commercial company may also come at a cost. The EPO office will most likely have to hand over a part of the control to the company. The specifics of this ought to be outlined in an (formal or informal) agreement before starting the collaboration, and this deserves some attention.

56 http://en.wikipedia.org/wiki/Copyleft

20.2 e-COMMERCE

Selling science communication products, for instance on the web, is a way of using commercial means and methods to increase the distribution of existing and new printed products and merchandising items. The sale and purchase of products on the web is known as e-Commerce. The benefits of entering into the already crowded e-Commerce market are manifold:

- Existing products are more visible – what good is it to have a good product hidden where nobody sees it?
- The whole product portfolio is more visible and acquisition is easier (via an order form).
- Products have a higher perceived value if sold.
- Sales figures can be used to evaluate the public interest in different products.
- The brand and name of the institution is spread more widely by having products for sale in addition to free products.
- The small added revenue from sale of standard articles such as posters and postcards in a web shop can help expand the product portfolio which makes it possible to be better prepared for public events such as Open House days, public talks and other events.
- High-quality products produced for e-Commerce can be used as presents for VIPs, visitors etc.

When going commercial a proper corporate visual identity is essential as the brand to be marketed and sold has to be recognisable. Read more about these issues in section 10.4.

20.3 CASE STUDY: THE HUBBLE SHOP

ESA/Hubble has had quite a large product portfolio consisting of brochures, posters, DVDs, CDs, books etc for a long time. So far this has been distributed (for free) somewhat “by chance” — pretty much if people happened to hear about them. The free products were not advertised as a high demand could have impeded the actual production — which would be self-defeating. Most of the products were always available on the web or could be picked up in person at the Hubble office in Munich.

The motivation for creating a European web shop marketing and selling simple products related to the Hubble Space Telescope arose from the considerations in the bulleted list above. A shop makes the products more visible and easier to find, increasing their “value” and the number and type of products available. As potential customers are spread over the whole of Europe or even further away, the best way to reach them is via a web shop.

Some basic conditions are imposed on the customers:

- Minimum order per purchase is 5 €.
- Payment is only possible by major credit cards (VISA, Master Card and American Express).

The customers are also informed that:

- Prices in the *Hubble Shop* are cost prices (ie the prices only cover the costs of production and handling).
- When the customer clicks "Place your order" the purchase is final.
- All material except merchandise and books can be picked up in person for free (one copy) at the *ESA/Hubble* office in Garching, Germany.
- Shipping costs will be added to the price when the customer clicks "Proceed to Checkout" just before paying.

20.3.1 Shipping costs

The physical cost of shipping products to the end-customers presents one of the main challenges to web shops of any kind. It is therefore important to put some effort into investigating different possible shipping cost schemes that depend on the local postal circumstances.

Both vendor and vendee require a clear shipping cost scheme — one that does not take a degree in economics for both sides to figure out.

Five different shipping cost schemes for the *Hubble Shop* were simulated prior to making a final decision:

a. Add the actual shipping price for each product individually to the product price as charged by the mail service (in this case Deutsche Post). Note that this scheme does not take the change in shipping costs by shipping more than one product in one parcel, into account.
b. Charge a certain percentage of the product price (numbers were found by iteration):
    - Germany (15%);
    - Europe (33%);
    - World (60%).
c. Charge a fixed shipping cost depending on the total order amount (numbers were found by iteration, and can naturally be tweaked) (table 11).
d. Charge the actual shipping cost of the first product (prices by the Deutsche Post), and add 2 € per each additional unit.
e. Charge a fixed shipping cost depending on the weight of the total order (table 12).

Order amount	Germany	Europe	World
5 €	2.00	4.00	7.00
>5 €	3.00	6.00	9.00
>10 €	4.50	8.00	11.00
>20 €	5.00	9.00	12.00

Table 11: *Shipping costs scheme based on total purchase amount (c).*

Weight	Germany	Europe	World
0 — 20 g	0.55	0.95	1.55
20 — 100 g	1.44	2.00	3.00
101 — 250 g	1.44	4.00	7.00
251 — 500 g	2.50	6.50	11.00
501 — 1000 g	3.00	8.00	12.90
1 — 4 kg	4.30	9.00	12.90
Above 4 kg	5.60	17.00	30.00

***Table 12:** Shipping costs scheme based on total weight (e).*

Ten different, representative, shopping carts were simulated, ie "filled" with different purchases. The actual shipping costs for each were calculated and then compared with the calculated results from the five different shipping cost schemes, a) - e) above. This enables a comparison of the actual shipping costs with the shipping costs that a customer would have been charged.

In the graphs below the line indicates the perfect one-to-one match between real and simulated shipping costs. This makes it easy to see which favour the customer (below the line) and which the shop (above the line). Graph 1 shows the shipping cost simulation for Germany, graph 2 for Europe and graph 3 for the rest of the world.

By calculating the standard deviation of the five shipping cost systems from the line y=x (which indicates perfect correspondence between actual and simulated shipping costs), one can assess which system fits the actual shipping costs best. The results are shown in table 13.

Standard deviations	a	b	c	d	e
Germany	0.75	1.73	2.47	1.25	1.12
Europe Zone 1	2.36	2.95	2.60	1.41	0.93
World Zone 1	5.43	5.27	2.95	2.00	0.86
Average	2.85	3.31	2.67	1.55	0.97

***Table 13:** Estimate of standard deviation of the different simulated shipping costs from the actual shipping costs. Model (e) is clearly the best model.*

It is clear that system **e** (based on the total weight of the purchase) with a standard deviation of 0.97 was the most appropriate. Other organisations may find other solutions, depending on the shipping destinations and the products typical of their range. Note that the reason that system **a** with the (predefined) actual shipping costs per product does not perform well as it cannot take the bulk shipping costs of shipping several products into account. There are usually savings by shipping

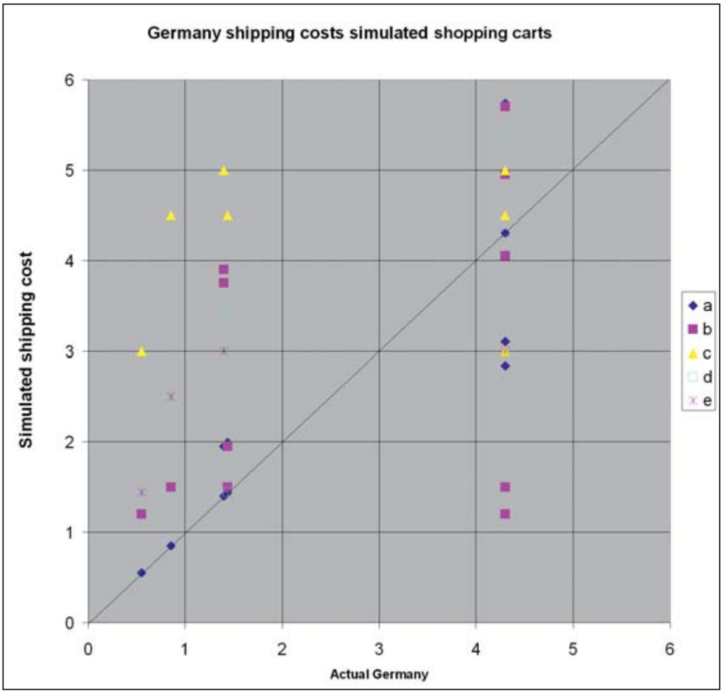


Figure 73: *Shipping cost simulation for Germany with five different shipping cost schemes and 10 different shopping carts.*

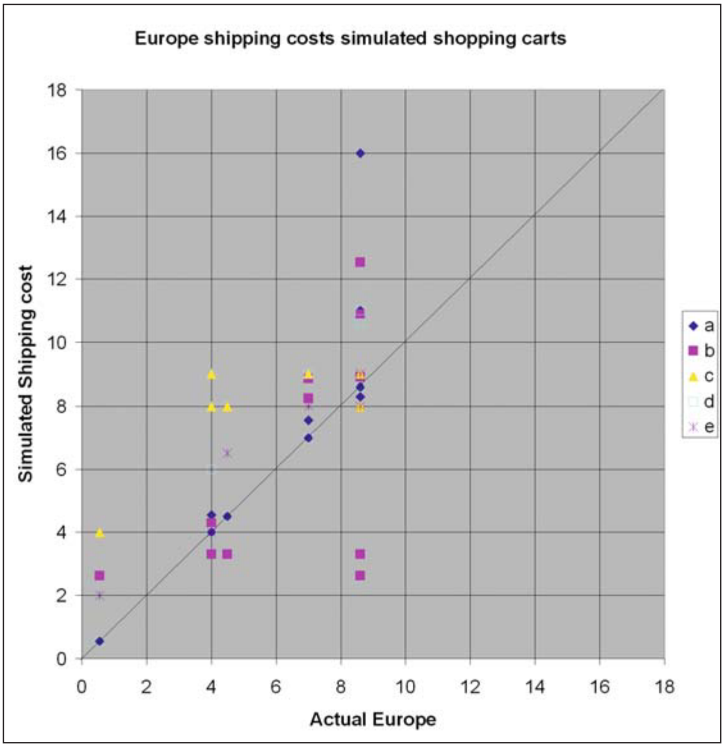


Figure 74: *Shipping cost simulation for Europe with five different shipping cost schemes and 10 different shopping carts.*

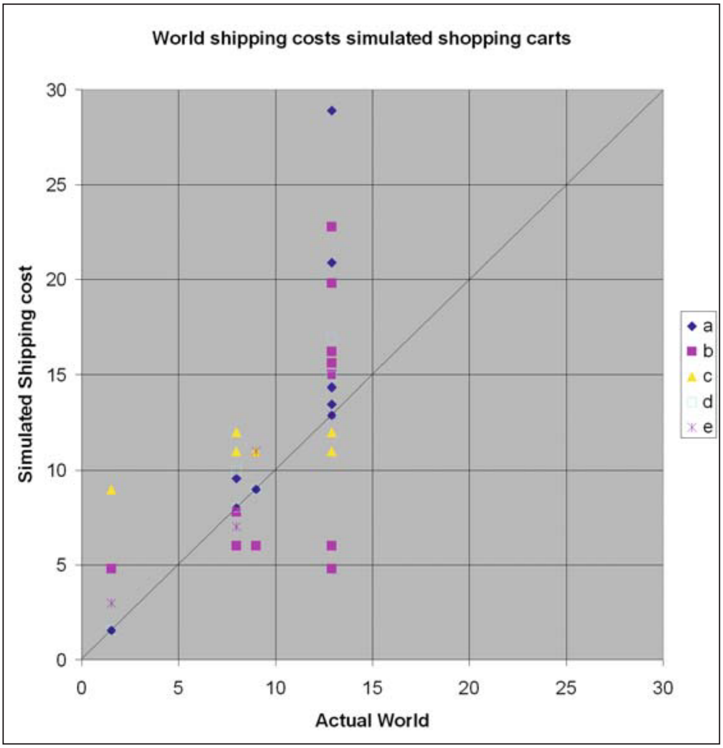


Figure 75: *Shipping cost simulation for the rest of the World with five different shipping cost schemes and 10 different shopping carts.*

in bulk (although not always as the shipment type may change due to local rules).

The conclusion in this case is that scheme **e** strikes the best balance between actual and charged shipping costs, and can be implemented fairly easily on the web while being comprehensible for the customer.

20.3.2 Web shop implementation

It was decided to build onto the existing web system, *Simplicity,* to set up the *Hubble Shop* (see section 14.5) and to expand it with some modules to take care of the new commercial aspects. The new components were:

1. A small expansion of the metadata definitions to include sales flag (yes/no), sales price, weight and a few other odds and ends.
2. A new way of showing the output of an archive query as a sales catalogue where the products can be ordered.
3. A shopping cart that keeps track of which and how many products have been ordered.
4. A checkout page with a form for shipping addresses and billing addresses that enables the shipping cost calculation (see section 20.4.1).

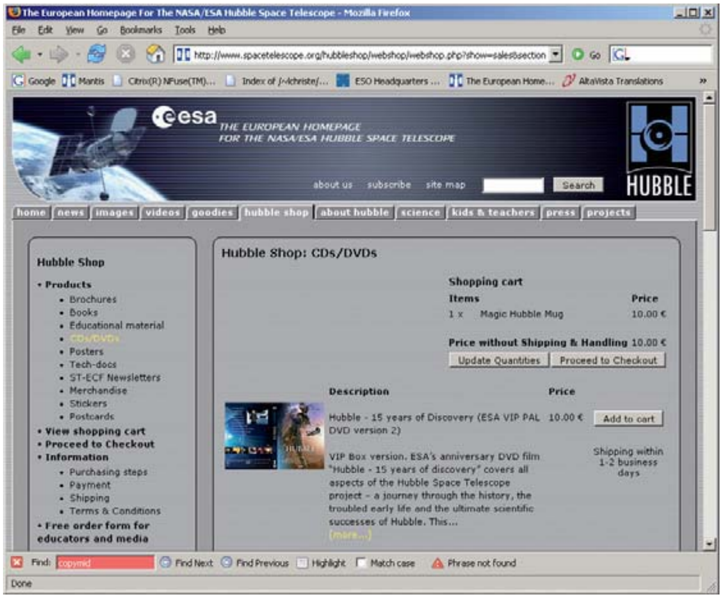


***Figure 76:** A query page in the Hubble Shop showing the shopping cart and the selection of CDs/DVDs.*

5. A payment page with a summary of the purchase, shipping costs, shipping and billing addresses and credit card information.
6. A few pages with information such as Terms & Conditions (see below), shipping costs (table 12 above) etc.
7. A credit card validation module that interfaces with the bank and returns information about the validation operation.
8. A basic communication module that emails the user and the person responsible for distribution when a purchase has been completed.
9. A free order form for educators and media using the same commercial ordering components as above, but calculating in "equivalent value" to show the customer the value of the merchandise they are requesting, with a comment field to argue why the merchandise should be free.
10. An additional module to interface the purchase information with the in-house administration/financial system (*Navision*).

20.3.3 Terms & Conditions

The *Hubble Shop* has the following Terms & Conditions (reproduced verbatim), which may be used as guidelines for similar web shops:

1. **Secure Internet Commerce:** All information placed in your orders is processed through our secure server. We utilise the newest industry-standard Secure Sockets Layer (SSL) technology that encrypts all your information before it is sent to us. The personal information provided to us will remain confidential and be used solely to communicate better with you.
2. **Payment Options:** Payment is only possible by Credit Card. We accept VISA, Master Card and American Express.

3. **Shipping information:** Shipping is carried out with Deutsche Post/DHL. Shipping costs are calculated by weight and for 3 different areas:
   1. Germany;
   2. Europe;
   3. World.

   The delivery times usually vary between 2-10 working days, overseas 7-17 days; depending on the product (see the individual items). The estimated delivery times include handling time and exclude weekends, also there may, on occasions, be unforeseen delays.
4. **Sales Tax:** As we are a European Intergovernmental Scientific Institution we do not charge Value Added Tax (VAT).
5. **Return Policy:** Inspect your merchandise as soon as you receive it and notify us immediately if the merchandise is not the one ordered or if it has been damaged in shipment. If this is the case you may return the merchandise at our expense. Opened and undamaged merchandise may be accepted for exchange within fifteen (15) days from the receipt date on the invoice and with prior approval.

20.4 ADVERTISING

Science communication cannot normally afford "real" advertising on TV or on billboards. However going commercial demands some kind of advertising effort as paying customers will not just "pass by" a web shop in the same way as by a real shop next to the bus stop. Web advertising may provide an affordable way to advertise. Web advertising can increase the awareness of a webpage, brand, an institution and products fast and relatively cheaply.

20.4.1 Case study: Google AdWords

Advertisements placed on *Google*'s search query page (*Google AdWords*)[57] are easy to implement and have a relatively large impact, as they place the product in an advantageous position on *Google*'s site.

When placing an ad, a list of predefined keywords has to be chosen. The AdWords advertisement will appear on *Google*'s search output page along with the result of the search query when a user enters one of these predefined keywords in the *Google* search field. If the user clicks on the ad, the click is registered and the user is passed on to the website that is being advertised (where the user hopefully gets "stuck").

The keywords should naturally be well chosen so as to target users with the right interests (basically keywords related to the relevant organisation and services).

The *AdWords* ad itself contains a title, two lines of description and a URL. The text should be carefully thought through to make it as attractive as possible for the user. It is fairly simple to create a test *AdWords* ad as can be seen in the example in figure 78.

57 https://adwords.google.com/select/

Table 14: *Calculation example with the keywords chosen above with a maximum Cast-Per-Click of 1.00 € (Source: https://adwords.google.com/select/CreateAdInput)*

Keywords	Avg. Position	Clicks / Day	Cost / Day	Avg. CPC	Status
Overall	1.3	106.3	€19.76	€0.19	-
ESA	1.0	24.0	€2.11	€0.09	On hold
european space agency	1.0	1.0	€0.05	€0.05	On hold
hubble	1.3	57.0	€11.38	€0.20	Normal
hubble images	1.6	2.0	€0.49	€0.25	Normal
hubble pictures	1.6	3.0	€1.01	€0.34	Normal
hubble space telescope	1.4	7.3	€1.67	€0.23	Normal
space images	1.4	5.9	€0.93	€0.16	Normal
space shop	1.1	2.1	€0.59	€0.28	Normal
space telescope	1.6	4.0	€1.52	€0.38	On hold
Estimates for these keywords are based on clickthrough rates for current advertisers. Some of the keywords above are subject to review by Google and may not trigger your ads until they are approved. Please note that your traffic estimates assume your keywords are approved.					

Google AdWords

The cost of *Google AdWords* depends on how advantageous a position (how high up on *Google*'s search output page) is required and uses Cost-Per-Click (CPC, the price paid per click of a user — selected by the advertiser themselves). But beware if other organisations or companies use the same keywords and pay more per click, their ad will be displayed more prominently. The Cost-Per-Click can vary between 0.05 € and 100 €.

Google has a tool (see table 14) that calculates the estimated daily cost of an ad based on their experience of how often different keywords are used. The user enters the required keywords, and the required Cost-Per-Click as well as a maximum cost per day (for example 20 €). If the maximum daily cost is exceeded the ad will no longer appear on the *Google* search output page and won't accrue any additional costs. The prices can be changed at any time by the advertiser via a personal account, where he can also follow the current clicks and billings.

The process is relatively transparent:

- there are no monthly fees, no minimum fee
- there are no costs if the ad is not clicked
- it is always possible to change the ad or the prices

Google

Figure 77: Example of Google AdWords *ad* appearing on the right hand side of the Google *search* output page.

Google

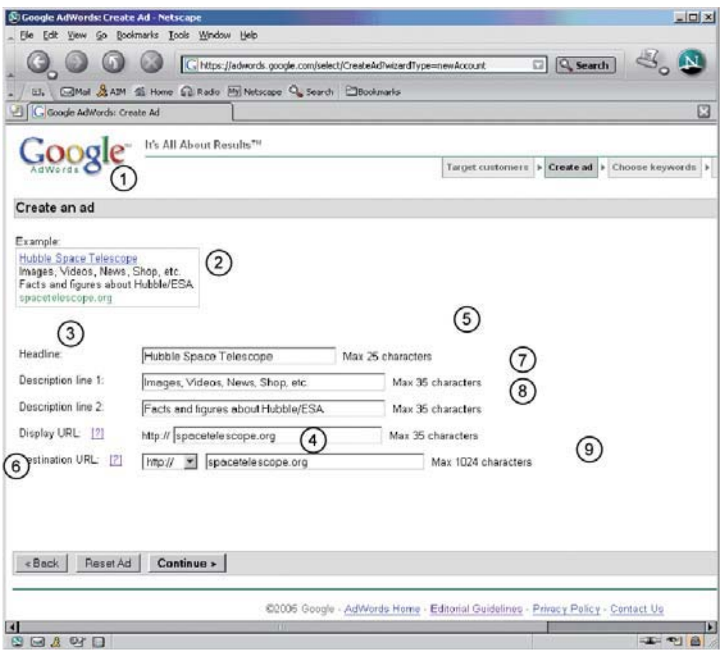


Figure 78: Example for creating Google Advertisement (from https://adwords.google.com/select/CreateAd?wizardType=new Account). 1. Link to Google AdWords Homepage. 2. The output from the ad construction tool below (updated live). 3. Headline and descriptions used in the ad. 4. URL of the advertised webpage.

- there is always access to a cost overview
- the monthly billing includes time period reporting with stats such as how often which keyword was clicked etc.

20.5 PROCUREMENT & PRODUCTION

Procurement is the actual process of acquiring the products and may need a bit of attention at the EPO management level. Since this chapter deals with aspects of a commercial nature it seems most naturally placed here.

Some research organisations have elaborate mechanisms for how to order products, and dedicated staff for this. For products, such as those discussed here, the procurement process is about acquiring the right product at the right price and deciding how many items of a given product to order to avoid getting stuck with a large overstock. Procurement involves a careful investigation of prices, suppliers and production parameters. Before making a final decision several offers from different suppliers should be requested and compared with each other. This can be rather a time consuming task.

For some, simpler products a procurement process that takes place outside the EPO office does not pose a problem. Unfortunately the *production* (which is internal) and *procurement* (which is external) workflows for many EPO products are often completely intertwined and the actual production and ordering of a product, such as a coffee mug, becomes a highly iterative process. This can easily create problems and delays in the procurement process as the procurements personnel are not trained to deal with intricate graphical and technical issues in the production. Delays, as so often preached in this text, are one of the worst enemies of an EPO workflow.

20.5.1 Case study: “Magic Mug”

Let us illustrate this issue by listing the specifications necessary for the production of a simple “Magic Mug” (a mug that changes colour when filled with warm liquid). Each specification has an impact on the price and is likely to change many times during the production and procurement process as facts emerge and graphical ideas change. Furthermore the requirements and possibilities on the supply side are not easy to get hold of as you tend to deal with sales, and not technical, personnel during the procurement process.

Some of the production parameters for a simple “Magic Mug” are:
- the mug type/model, size, volume;
- the mug background colour;
- number of print colours;
- the type and specifications of the extra thermo-sensitive colour;
- the printable area top, bottom and near the handle;
- the packaging, eg individually in a box;
- production time.

These parameters are unfortunately not "free" but depend on each other and on the supplier's requirements. This makes a seemingly simple order rather complex.

There are only two things to do to avoid the procurement process running *ad infinitum*:

1. Allow for extra time for procurement in the production plan (as we live in the real world as opposed to the perfect world this is unfortunately, as we know, not always possible).
2. Participate as much as possible in the procurement process, paving the way for the actual order as much as possible. Try to reduce the number of free parameters by making design and management decisions as early as possible.

Costs

The unit price and the total cost (equivalent to total number of units) are naturally two of the most important parameters in the procurement process. As the budget usually is second only to manpower in importance in an EPO office, this issue deserves some attention.

The unit cost determines the "cost per impact" of the product. The total cost determines the total risk of the production.

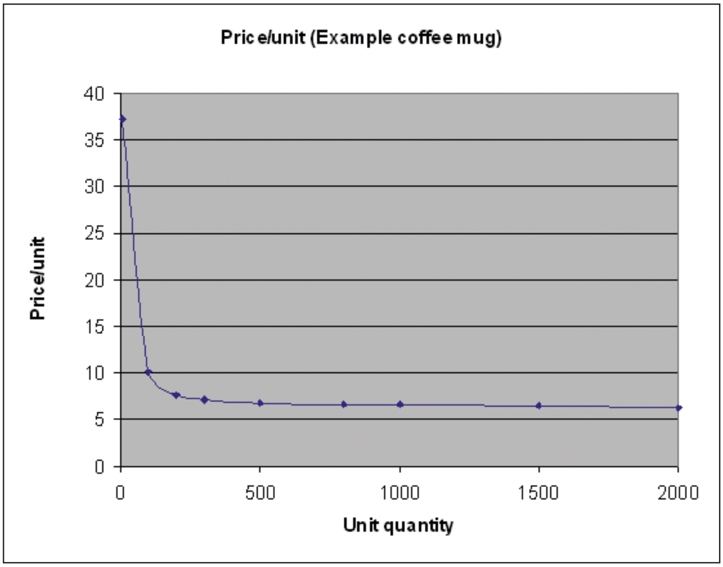
In figure 79 the dependence of the unit cost on the total number of units of "Magic Mugs" ordered is illustrated. It is clear that the start-up costs (print costs, manual labour, production of a draft, etc) make the first few mugs very expensive and that the price per mug levels out above a certain number of mugs. The price for one hundred coffee mugs is 10.09 €/unit, if 2000 coffee mugs are ordered the price drops to 6.61 €/unit.

Naturally the total costs increase for more ordered units, but the increase of the total price per quantity gets smaller for larger quantities as the price per unit decreases. In other words the price does not increase in proportion to the quantity. The total risk however is determined by the total costs, as the risk of having unused or unwanted leftovers increases. The challenge is to find the right point where the unit price is low and the risk not too high.

20.6 FUNDRAISING

Many non-profit organisations use fundraising to solicit and gather money by requesting donations from individuals, businesses, charitable foundations, or governmental agencies. Some organisations, especially in the US, receive some annual funding from a financial endowment, which is a large sum of money that is usually invested to generate a sizable amount of interest each year. Endowments are generally created when a sizable gift is received from an individual or family. In the local environment links with local sponsors or local industry can sometimes be created. In special cases, again most often occurring in the US, philanthropists may support scientific and other non-profit purposes.

Figure 79: *Graph showing the dependence of the price in € per unit on the total number of units of "Magic Mugs" ordered.*



The initial phases of fundraising can be very hard. Once the ball starts rolling and the money begins to roll in it is easier to get co-funding. As Hill (2005) says: *"It's better to ask for water with a glass half full"*.

The success of any fundraising campaign depends on a number of factors including the available manpower for the campaign, the local situation and the topic.

As an example, a fairly commercially useless topic such as astronomy is more difficult to promote than an applied subject like space science that will have some immediate commercial interest.

Writing grants is a time-consuming task, but naturally becomes easier with experience and when a library of standard texts and images about the organisation's advantages has been collected. Good personal connections are important in a fundraising drive as well as the ability to explain convincingly why the case in question deserves support. Often it is about creating a win-win situation and giving the donor some substantial Return-On-Investment.

Professional grant writers exist and may take a commission (either a flat rate or up to 10% of the awarded grant). This may, or may not, be considered morally correct depending on local rules and circumstances, but 90% of any given amount is naturally better than 0%, so this may be an option to consider.

20.7 ALTERNATIVE METHODS OF INCOME

One could imagine other ways of generating a small revenue from science communication products. Scientific images, especially those in astronomy, have a big fan base. These images should be freely available on the web for all to use, but there are other, more specialised, ways of offering commercial products that use these images.

One could try to offer images and other information to people and organisations not directly related to science or astronomy. For instance, a series of hand-picked, beautifully framed images from your own production for corporate high-tech boardrooms and universities. This should be done on a non-exclusive basis so as not to prevent the free use of these products.

There are numerous companies selling stock images such as *Getty images*, *Science Photo Library*, *Corbis* etc. One can team up with these organisations to try to create revenue from the best scientific images and illustrations from the production.

Another idea is to create a membership scheme for the organisation if there is an associated venue such as a museum, an observatory or similar. Most people like to feel appreciated, and a "gold card effect" may result that can also help to attract sponsors.

Courses and talks can be another potential source of revenue, for instance:

- university-level courses in science communication;
- media training of scientists;
- training of media trainers;
- training of high-school teachers;
- public talks to specialist, more demanding, audiences such as companies etc.

21. CREDIBILITY IN SCIENCE COMMUNICATION

"In public affairs you are pulled between two poles, sensationalizing the results and correctness."

Hurt (2005)

This chapter was inspired by the credibility panel discussion, "Keeping our credibility: Release of News", held at the conference *Communicating Astronomy with the Public 2005* in Munich in June 2005[58]. Part of the content here is based on an exploratory qualitative study of press releases in astronomy (Nielsen et al., 2006) by a study group from Roskilde University (Denmark), under the leadership of Lars Holm Nielsen, who conducted part of their studies at the ESA/Hubble in the winter of 2005-2006. The other group members were Nanna Torpe Jørgensen, Kim Jantzen and Sanne Bjerg. As part of the study a series of 12 in-depth interviews[59] with public information officers from large government scientific institutions, as well as journalists and scientists closely involved in the work of public information officers, were conducted in the winter of 2005. Most of the conclusions below have been extracted from this study.

21.1 THE PROBLEM

Science communication acts in the modern market place and competes with large commercial communication players such as the entertainment industry for space in the science and technical headlines. Science communication is also a political tool and the pressure on communicators is greater than ever. The temptation to overstate the importance of scientific results, or to take credit for more than you deserve, is huge.

Science communication acts in the modern market place and competes with large commercial communication players such as the entertainment industry for space in the science and technical headlines.

The extent of the damage done to the public perception of science and scientists by examples like these is very complicated to measure. A recent public opinion survey (European Commission, 2005) has shown that Europeans generally see scientists as being credible and having a positive impact on society. Journalists scored poorly in the survey, but still much better than politicians, who were almost at the bottom of the scale.

Credibility in science communication is one of the most actively discussed issues in science communication today (see for instance Robson, 2005-II):

"How far can we, in the name of science communication, keep pushing, or promoting, our respective results or projects without damaging our individual, and thus also our collective credibility?"

As science communicator Ray Villard (Villard, 2005) states, *"once [credibility is] lost it is very hard to achieve again."*

58 Webcast of the panel discussion and the subsequent wide-ranging and lively discussion is available at http://www.communicatingastronomy.org/cap2005/programme.html.

59 http://www.spacetelescope.org/projects/credibility/credibility.html

21.1.1 The Mars meteorite and Cold fusion

Two of the most well known examples of overstating scientific results are the "Mars meteorite" case and the "Cold fusion" case. In 1996 *NASA* announced that a Mars meteorite, suspected of containing fossil evidence for micro organisms on Mars, had been found (NASA, 1996). Many in the scientific community questioned this extraordinary claim, and it took only a few months before the first paper challenging the results was published (Kerr, 1996). *NASA* received a huge amount of media attention at the announcement, and, according to some communicators, the timing of the news was conspicuously close to the US Congress vote on the further funding (Heck, 2005). Today *NASA*'s claim has been rejected by most of the scientific community (Jeffs, 2004).

In March 1989 two chemists, Stanley Pons and Martin Fleischmann, claimed to have succeeded in creating energy from a fusion process taking place at normal room temperatures. They were given worldwide media coverage for solving the world's energy problems, but although many scientists tried to replicate the experiments, their attempts failed and none managed to replicate the cold fusion results. It was an *"extraordinary claim that requires extraordinary evidence"* as Carl Sagan would have said. Furthermore Pons and Fleischmann did not follow the "normal" scientific procedure (Gregory & Miller, 1998) and did not publish their results in a refereed paper.

21.2 CREDIBILITY PROBLEMS ARE UBIQUITOUS

Credibility problems are ubiquitous and integrated into the public information officer (PIO)-journalist interaction

Credibility problems are ubiquitous and integrated into the public information officer (PIO)-journalist interaction:

> *"There is hype everywhere and everybody is doing it ... every serious science journalist knows that press releases are made by public information officers who emphasise their own organisation."*
>
> Schilling (2005)

There is a general view that a certain amount of hype is necessary to reach the general public. This is supported by science writer Dirk Lorenzen:

> *"It is the responsibility of the journalist to check the press releases. [...] people who lie are dead to me and to my colleagues too."*
>
> Lorenzen (2005)

Even though overstatements in press releases are normally perceived as harmful by the scientific community, the view, especially among science communicators and journalists, is that some overstatement is unavoidable when communicating a technical scientific result to the public. Most would agree that high accuracy is vital when communicating to the general public, but:

"[...] the level of accuracy is irrelevant if no one pays attention. To make something interesting and glamorous is not hype — hype is when you take credit for more than you deserve."

Villard (2005)

Public information officers are juggling daily to find the sensitive balance between correctness and overstatement, and they constantly need to walk a line to get news out to the media. If press releases are accurate, but uninteresting, they will not receive media attention, but if PIOs sacrifice accuracy while injecting colour, the press releases lose credibility with journalists and are not used. Science communicator Megan Watzke (Watzke, 2005) agrees:

Public information officers are juggling daily to find the sensitive balance between correctness and overstatement, and they constantly need to walk a line to get news out to the media.

"[We PIOs] end up walking a line, because you want to be as interesting and provocative as possible without being wrong."

Although scientific organisations compete to be heard by the same media and are sometimes in competition for the same funding, most would agree that if competition between organisations becomes unethical it may damage the credibility of the whole community. Science communicator Robert Hurt states this clearly (Hurt, 2005):

"Any chink in the armour of credibility can make the entire scientific community vulnerable to attack."

21.3 THE NEED FOR VISIBILITY

Credibility problems are most often caused by an intense need for visibility driven by personal or organisational desires for recognition or financial gain. As stated by Heck (2005):

"Behind hype is the problem of visibility and recognition — the fight of organisations, laboratories or people for money."

This development inevitably leads to science communication with more spin, more push and a shorter elapsed time from scientific results to publicly communicated results.

The pressure is applied from different sides: from the organisation itself — often from management, from PIOs and also from scientists. While many scientists try to stay modest when they publish their results, the increased competition in the scientific community may push scientists to overstate their results to become more visible, thereby attracting more funding and gaining recognition. As stated by science communicator Claus Madsen (Madsen, 2005):

"in the 'conventional wisdom' scenario, the scientist is the guardian of 'truth' and objectivity, urging caution and

> *moderation. [...] But this is a simplistic scenario. I have seen several cases where the scientist fell into the trap of serious 'overselling' or hype and the press officer had to exercise the necessary restraint."*

Scientists fear to lose credibility among their peers and thus fear to lose their recognition in the scientific community. As a result:

> *"Scientists can be overly concerned about the accurate reporting of their work due to criticism from their peers."*
> Villard (2005)

Not only scientists, but also the scientist's home institution may be overly concerned about accuracy, since they also strive for recognition in the scientific community.

However, while many scientists try to stay modest when they publish their results, PIOs and journalists know that eye-catching headlines and simplifications are necessary in order to get the attention of public, leading to the notion common among scientists that science reporting is inaccurate and news is often hyped. This perception has been shown to be false by Shaefer et al, (1999), who investigated the accuracy of three astronomical topics published in US newspapers. This result is also supported by Madsen, (2001) and Madsen (2003) in his study of European newspapers.

The scientist-communicator conflict (see section 2.4) often deals with the issue of credibility. It is therefore important, according to Watzke (2005),

> *"[...] not [to] do anything without the scientist's agreement, even though we might strongly disagree with their ideas of about how to represent their result to the public".*

However, according to scientist Bob Fosbury (Fosbury, 2005):

> *"it's [...] a problem that the science community does not understand the work of communicators",*

which is further emphasized by Villard (Villard, 2005) who states that:

> *"The scientist does not understand what the public comprehend and find interesting, and needs to accept what the public affairs professionals bring to the table."*

Another problem is that many scientists do not want to publish as *fast* as the science communicators or the institution may wish to. This can be due to concern about the reactions of their peers or sometimes by a wish to maintain scientific standards and norms in the communication process (Schilling, 2005; Villard, 2005). Furthermore research success is still measured purely in term of the number of refereed papers, grants etc (Robson, 2005-I), giving scientists less motivation to participate in the communication process.

21.4 FACTORS AFFECTING VISIBILITY IN THE MEDIA

Naturally, all scientific findings are not of equal scientific significance and the PIO will have to choose from different levels of distribution efforts (see section 12.1) to emphasise the finding and thereby try to convince the media to run the story. The chosen communication efforts may have great influence on the resulting news coverage of the story. As an example, merely posting science news on the website of the public information officer's institution is unlikely to receive as much attention as a live, televised press conference.

The visibility ("boosting") of a scientific result can be increased as a result of (at least) the following factors (Nielsen et al., 2006):

1. Using too high a level of communication effort for the level of scientific importance.
2. Using wording that does not correspond to the level of scientific importance.
3. Letting unscientific factors dictate the timing of the publication a press release.
4. Omission of references to other scientists' work.
5. Unjust comparisons with other facilities.

The above factors are an important key when analysing and discussing the issue of credible science communication. The central question to ask is, when do the visibility "boosting" efforts exceed the "hype-threshold", defined as the upper limit where the efforts start to affect the credibility negatively.

21.4.1 Level of communication efforts

Naturally, all scientific findings are not of equal scientific significance. The scientific importance *ought to be* the prime factor in determining the visibility of a press release. Discovery of life on Mars *ought to* achieve instant worldwide media attention in comparison with the discovery of some new kind of dust in stellar atmospheres. The PIO has to choose from different levels of communication efforts to emphasise the finding and try to convince the media to run the story. In the real world this decision will be based on a subjective assessment of the scientific importance. The chosen communication effort will have a great influence on the resulting visibility of the story in the media.

The level of effort with which a science press release is distributed or disseminated is defined by the press release visibility scale (see section 12.1). When releasing a given result, an organisation will choose a level of effort according to the importance of the given result. The scale consists of seven steps, with magnitude 7 being the highest level of effort an organisation can put into communicating a result. If too high a level is chosen relative to the story's science importance, credibility problems may occur. The higher a level of effort the more solid the science case has to be. Also, too low a level of communication effort can create problems. It may give the impression that the organisation does not believe in its own scientific result.

21.4.2 Use of wording

Simplification and analogies are often used in the process of making a press release easily understandable to the general public. However, the wording can be used to overstate claims and thus increase visibility of a scientific finding. It can be tempting to omit a question mark in a headline and also to omit the caveats and qualifiers that are really necessary. According to scientist Mario Livio (Livio, 2005):

> *"when using words like 'may', 'could', 'possible' etc, the news media does not find these stories to be exciting enough, and does therefore not print them [...]".*

Superlatives are added to catch the attention of the journalists. Since general journalists work under heavy time pressure and deadlines, they often only have time to read the headline of a press release. Furthermore, if the headline of a press release has caught the attention of general journalists, they are often too busy to do the background checks (Lorenzen, 2005; Schilling, 2005). Hence, the press release must be interesting and easy understandable, since, if the journalist finds it interesting, then there is a good possibility that the general public will as well (Siegfried & Witze, 2005). It is however always possible to find at least one superlative for even the smallest science results. The resulting "superlative dilution" can make it difficult for journalists to separate press releases for the really big science stories from the smaller ones.

21.4.3 Timing

Timing is another factor, which can affect the visibility of a given science story greatly. As we all know, news is one of the products that spoils quickest. News stories have to be reported at the time of the event before they become "old news". Science can take a long time to materialise, but the right time is — at the latest — the time of the publication of the scientific paper. Conflict over timescales is one of the inherent potential flashpoints in the scientist-journalist interaction (see Valenti, 1999).

Timing may be used as a political tool, for example, when the announcement of a press release happens just before the US Congress is voting on funding. Some journalists are aware of this, as Fosbury points out (Fosbury, 2005):

> *"When a professional in, I guess, any science sees a press release they think the organization must have a grant application review coming up and therefore they are trying to create some kind of event around this."*

A press release can also be forced out before a peer reviewed paper exists. This bypasses the scientific method and opens up a whole range of potential credibility problems (see section 21.6).

The timing of a press release can planned so as to interfere with a press release or an event from a competing scientific organisation. Not only is this unethical and counterproductive for science in general, but it raises concerns about the real motives behind the press release.

21.4.4 Omission of references to other scientists' work

Giving proper credit to earlier work in the same field is another stress point in the battle between the communicator's need for conciseness and the scientist's need for completeness. There is no doubt that this decision is very subjective. Credibility problems may arise if credit is taken for work that has been done by others or a conscious decision is taken to omit references to earlier work where it is obvious that it has to be acknowledged.

21.4.5 Unjust comparisons with other facilities

Comparisons of scientific and technical abilities are a standard part of public communication. It is most likely unavoidable and, to some extent, a healthy part of justifying the funding spent on scientific projects. A newly funded project is supposed to be an improvement, incremental or more, on older existing projects. Credibility issues can occur if this is done in an unjust way or so as to diminish other projects.

21.4.6 Loss of credibility mostly affects the scientist

Individual scientists stand to lose more credibility than an entire institution, a reporter or a PIO. So it is natural that scientists are more concerned about this topic than other actors. Scientists know that negative reactions from their peers can have devastating consequences for their career.

21.5 REFEREEING

Refereeing either by the main scientist, an internal editorial board or an external editorial board can reduce the risk of credibility problems. One way to improve the scientists' view of communication via press releases is to encourage scientists to collaborate as much as possible and to understand the different priorities operating when communicating with the public.

If a press release is run past an internal refereeing board before its public release some factors that are known to increase inaccuracy can be eliminated. This means that there is less risk of oversimplified results, incorrect analogies, problems of political nature and other factors that can harm credibility. Internal refereeing also helps scientists maintain credibility with their peers, which, as mentioned above, is important for the scientist's willingness to communicate.

The lack of a peer reviewed scientific paper makes a press release more vulnerable to loss of credibility.

21.6 THE IMPORTANCE OF PEER REVIEWING

The lack of a peer reviewed scientific paper makes a press release more vulnerable to loss of credibility. To most actors in the communication process it is important that the result has been peer reviewed prior to public dissemination. This is vital to increase the scientific accuracy of the communication. In its most extreme form this principle is implemented by some journals, like *Science* and *Nature*, in the form of the Ingelfinger rule (Toy, 2002).

As mentioned in section 2.2.1 the original intentions of the Ingelfinger rule partly make sense, as it seems fair for a publication to protect the newsworthiness of its stories and to put a brake on the accelerating pace of the public dissemination of science results. However, the embargo system also has negative effects (Kiernan, 2000 and Marshall, 1998) that lie beyond the scope of this book.

As an example of a, somewhat extreme, scientist's point of view on the importance of letting the scientific publication precede the publication in the public domain, we can quote Einstein. Einstein wrote a letter in 1930 to the editor of the *New York Times* as a reaction to an announcement regarding the Einstein, Podolsky & Rosen paper. He expressed sternly:

> *"It is my invariable practise to discuss scientific matters only in the appropriate forum and I deprecate advance publications of any announcement in regard to such matters in the secular press"*
>
> Albert Einstein quoted in Mermin (2005)

The need for a refereed scientific paper backing a press release increases as press release claims become more significant. If no paper is used to support significant claims the consequences can be quite severe. It is risky to use high levels of communication efforts without a peer reviewed scientific paper in the background.

21.7 CONCLUSION

Credibility issues are found everywhere in scientist-PIO-journalist interactions and are deeply integrated into their workflow. Overstatements are, to some degree, accepted and recognised as a necessity for the communication process. All actors also recognise the sensitivity of the issue and know that the issue can be lethal to the actors. The real reason behind credibility problems is an intense need for visibility that is driven primarily by the desire for recognition or funding.

Credibility problems in press releases can be caused by using too high a level of communication efforts, by overstating scientific claims, omitting qualifiers and diluting the text with too many superlatives, by dictating the timing of a release due to political motives, by announcing the finding to the public before the peer reviewing process has had a chance to work or to time a release in order to interfere with other press releases, by omitting references to other important work in the same field, or by making unjust comparisons with other projects.

Credibility problems often have the largest negative implications for scientists.

Internal refereeing and the peer reviewing system can reduce the risk of credibility problems for all actors (see section 4.5).

21.8 RECOMMENDED CODE OF CONDUCT FOR PRESS RELEASES

To make the conclusion above applicable to practical science communication it may be useful to synthesise them into guidelines that can aid the work. Nine specific recommendations are listed below. These can be seen as a suggestion for a "code of conduct for press releases" that organisations could adapt as guidelines, or an ethical charter, to help to minimise credibility problems and to evaluate cases of questionably aggressive science communication.

Some of these recommendations are aimed directly at ensuring scientific accuracy in press releases announced to the public; others are included to ensure credibility within the scientific community, and among public information officers and scientists. As is natural in such a diverse field as press releases in astronomy there is much room for interpretation in each recommendation and exceptions to these guidelines can also occur.

It is recommended that:

1. Scientific results should be peer reviewed prior to public dissemination.
2. Press releases should be validated scientifically by the main scientist.
3. Press releases should be validated scientifically and politically by an internal institutional refereeing body.
4. Substantial work by others in the same field should be acknowledged.
5. The incremental nature of scientific process should be mentioned if at all possible.
6. If the science that forms the basis for a press release turns out to be really erroneous a correction on the web version of the release should be posted, or in grave cases a correction release should be issued.
7. The level of communication effort should fit the level of importance of the science.
8. The wording in the release text should match the level of importance of the science and include the relevant qualifiers.
9. A press release should not be intentionally timed to counteract press releases from competing organisations.

22. THE HUBBLE SPACE TELESCOPE — A PUBLIC OUTREACH CASE STUDY

The NASA/ESA Hubble Space Telescope is one of the most successful scientific projects of all time, both in terms of its scientific output and in terms of its public appeal.

22.1 INTRODUCTION

The joint American and European Hubble Space Telescope is one of the most well-known and high profile of all scientific projects. The main reason for this is naturally the excellent scientific results coming from the telescope, but a very dedicated and meticulously planned strategy for the communication of its results to the general public has also been a key factor in the success of the project.

22.2 HUBBLE AS SCIENTIFIC PROJECT

The Hubble Space Telescope is a unique project resulting from a collaboration between the American Space Agency, *NASA* (85%) and the *European Space Agency*, ESA (15%). Hubble is an upgradeable, space-based telescope flying 600 km above most of our image-distorting atmosphere.

Hubble was designed to take high-resolution images and accurate spectra by concentrating starlight on a much smaller area of the detector than possible from the ground, where the atmospheric “twinkling” of the stars limits the sharpness of the images. Despite its relatively

Figure 80: *3D rendering of The Hubble Space Telescope.*

modest size, 2.4 metres, Hubble is more than able to compete with ground-based telescopes that have light-collecting (mirror) areas that are as much as 10 or 20 times larger. Hubble's second huge advantage is its access to near-infrared and ultraviolet light, which is filtered away by the atmosphere before it can reach ground-based telescopes.

The total cost of Hubble in the course of its full 20-year lifespan (ending in 2010) is estimated to be about 6 billion €, of which about 600 million come from *ESA*. Hubble was launched on the *NASA* Space Shuttle in 1990, but it took three years before its full scientific potential was reached after initial problems with the primary mirror. The Space Shuttle has visited Hubble on four occasions and teams of American and European astronauts have serviced and upgraded the observatory and its instruments.

Hubble has in 2005 orbited the Earth almost 100 000 times and travelled a total of more than 3.5 billion kilometres — more than 20 times the distance to the Sun. It has made more than 750,000 exposures of 25 000 different astronomical targets, producing more than 26 terabytes of data that have resulted in 4 000 scientific papers — a very high number even given the considerable outlay on the project.

22.3 HUBBLE'S SCIENTIFIC SUCCESS

Hubble has exploited its unique scientific capabilities in regions where no other instruments can compete. The telescope consistently delivers super-sharp images and clean, uncontaminated spectra over the entire near-infrared to ultraviolet regions of the electromagnetic spectrum. This has opened up new scientific territory and has resulted in many paradigm-breaking discoveries.

Exquisite quality images have enabled astronomers to gain entirely new insights into the workings of a huge range of different astronomical objects. Hubble has provided a visual overview of the underlying astrophysical processes taking place in these objects, ranging from planets in our Solar System to galaxies in the young Universe.

The renowned British astronomer Malcolm Longair writes in the preface to *ESA*'s Hubble 15th anniversary book (Christensen & Fosbury, 2006):

> *"The Hubble Space Telescope has undoubtedly had a greater public impact than any other space astronomy mission ever. The images included in this beautiful volume are quite staggering in the detail they reveal about the Universe we live in and have already become part of our common scientific and cultural heritage."*

Hubble's acute vision is approximately five times sharper than that normally reached at the best ground-based observatories.

Also, the very high quality of the data processing and data archiving makes the observations from Hubble extremely useful not only to the astronomers who originally planned a particular observation, but also to other astronomers who gain access to the observations in the archive later.

There is no doubt that the meticulous planning of the Hubble project has played a major role in ensuring a consistently high quality in all phases of the project from documentation to data archiving.

22.4 THE HUBBLE EPO MACHINE

The Hubble project has a smooth-running EPO-machine that, especially since the mirror was "fixed" in 1993, has helped to bring Hubble to the forefront of the public mind — as much as is possible for a scientific project. According to Hanisch (2000) a 1998 *CNN* news poll showed that 97% of the Americans say that the Hubble Space Telescope has delivered its scientific promise.

A somewhat one-sided, but highly entertaining, account of the action-laden first years of the Hubble project up to 1993 can be found in Chaisson (1998).

Hubble's excellent results are naturally a firm basis on which to build good science communication, but the unique and exotic nature of the project has been just as important. In order to stand out from other scientific projects it is important to identify the features of a given project that best will enable the communication of its results — its "communication-niche", if you will. Hubble's communication-niche is its high-resolution imaging capability and access to infrared and ultraviolet observations unavailable on the ground.

Hubble has another inherent advantage in that it is in effect a very high-quality camera. This has been a very important element in its PR-success as the media have an insatiable appetite for good images and animations to illustrate written and electronic articles. This need has increased over the years and Hubble has had huge success in delivering crisp, large-format, colourful images of space to the media.

Last, but certainly not least, there has been reasonable funding for science communication for the Hubble project. In the US, the *Office for Public Outreach* (OPO) at the *Space Telescope Science Institute* employs close on 40 professionals (Villard, 1999). It is a mix of highly skilled graphic designers, writers, managers, video animators, producers, technical people, media specialists and educators. Read more about *OPO*'s work in the excellent review article by Griffin (2003).

In Europe, *ESA/Hubble* was created as a science communication office at the *Space Telescope — European Coordinating Facility* (ST-ECF) in Munich late in 1999. Its job is to fulfil the Hubble Space Telescope outreach

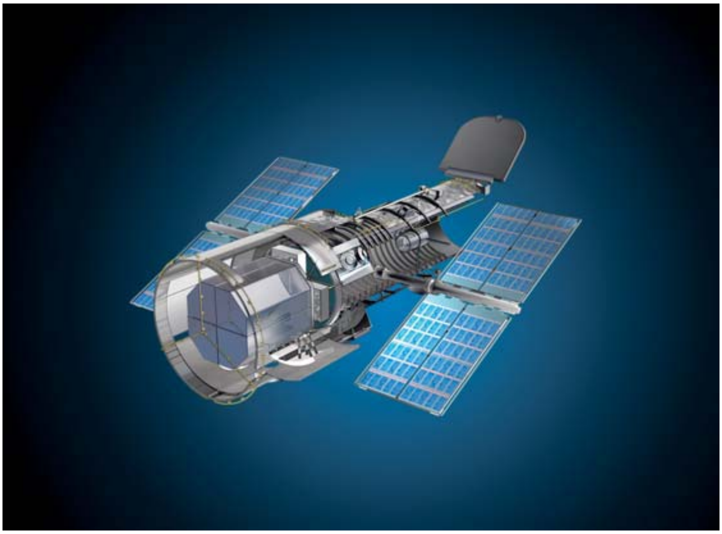


Figure 81: *A look inside the Hubble Space Telescope.*

and education tasks for the *European Space Agency*, ESA, as outlined in the agreement between *NASA* and *ESA* (the so-called Memorandum of Understanding). In principle, *ESA/Hubble* is communicating science, more precisely: astronomy and the Hubble Space Telescope in Europe. Within the past years, it has, despite its size, become one of the more productive and innovative science communication groups worldwide. *ESA/Hubble* employs two full-time staff members and as well as part-time interns and contractors working on the communication of results from Hubble and produce a wide range of communication products: brochures, press releases, webpages and videos to name but a few.

23. COMMUNITY INITIATIVES

Science communicators may benefit greatly from internal collaboration within their community. The advantages of exchanging ideas and sharing resources far outweigh the disadvantages of helping colleagues who in some senses may be in direct competition with you.

Here are some ideas for getting involved in intra-community work that may help to improve your own work in the short run, and also help the community, scientists and science itself in the long run:

- Attend conferences in science communication or communication of your own field of science.
    - Network: Get acquainted with colleagues working under similar conditions and with similar needs.
    - Share ideas, experiences and best practices.
    - Break down barriers and remove the sense of "competition".
    - Learn from each other in hands-on sessions.
- Share resources: Exchange images, animations, tools etc. Perhaps even manpower.
- Political lobbying.
    - Form global interest groups, such as the Working Group described in section 23.1 below.
    - Promote science communication in general.
    - Endorse standards, best practices and requirements for public communication. Examples of this are the code of conduct (see section 21.8), and standard metadata tags for products such as images and videos[60].
    - Compose political documents such as the *Washington Charter* shown in Appendix B below.

23.1 CASE STUDY: THE COMMUNICATING ASTRONOMY WITH THE PUBLIC WORKING GROUP

The *Communicating Astronomy with the Public* meeting held in October 2003 in Washington DC was the second such international event; the first being held in Tenerife, some eighteen months earlier. The Washington meeting was organised very much along workshop themes and had specific outcomes (or charges) in mind. Two key items emerged from the meeting: the production of the *Washington Charter* and the setting up of a Working Group within the *International Astronomical Union* (IAU) to promote astronomy public communication in the global sense.

The key concept for the *IAU Communicating Astronomy with the Public Working Group* is that:

> *"It is the responsibility of every practising astronomer to play some role in explaining the interest and value of science to our real employers, the taxpayers of the world."*

60 See for instance http://www.communicatingastronomy.org/repository/virtual_repository.html

***Figure 82:** The Washington Charter being officially endorsed by the 26th General Assembly of the International Astronomical Union in Prague, in the Czech Republic.*

It is widely recognised that there are a number of barriers to communicating astronomy, and these are specifically addressed by the Working Group:

1. A number of professional astronomers do not feel comfortable with the very concept of talking with the public.
2. Many employers do not regard communication and outreach as a real part of the "job description". Hence, for the researchers the time taken for public communication may not only go unrewarded, and indeed, it may well in effect act against the researcher if outreach is not perceived as a merit in the same way as grants, refereed papers, etc.
3. A number of organisations (especially those outside the US) have not yet integrated public communication into their own structure by providing the necessary support—funding, training, infrastructure, personnel, etc.

The Working Group Mission statement reads:

- *To encourage and enable a much larger fraction of the astronomical community to take an active role in explaining what we do (and why) to our fellow citizens.*

- *To act as an international, impartial coordinating entity that furthers the recognition of outreach and public communication on all levels in astronomy.*
- *To encourage international collaborations on outreach and public communication.*
- *To endorse standards, best practices and requirements for public communication.*

The *Washington Charter for Communicating Astronomy with the Public* was developed by the community in 2003 (Blue, 2005, Crabtree, 2005 and Pasachoff and Percy, 2005) to underscore the importance of delivering first class science communication. A series of recommendations outlines the necessary communication actions for every part of the science food chain (in this case for astronomy). The Charter is attached as Appendix B.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FINISHING OFF

PART IV

24. SUMMARY

Cookbooks normally do not have conclusions. In the same way it is not easy to conclude a practical guide about science communication. The aim of this book was to give hands-on descriptions of methods, tools and workflow for a huge field. However to summarise some of the most important points:

Science communication and EPO offices:

- Popular science communication provides a bridge between the scientific community and the wider world.
- Public information officers (PIOs) are fulfilling part of the obligation that scientific institutions have to share scientific results with the public and with important stakeholders.
- To a first approximation the main part of science stories reported in the news have been facilitated by education and public outreach (EPO) offices.
- The roles of an EPO office are very varied, but two important ones are as a content provider and an intermediary.
- A communication strategy should be started by writing a vision, a mission and a list of objectives and corresponding deliverables.
- A budget allocation for science communication of between 1 and 2% of the total operations budget for a scientific project seems reasonable.
- The practical production of any science communication product is an intertwined mix of three main skills: the communication itself, the graphical part and the technical part.
- Having a strong technical skills base is absolutely mandatory if the communication office is to keep pace with the speed of the news flow and the demands of the press.
- Flexibility and freedom are two keynotes of a communication office. Having “technical autonomy” is mandatory.
- In the real world (as opposed to the perfect world) the EPO offices that succeed are those who manage their resources in the cleverest ways, who learn from experience and never merely solve problems, but analyse and use every solution and outcome to make strategic decisions for the future.

Some advice for the daily work:

- Problems can be solved in two ways: Fire-fighting, or strategically.
- Apply the 80/20 principle: 80% of the result will be achieved with 20% of the effort. Perfection does not pay off as communication moves too fast and truly perfect results may not even exist in a complex communication environment.
- There are two dominating poles in the production process: the chaos of creativity and the order of a rigorous workflow. In the struggle between the two, excellence is born.
- If no mistakes are made, the envelope has not been pushed far enough.

- Any EPO product can be produced in a thousand ways. No single solution will ever be shown to be the best.
- The devil lies in the detail: The secret of successful EPO work lies in the details of the implementation.
- A typical production sequence can be perceived as a chain with a number of links. If any of these links break, the production fails. The links are: market research, planning, written communication, visual communication, scientific and political validation, technical production, distribution, promotion and evaluation/archiving.
- Distribution is one of the most important links of the production chain, and should be continuously improved to reach a wider audience.
- When publishing or distributing a given science result, an organisation can choose different "levels of effort" in the distribution process according to the importance of the given result. These can be graded on a press release visibility scale consisting of seven steps.
- Part of the communication strategy should be to identify clearly some qualitative and quantitative success metrics and evaluate products after completion.
- Images, illustrations and visual design are key factors in successful science communication and their importance can hardly be overemphasised.

About the target groups:

- Communication is a highly result driven field and our customers — the consumers — decide when, where, how and why our products will be "purchased". The narrower the target for a product, the better the product can be tailored to the target group. However, in the real world, where resources are limited, it is sometimes necessary to hit several target groups at once.
- The most important target group is the group of mediators — "helpers" or "multipliers" that feed the information to the population: media, educators, museum staff etc.
- By using the medium of television the recipients of your communication products will be counted in millions instead of in thousands.

About writing:

- When writing about science, know your boundary conditions, research the topic properly, structure your thinking, relax, follow consistent writing guidelines, be clear, concise and precise, match the writing to the level of the target group and edit the piece as much as is needed.
- When writing a press release, as early as possible answer the six golden questions: What? When? Where? Who? Why? and How?

- Press releases should obey the seven “c”s of Successful Communication, ie be: Correct, Clear, Concise, Comprehensive, Compelling, Concrete and Concentrated.
- A press release needs to be issued to journalists a few days (at least) in advance of publication as a so-called “embargoed release”.
- Apply the 14 news criteria to probe whether a science result is “hot or not”.

Crisis communication:

- Even in science communication “corporate” crises cannot be avoided.
- In crisis communication follow the five “c”s: Concern, Clarity, Control, Confidence, and Competence.
- Anticipate crises and plan for them.
- The essential tool to cope with a crisis situation is *communication* following a set of basic rules and always communicate internally first.

Collaborations:

- Scientists and journalists have much in common, for instance objectivity and an inquisitive mind, but they are also many differences that can give rise to conflicts.
- A good communication collaboration starts with information and an openness to understand the work of the other actors.
- The scientist is an integral part of in the communication process. Give the scientists advice or even training on how to deal with the press and public.
- Partnerships with commercial companies can create win-win situations for non-profit research organisations.
- Science communicators may benefit greatly from internal collaboration within their community. The advantages of exchanging ideas and sharing resources far outweigh the disadvantages of helping colleagues who in some senses may be in direct competition with you.

A knowledge-driven society requires proper political attention to, and proper funding for science communication in the coming years. The future of science depends on our ability to spark scientific interest in the young generation.

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WEB LINKS

These links and more are available on-line at the book's web page: http://www.eso.org/~lchriste/scicomm

SCIENCE COMMUNICATION ORGANISATIONS

- *Australian Science Communicators* (ASC), http://www.asc.asn.au/
- *British Association for the Advancement of Science* (BAAS), http://www.the-ba.net/
- *COPUS*, http://www.copus.org.uk
- *International Network on Public Communication of Science and Technology*, http://www.pcstnetwork.org/
- *National Association of Science Writers* (NASW), http://www.nasw.org/
- *Psci-com*, http://psci-com.ac.uk/
- *The American Association for the Advancement of Science* (AAAS), http://www.aaas.org/
- *The Royal Society*, http://www.royalsoc.ac.uk/
- *The Science, Technology, Engineering and Medicine Public Relations Association* (STEMPRA), http://www.stempra.org.uk/

HANDS-ON GUIDES

- *American Geophysical Union*'s, *You and the Media*, http://www.agu.org/sci_soc/media.html
- BBRSC's *Communicating with the public guidance notes*, http://www.bbsrc.ac.uk/support/communicate/training/notes.html
- CASC's *Communicating Anthropology*, http://sciencesitescom.com/CASC/ancom.html
- COPUS' *Good Practice in Science Communication Project Management*, http://www.copus.org.uk/pubs_guides_goodpractice.html
- COPUS' *Out and About*, http://www.copus.org.uk/pubs_guides_outandabout.html
- COPUS' *Reaching Out* , http://www.copus.org.uk/pubs_guides_reachingout.html
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- EC's *A guide to successful communications*, http://ec.europa.eu/research/conferences/2004/cer2004/pdf/rtd_2004_guide_success_communication.pdf
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- eConnect's *Quick Tips*, http://www.econnect.com.au/news_qt.htm
- ESRC's *Communcation Toolkit*, http://www.esrcsocietytoday.ac.uk/ESRCInfoCentre/Support/Communications_Toolkit
- ESRC's *Heroes of dissemination*, http://www.esrc.ac.uk/ESRCInfoCentre/about/CI/CP/best_practice_guides/heroes_of_dissemination/
- ESRC's *Influencing the UK policymaking process*, http://www.esrc.ac.uk/ESRCInfoCentre/about/CI/CP/best_practice_guides/influencing_the_uk_policymaking_process/
- ESRC's *Television and radio*, http://www.esrc.ac.uk/esrccontent/PublicationsList/4books/tvframeset.html
- ESRC's, *Developing a media strategy*, http://www.communicatingastronomy.org/repository/guides/media.pdf

- NASWs *Advice for Beginning Science Writers*, http://www.nasw.org/resource/beginning/archives/000145.htm#more
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EUROPEAN COMMISSION, NSF

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- *National Trends*, http://ec.europa.eu/public_opinion/archives/ebs/ebs_154_national_en.pdf
- *NSF Science and Engineering Indicators*, http://www.nsf.gov/statistics/indicators/

PRESS RELEASE PORTALS

- *Alphagalileo*, http://www.alphagalileo.org/
- *Eurekalert*, http://www.eurekalert.org/

LINKS COLLECTIONS

- *South African Agency for Science and Technology Advancement* (SAASTA), http://www.saasta.ac.za/links/scicomm.shtml
- *International Network on Public Communication of Science and Technology*, http://www.pcstnetwork.org/links.html

APPENDIX A: ASTRONONOMICAL IMAGE PROCESSING FOR EPO USE

Although this very specialised appendix may only be of direct interest to a few, this topic is an important and integrated part of astronomical communication and therefore relevant to at least a subset of readers.

The importance of images in the public communication of astronomy cannot be overstated. But how are these “pretty pictures” produced? Recent advances in software and technology have made it even easier to make attractive colour composites from the raw data. When producing PR-ready colour images from raw data from astronomical telescopes there is a standard workflow that is described below.

A.1 IMAGES: WHERE ART MEETS SCIENCE

This Appendix discusses how to construct clean, attractive, colour images that actually represent nature from the raw, noisy, monochrome, unattractive science data. The topic of making astronomical colour images is an excellent example of the skills triangle at work (see section 3.4) as it combines knowledge of graphics and science communication with that of technical issues.

The power of images is great. Today’s fleeting attention span often means that reading an article is restricted to a glance at the images and illustrations in a text and perhaps reading a few figure captions. Admittedly this method *can* give a very basic idea of almost any topic

Today’s fleeting attention span often means that reading an article is restricted to a glance at the images and illustrations in a text and perhaps reading a few figure captions.

ESA/NASA & Martino Romaniello (ESO)

Figure 83: *“Pretty picture” of star cluster NGC 1850.*

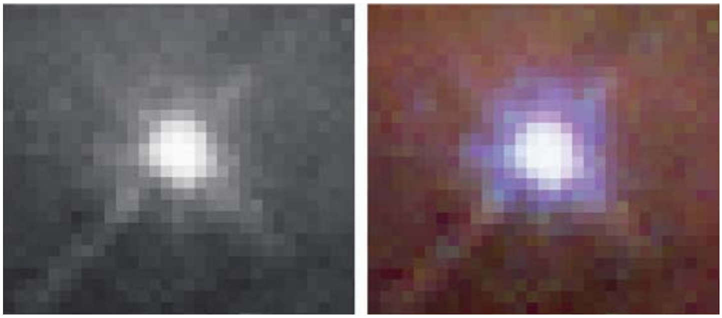


Figure 84: *Left: An "image" — an array or matrix of pixels arranged in columns and rows. Right: A "colour image" assembled from three greyscale images coloured red, green and blue. Such an image may contain up to 16 million different colours.*

in a few minutes — just so long as the images are well-chosen, captivating and illustrative!

Images are not just a means of visual communication. They can inspire awe, wonder and enthusiasm. Bear in mind that one of our most important tasks is to awaken enthusiasm in the younger generation in particular. Images are a perfect way to portray the Universe as a fascinating place. Images are where art meets science.

A.2 IMAGES 101: WHAT IS AN IMAGE?[61]

To begin at the beginning: An image is an array or matrix of square pixels (picture elements) arranged in columns and rows.

In a greyscale image each picture element has an assigned intensity that ranges from 0 to 255.

A normal greyscale image has 8-bit colour depth = 256 colours. A "colour image" has 24-bit colour depth = 8 + 8 + 8-bits = 256 x 256 x 256 colours = ~16 million colours.

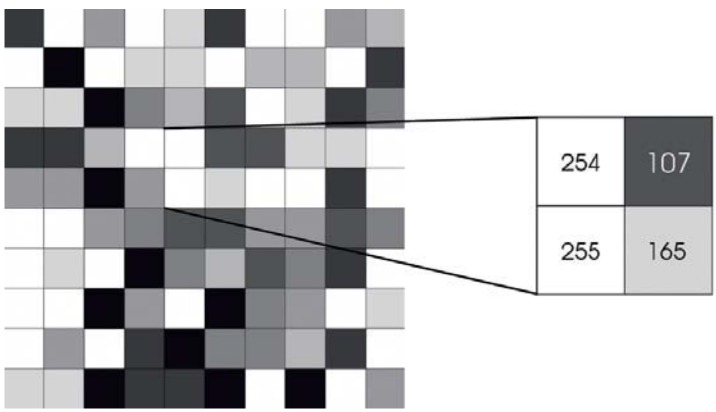


Figure 85: *Each pixel has a value from 0 (black) to 255 (white). The possible ranges of the pixel values depend on the colour depth of the image, here 8-bit = 256 tones or greyscales.*

61 More about images in general at: http://www.spacetelescope.org/about/further_information/techdocs/html/fits_intro.html

Adobe® Photoshop®

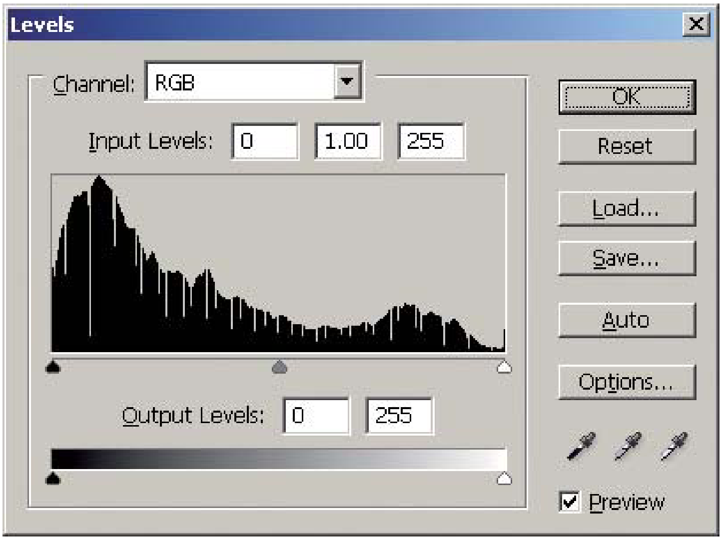


Figure 86: *An intensity histogram: The distribution of the different shades or intensities in an image can be visualised in a level histogram where the intensities are plotted along the x-axis (between 0 and 255) and their number of occurrences on the y-axis (here shown without values as the relative occurrence of a given intensity is more interesting than the absolute value, which depends on the total number of pixels (also known as the size of the image).*

Distribution of intensities

Depending on the image itself, it will have a distribution of greyscales, or intensities, ie some distribution of dark pixels, grey pixels or bright

NASA/ESA Hubble Space Telescope

Figure 87: *Example of an image constructed from narrow-band exposures. Since the narrow-band exposures probe individual atomic transitions the result is an image that has very "sharp" features.*


NASA/ESA & the Hubble Heritage Team

Figure 88: *A broad-band image of the Sombrero galaxy.*

pixels. The easiest way to study this distribution of intensities is by looking at an intensity histogram.

It is possible to manipulate the intensity levels in an image for instance with the levels or curves tools in *Photoshop*® (or the stretch function in *FITS Liberator*, see section A.4 below). With the curves tool (or a stretch function) it is even possible to make non-linear adjustments to the intensities, and thereby emphasise faint or bright areas selectively.

Colour filters

Images of astronomical objects are usually taken with electronic detectors such as a CCD (Charge Coupled Device). Similar detectors are found in normal digital cameras. Telescope images are nearly always greyscale, but nevertheless contain some colour information that comes either from taking each exposure through a different filter or from using different detectors, each having different wavelength (colour) sensitivity. A telescope typically has a fixed number of well-defined filters available.

Filters can either be broad-band (**W**ide) or narrow-band (**N**arrow). A broad-band filter lets a wide range of colours through, for instance the entire green or red part of the spectrum. A narrow-band filter typically only lets a small wavelength span through, thus effectively restricting the transmitted radiation to that coming from a given atomic transition, allowing astronomers to investigate individual atomic processes in the object.

Below is an example of an image composed from narrow-band exposures. This results in very sharply defined wisps of nebulosity since each exposure separates out light from some very specific physical processes and locations in the nebula.

Galaxies are often studied through broad-band filters as they allow more light in total to get through. Also the processes in a galaxy are more "mixed" or complicated, as they result from the outputs of billions of very different stars and so narrow-band filters give less "specific" information about the processes there.

Compositing images

Colour images are composited by taking the individual greyscale filter exposures, colourising them and "stacking" them together as if "sandwiching" film slides together.

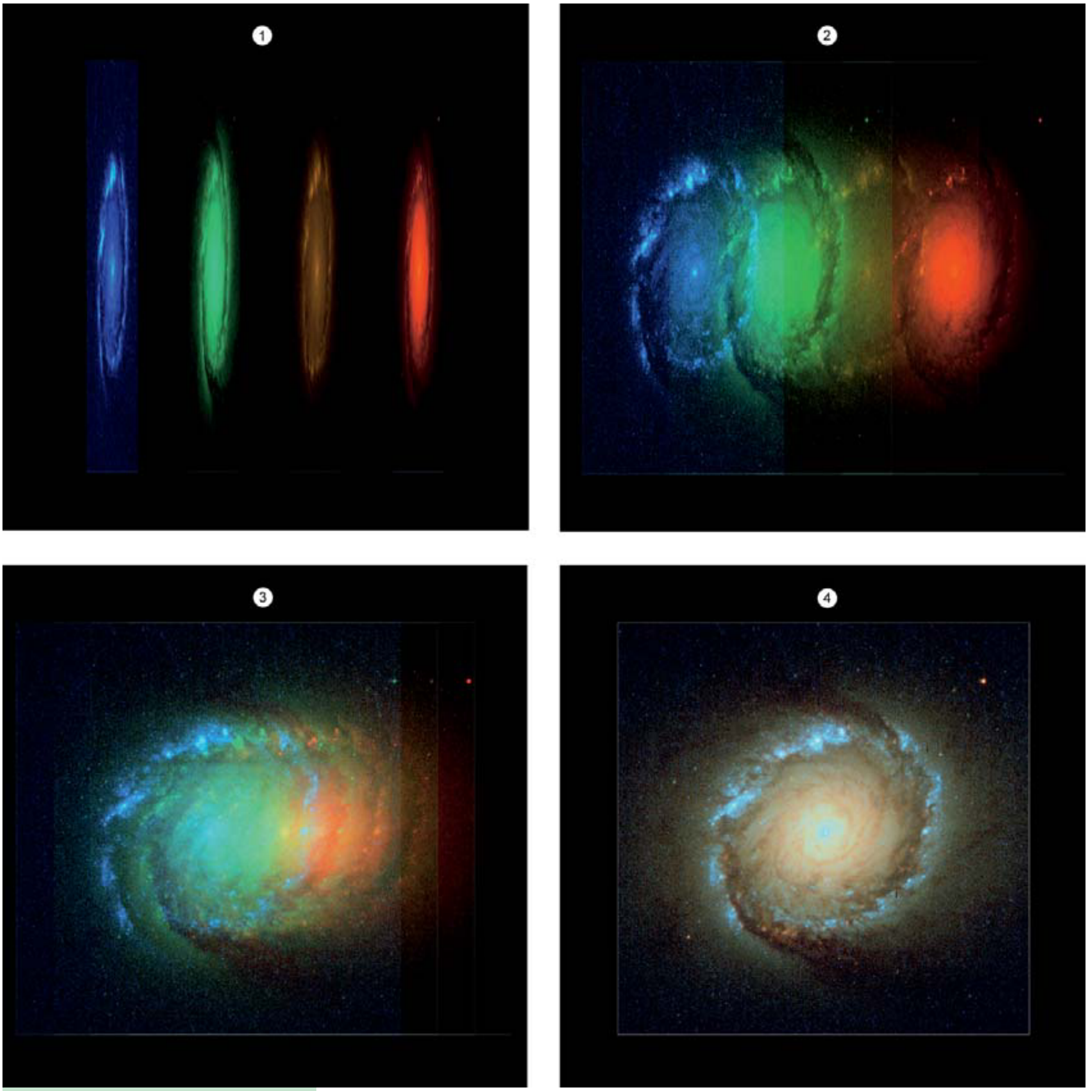


Figure 89: *A didactic example showing how a colour image is constructed from four broad-band filters (seen from the side in 1.): blue, green yellow and red. When the images are overlaid (2. and 3.) the resulting image (4.) is a colour composite.*

A.3 THE MAIN ISSUES

Before describing the workflow of producing colour images in detail let us look at some of the main problems in the production flow:

- Astronomical datasets have a **high dynamic range** (see below).
- **No datasets are optimal** for producing good images: with very few exceptions datasets have been collected for scientific research and therefore have natural limits when used to produce colour images:
  - Three filters evenly distributed over the spectrum are rarely available.
  - Often the exposures are slightly too short and are therefore noisy.
  - The different filters often have uneven exposure times and therefore different signal levels.
- When processing raw science images one of the biggest problems is that you are essentially "creating" the image yourself, with total freedom to choose within **a large parameter space**. There are literally thousands of sliders, numbers, dials, curves etc to twist and turn. And lots of room to take a wrong turning. There are some fundamental scientific principles that should be observed, but no real right or wrong. Mostly it is a matter of aesthetics or taste. Image processing for PR use is trial-and-error. Lots and lots of it!
- **Colour management issues**, or What You See Is NOT What You Get (WYSINWYG as opposed to WYSIWYG):
  - Display differences: It can be very difficult to actually *see* what is in an image since all monitors have different colour and light (brightness/contrast) representations. It is a well worth the investment to get a monitor calibrated.
  - Printer differences: Printers will never tell the truth about what is actually *in* an image.
  - Differences in perception: We all look at images differently.
- **Taste**: No two persons appreciate an image in the same way. This can best be described as "individual taste". Some people even have a radically different perception of colour (colour blindness).

High dynamic range

One of the most fundamental issues for astronomical images is the enormous dynamic range in the input images from the telescopes and the relatively limited dynamic range in output devices such as monitors, printers etc.

High dynamic range means that the brightest areas of interest may be many thousands (or even millions) of times brighter than the faintest structures in the image.

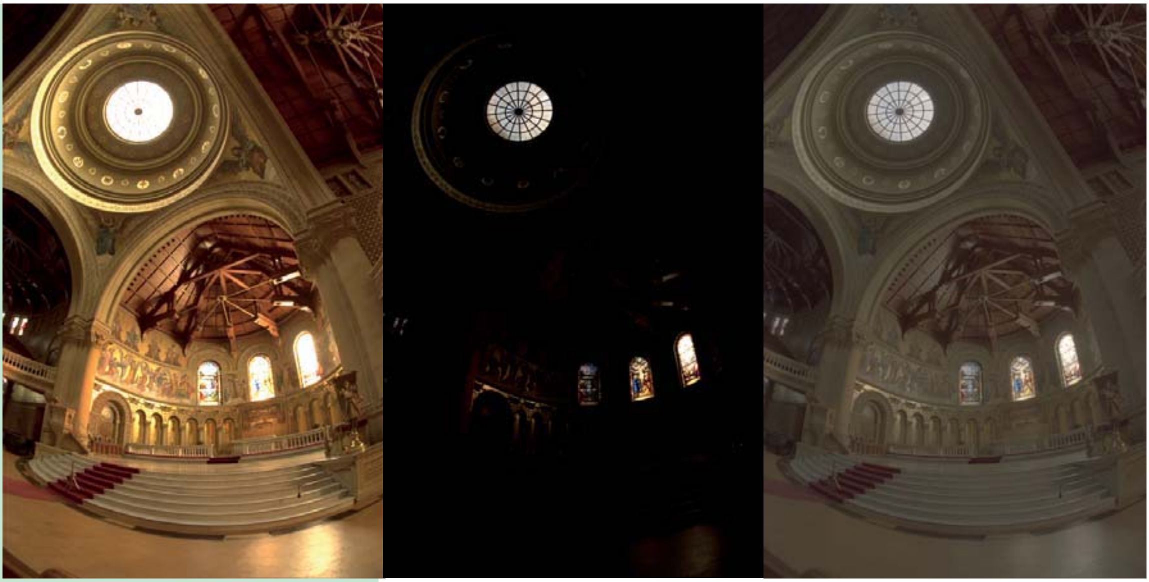


Figure 90: *This figure illustrates a well-known problem in photography that is even more pertinent in astronomy: the high dynamic range (HDR), or large difference between bright and dark regions in nature. Two normal (low dynamic range, LDR) photos are seen here: A long exposure to the left, and a short in the middle. It is very difficult, if not impossible, to get good details in the highlights at the same time as in the shadows — unless one creates an HDR image (right) and displays the intensities with a non-linear stretch function for print purposes. Astronomical images are usually HDR images.*

The remedy is to apply a non-linear stretch function to the image that shifts some of the emphasis away from the uninteresting intensities (often the bright parts in an image) to the more interesting ones where the structure appears (often in the fainter areas). This is somewhat analogous to the "compression" that is done to music before it is broadcasted through radio. More about stretch functions in section A.5. Read more about High Dynamic Range imaging in Reinhard et al. (2006).

Striking the contrast balance

A good question to ask is: What makes an image "nice to look at"? Is it possible to set up some basic ground rules that describe which images work and which not? Some would say: "No, it's an art form", some would say: "Perhaps to some degree, yes". There are however some basic pointers that can be identified:

- **Strike the contrast balance**: See figure 92 below.
- **Have a good colour balance**: Usually all three main colours (red, green, blue) should be represented, although not necessarily in pure form. Stars should be whitish.
- **Show interesting structure**: Spiral arms, intricate weaved filaments of nebulosity etc.
- **Bright sparkling colourful pinpoint stars**: In general the larger the field of view is, the smaller the star images are and the nicer they look. This is a way for ground-based telescopes to produce "Hubble-class" images. The colours should be balanced around white, but preferably with as many different colours as possible.

NASA/ESA Hubble Space Telescope

Figure 91: Astronomical images contain many more greyscales than can be viewed on a computer monitor or printed. In the image to the left a "normal" or linear representation of the image is shown. To the right the effect of a non-linear Scaling, a Logarithmic scaling, is shown. By using non-linear scaling it is possible to enhance some greyscales in the image more than others and so to make faint details visible without saturating the brighter parts of the image.

A.4 THE PRACTICAL WORKFLOW

FITS is the file format for most astronomical observations. The FITS format is very versatile, and therefore more difficult to "handle" than eg a tiff file. Traditional science software that works with FITS files, such as *IRAF*, *MIDAS* or *GIMP*, is fairly limited, rather slow and inaccessible to non-scientists.

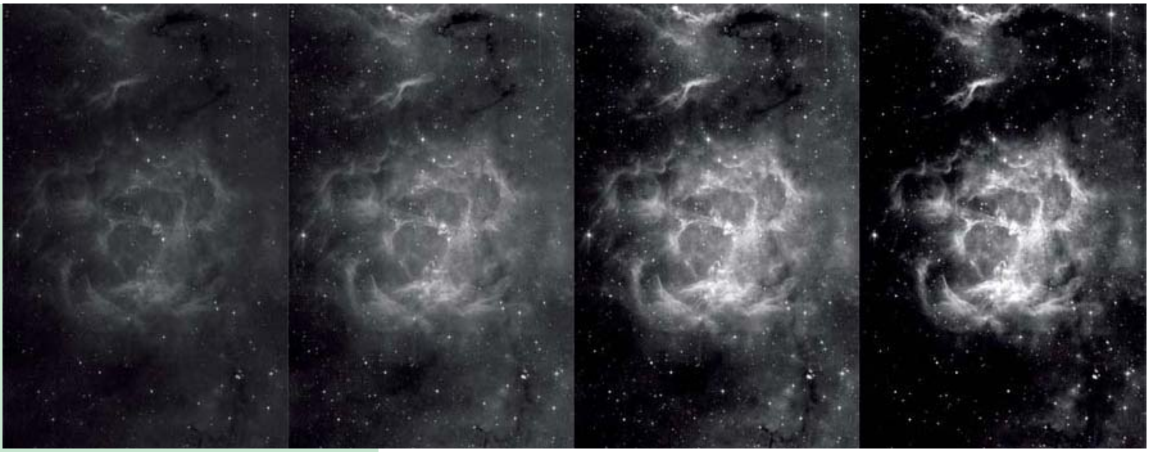
A better tool may be the *ESA/ESO/NASA Photoshop FITS Liberator* which has, since its release in July 2004, given easy access worldwide to astronomical FITS images and thereby simplified the workflow significantly. In this way the *Liberator* has become the "industry standard" for the production of "pretty pictures". This free *Adobe® Photoshop®* plug-in was produced with the precise intention of producing beautiful colour images from raw data and is so powerful that it makes little sense to describe the function of alternative tools here. A complete User's Guide (Hurt & Christensen, 2005) can be downloaded for free from the *FITS Liberator* webpages[62].

The steps in the workflow are illustrated in figure 94 (the final image is seen in figure 19). The image of the Swan Nebula is a typical 3-colour example. The images are narrow-band which gives the very crisp and well-defined nebulous ridges. The stretch function is linear. The individual exposures were found in, and retrieved from, the public *ESO/ST-ECF Archive*[63].

Let us look at some of the most important of the steps in the workflow.

62 http://www.spacetelescope.org/projects/fits_liberator

63 http://archive.eso.org/



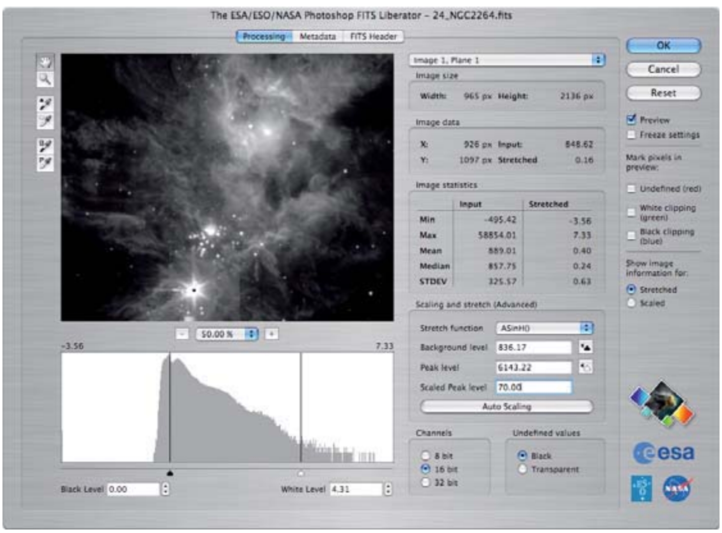
Robert Hurt (Spitzer Science Center)

***Figure 92:** Striking the contrast balance: Choosing the right stretch function is one of the toughest decisions when image processing (this also implies the fixing choice of Scaled Peak Level, see section A.5). The right choice here would probably be in the middle between low contrast (left) and high contrast (right). Contrast is also known as "hardness" in the photographic world.*

A.5 ADVANCED PROCESSING: STRETCH FUNCTIONS AND SCALING OF IMAGES

One of the most important aspects to be appreciated and used effectively in image processing, albeit primarily in somewhat more advanced or scientific processing, is the large dynamic range inherent in the data. The right choice of stretch function and scaling of the image is the solution.

A raw astronomical image typically has tens of thousands of greyscales, but on a computer screen, one only can see 256 levels of brightness (8-bit greyscale). If the original high dynamic range image is imported directly into *Photoshop* using simple linear stretch, either the detail in



ESA/ESO/NASA Photoshop FITS Liberator

***Figure 93:** The* FITS Liberator*'s Graphical User Interface. A more detailed overview can be found in Hurt & Christensen (2005).*

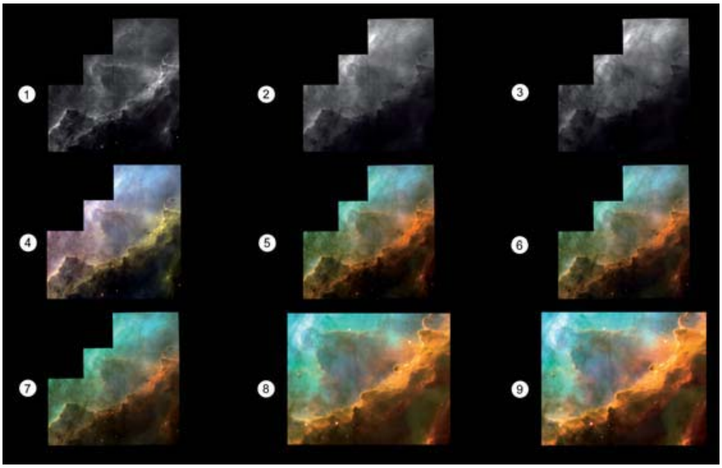


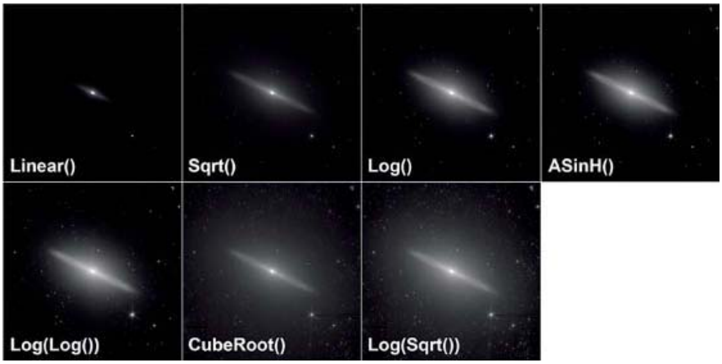
Figure 94: Sequences in the production for a Hubble Space Telescope image of the Swan Nebula. First the individual exposure (taken through three different filters): 1. 673n (Sulphur) shown in red in the final image), 2. 656n (hydrogen, green), 3. 502n (oxygen, blue), 4. First colour composite attempt, 5. Improving colour balance, 6. Improving colour balance, 7. Improving colour balance, 8. Adjusting the composition and then 9. Final colour and contrast adjustments for the final image (also seen in figure 19).

the fainter structures is lost in the black background, or the brightest objects over-saturate (or burn in).

Photoshop can partially compensate for this by applying levels or curves transformations after the FITS image has been imported. However, an image that has been reduced to 8-bit greyscales can only be adjusted a little bit before it begins to posterize, obscuring low-level features. Even extreme curve adjustments cannot bring out the faintest detail in some of these images.

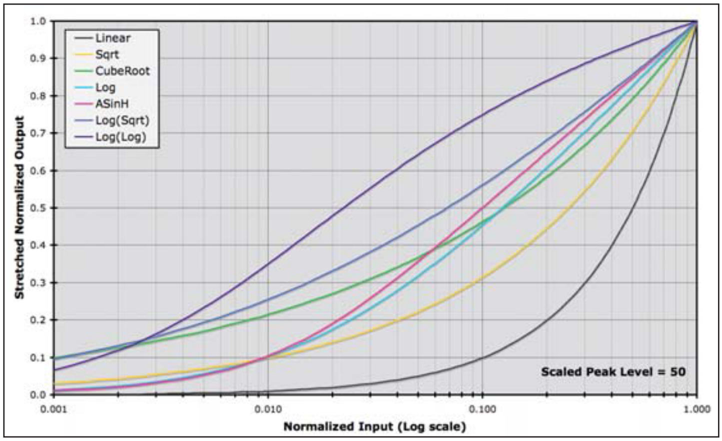
A non-linear stretch function such as logarithm, square root, cube root, or Inverse Hyperbolic Sine (ASinH) applied to the FITS image can mimic the operation of the human eye, which can accommodate to perceive dramatically different levels of brightness simultaneously.

As an example, a logarithmic representation of the pixel values tends to suppress the bright parts of the image, ie the stars, and enhance the fainter parts, eg nebulosity. This can be very desirable if "the faint stuff"



Robert Hurt (Spitzer Science Center)

Figure 95: Comparison of different stretch functions. It is seen that a stretch function can help displaying data with large dynamic range by suppressing the brighter areas and enhancing the fainter areas.



Robert Hurt (Spitzer Science Center)

Figure 96: *Different stretch functions — logarithmic plot.*

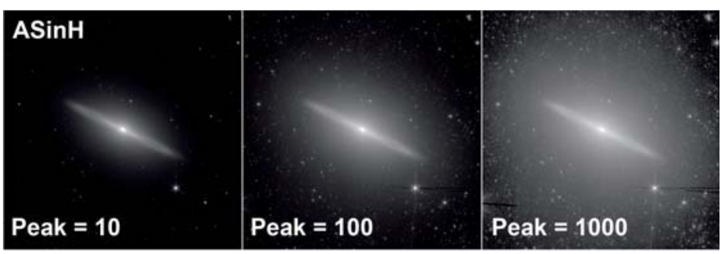
needs "a boost". But a logarithmic stretch can also reduce the contrast in images with lower dynamic range and make them blander.

Looking at the stretch issue with scientific eyes, one can plot the different stretch functions (figure 96) to compare what they actually do. There are two tricks when doing this:

1. As we are only interested in the relative pixel values (ie how many output greyscales are allocated to the faint, or alternatively the bright parts of the image) and not the absolute values since Photoshop rescales them in any case, the curves can be rescaled to fit on the same plot.
2. The interesting area for astronomical images is typically at the faint end and the curves are therefore plotted logarithmically.

It can be seen that if an image has a contrast ie ratio between the faint and the bright parts of an image of 100 (ie the rightmost two decades of x-values), a linear stretch (ie no stretch) preserves only a few percent of the greyscales for the faint details (at x=0.01). A log(log) stretch allocates some 35% of the greyscales in the output image for the faint details.

When stretching the data another issue becomes pertinent: scaling. Some mathematical stretch functions behave differently[64] depending whether they are operating on images with pixel values between 0 and



Robert Hurt (Spitzer Science Center)

Figure 97: *The Inverse Hyperbolic Sine (ASinH) stretch function with different scaling (ie values of scaled peak level from 1 to 1000) of the image.*

64 Note that the Linear(), Sqrt(), and CubeRoot() stretch functions are not affected by scaling.

Robert Hurt (Spitzer Science Center)

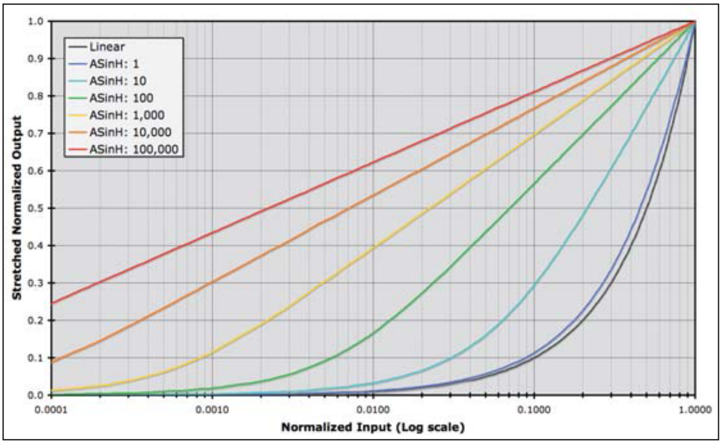


Figure 98: *A closer look at how one particular Stretch function, inverse Hyperbolic Sine (ASinH) depends on how the image is scaled.*

1, for example, or on images with pixel values between 0 and 10000. For this reason, it is necessary to scale the image. The *FITS Liberator* offers a set of scaling controls that can be used to change, or scale, the pixel values in an image. It turns out that the most consistent value to use is not scaling as such (ie multiplying the image with a factor x), but setting the scaled peak level. Scaled peak level is the desired pixel value of the brightest parts of an image after scaling.

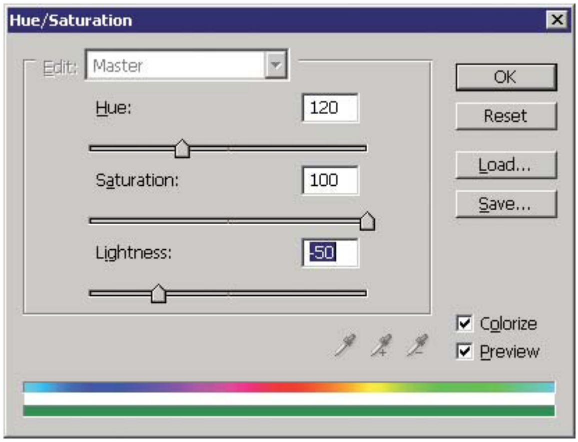
The main message is that low values of scaled peak level, ie near 0.1, brings the stretching process closer to a linear stretch for functions such as ASinH or Log, and higher values makes the stretch more pronounced, but also lowers the contrast in an image. Different values of the scaled peak level are shown in figure 97 with the same stretch function (here Log) to illustrate this concept.

Again, looking at this concept scientifically, we can plot one (figure 98) particular stretch function for different values of the scaled peak level from 1 to 100,000. It is clear that low values make the stretch approach a linear stretch (ie no stretch).

A.6 COMPOSITING IN PHOTOSHOP

After an astronomical image has been "liberated" it can be processed in *Photoshop*. This is an overview of the steps:

1. Assemble filters with screen mode
2. Colourise each pixel layer with hue/saturation adjustment layers
    - i. Make an adjustment layer
    - ii. Group with pixel layer (make clipping mask)
    - iii. Colourise by choosing initial values for hue, saturation, lightness (see figure 99):
        1. Hue: 0=Red, 120=Green, 240=Blue
        2. Saturation: 100%
        3. Lightness: -50

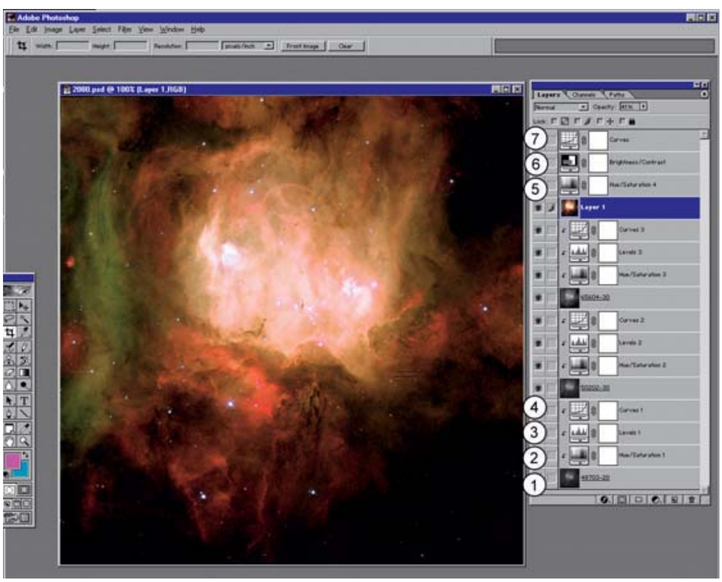


Adobe® Photoshop®

***Figure 99:** Setting the Hue/Saturation parameters in* Photoshop *to colourise a layer.*

3. Apply local levels and curves adjustment layers (see figure 100).
4. Tweak and tune until satisfied.
5. Apply global adjustments: For instance selective colour, contrast, curves etc (see figure 100).
6. Use small tricks: Careful blurring, careful sharpening, Autolevels (to check on the colour balance) and calculations to create a pseudogreen layer if the dataset consists of only two layers.
7. Clean up the last cosmetic details.

More details can be found in Hurt & Christensen (2005) and http://www.spacetelescope.org/projects/fits_liberator/stepbystep.html



Adobe® Photoshop®

Figure 100: Photoshop *used to construct a 3 exposure narrow-band composite of the Ghost Head Nebula seen in figure 86. To the right the layers are seen with the 3 exposures (1). Local adjustment layers are seen over each exposure, and they colourise (2), adjust levels (3) and adjust curves (4). On top four global adjustment layers are seen for the last adjustments of colour (5), brightness/contrast (6) and curves (7).*

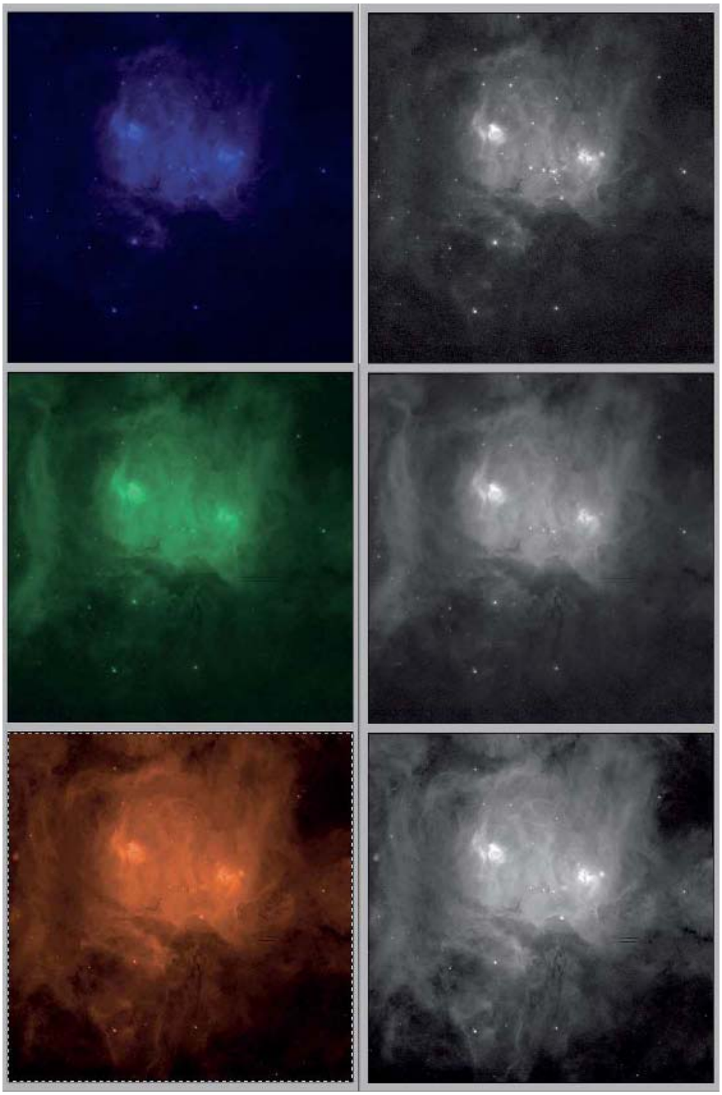
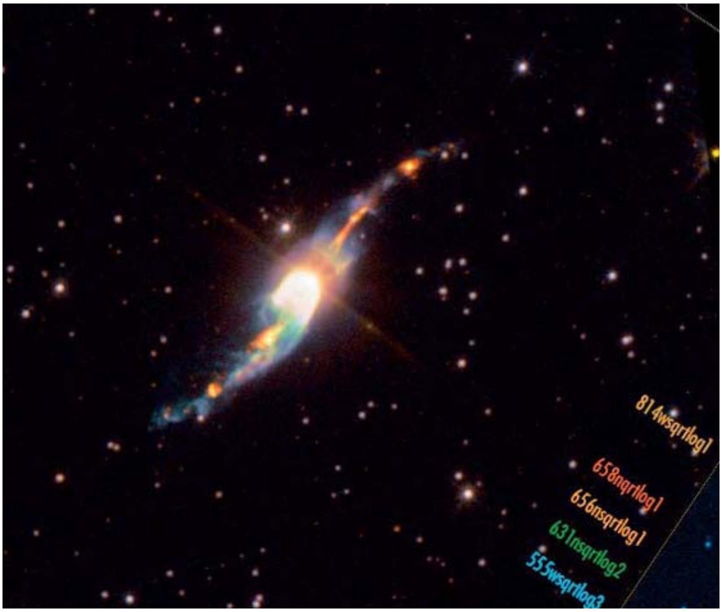


Figure 101: *The resulting blue, green and red components of the colour image above. To the right the greyscale image is shown, to the left the colourised version is shown.*

A.7 SOME FINAL STRATEGIC ADVICE

- An image can always be improved. The knack is to know the right time to stop improving it. Develop your own measures of quality and decide when a given image has reached the right level.
- When working on an image, "blindness" occurs after a while: you can no longer tell what is beautiful or ugly, right or wrong.
  - Compare different versions of the image with a "slideshow display" on a black background.

Figure 102: Example showing a complex 6-colour image. The labels to the right are white text embedded in each exposure, and will therefore get the colour that is assigned to the filter — a way of getting an overview when testing different colours. The filter names show what type of filter is used: w = wide and n=narrow.



  - Ask the opinion of others. Their opinion is as good as your own or even better as they have no emotions attached to the image.
  - Take a break.
  - Work on something else.
  - Sleep on it.
  - Look at different monitors.
  - Make a contact sheet with different versions of the image to get an overview (see figure 103).
- Always tweak the parameters (contrast, saturation etc) somewhat conservatively — they can always be tweaked again later.
- Keep your layers and adjustment layers as long as possible. This will make it possible to go back and adjust parameters at no cost.
- Blurring or sharpening may be okay, but applying it to one layer only gives you the advantages with smaller side effects.
- If it is not necessary do not compromise on quality.
- Preserve greyscales at all cost.
- Compression is a necessary evil: know the advantages and disadvantages of compression and use it with care.
- Do not be scared about visible pixels in your images.
- Noise cells seem to be less visible in print.
- A two-colour image can be as pretty as a three- (or four-) colour image.
- Using more than three colours doesn't always help. Instead select the filters with care.

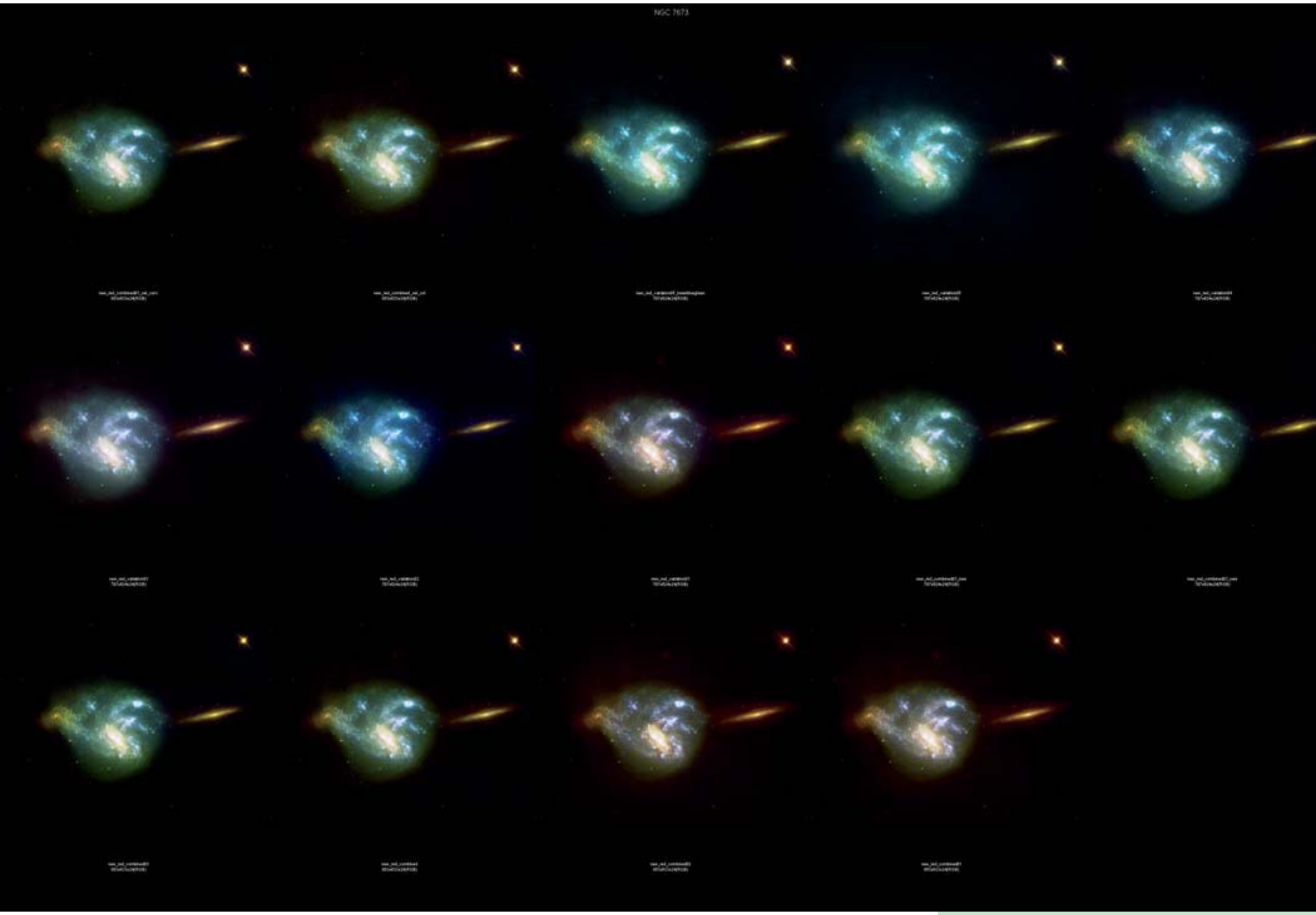


Figure 103: *Digital "contact sheet" showing some of the many different versions of a single image. When undertaking trial and error testing it is easy to get 'blind' and therefore looking a sheet like this can help to recover your bearings*

- A trivial rule to most readers, but often ignored: For use with press releases (and in most other places) your images should always be delivered in optimal quality — tiff format and highest possible **resolution** (3000 pixels or more). By not making your images available in optimal resolution you will only create more work for yourself.
- Experiment with different methods of compositing, for instance the technique known as LRGB[65], depending on the nature of the dataset.
- Always make many tests. Image processing seems to be meta-science at times. It is not always predictable which tricks will work. Save the different tests in individual files, and discuss the result with others.

65 For instance http://www.robgendlerastropics.com/LRGB.html

APPENDIX B: CASE STUDY: THE WASHINGTON CHARTER

The Washington Charter for Communicating Astronomy with the Public (see figure on next page), usually referred to as the *Washington Charter*, has its origins in the *Communicating Astronomy to the Public* conference held at the US National Academy of Sciences in Washington, D.C., in early October, 2003 and later revised by the ESO/ESA/IAU conference *Communicating Astronomy with the Public 2005*. The Charter outlines *Recommendations* for individuals and organisations that conduct astronomical research that *"have a responsibility to communicate their results and efforts with the public for the benefit of all"*.

The idea is to have this document endorsed by as many organisations as possible to raise awareness of the importance of public communication in astronomy.

IAU Working Group for Communicating Astronomy with the Public

IAU COMMUNICATING ASTRONOMY WITH THE PUBLIC

— an IAU DIVISION XII Working Group

THE WASHINGTON CHARTER FOR COMMUNICATING ASTRONOMY WITH THE PUBLIC

As our world grows ever more complex and the pace of scientific discovery and technological change quickens, the global community of professional astronomers needs to communicate more effectively with the public. Astronomy enriches our culture, nourishes a scientific outlook in society, and addresses important questions about humanity's place in the universe. It contributes to areas of immediate practicality, including industry, medicine, and security, and it introduces young people to quantitative reasoning and attracts them to scientific and technical careers. Sharing what we learn about the universe is an investment in our fellow citizens, our institutions, and our future. Individuals and organizations that conduct astronomical research — especially those receiving public funding for this research — have a responsibility to communicate their results and efforts with the public for the benefit of all.

RECOMMENDATIONS

For Funding Agencies:

Encourage and support public outreach and communication in projects and grant programs

Develop infrastructure and linkages to assist with the organization and dissemination of outreach results

Emphasize the importance of such efforts to project and research managers

Recognize public outreach and communication plans and efforts through proposal selection criteria and decisions and annual performance awards

Encourage international collaboration on public outreach and communication activities

For Professional Astronomical Societies:

Endorse standards for public outreach and communication

Assemble best practices, formats, and tools to aid effective public outreach and communication

Promote professional respect and recognition of public outreach and communication

Make public outreach and communication a visible and integral part of the activities and operations of the respective societies

Encourage greater linkages with successful ongoing efforts of amateur astronomy groups and others

For Universities, Laboratories, Research Organizations, and Other Institutions:

Acknowledge the importance of public outreach and communication

Recognize public outreach and communication efforts when making decisions on hiring, tenure, compensation, and awards

Provide institutional support to enable and assist with public outreach and communication efforts

Collaborate with funding agencies and other organizations to help ensure that public outreach and communication efforts have the greatest possible impact;

Make available formal public outreach and communication training for researchers

Offer communication training in academic courses of study for the next generation of researchers

For Individual Researchers:

Support efforts to communicate the results and benefits of astronomical research to the public

Convey the importance of public outreach and communication to team members

Instill this sense of responsibility in the next generation of researchers

Authored by CCAP, Washington DC, October 2003 – Revised by CAP 2005, Garching bei München, June 2005

GLOSSARY

The words in italics refer to other entries in the glossary. See "The Chartered Institute of Marketing's Glossary"[66] for additional definitions of marketing concepts that have a useful overlap with communication. For more explanation about words used specifically in video production, consult Adobe's *Glossary of digital video terms*.

#

24-bit colour — See *true-colour*

2D animations — *Animations* that use 2D images and *vector graphics* often simulating a 3D environment. These *animations* are less CPU and manpower intensive to create than 3D animations. Adobe® After Effects® is one of the most used software packages for creating 2D animations.

3D animations — *Animations* that use material modelled and *rendered* in a 3D programme on a *3D workstation*. The graphics designer can control the environment, the flow of time, and choice of viewpoint to place the viewer in a physically impossible situation and so experience virtually a distant planet, the bottom of the ocean or the world of atoms.

3D workstation — Powerful computer that performs the many calculations needed to produce *3D animations*.

A

A-roll — First part of a Video News Release. A 2-5 minute sequence, fully edited with voiceover (channel 2) and ambient sound (channel 1).

Acknowledgement — Information in a *press release* or other publication showing the involvement of others, for instance, other *scientists*. Despite being rarely used by *journalists* it is a good way to credit other people's work and can help keep everyone happy internally.

Additive colour model — Colour model in which colours are produced by combining various percentages of red (R), green (G), and blue (B) light. White is produced by mixing 100% of each primary, whereas black is produced by the complete absence (ie 0%) of each primary. The additive colour model is used by computer monitors to produce their display.

Address database — Database containing the records of all the recipients of *products*. Each record has a number of fields with different information for each customer.

Afterglow — Characteristic phosphorescent glow on a *television* screen caused by the finite decay time of the electron beam. Typically lasts a fraction of a second and makes television images much less susceptible to noise and flicker than digital images and so appearing very natural despite their very low *resolution*.

Airtime — Amount of time a video *product* receives on a given radio or television channel.

Alpha channel — Additional information stored for every pixel in an *image* that gives the coverage information, ie whether the pixel is opaque, transparent or partly transparent.

Analogy — Correspondence in nature, function or form between a well-known process or situation used as an example and the entity whose workings are being described.

Animation — Sequence of still artwork or objects *composed* in such a way that they appear to move on film or video. A rate of 24-30 frames per second is an appropriate *frame rate* for animation.

Annual report — *Product* showing the achievements of an organisation during a (calendar-) year. Usually contains lists of staff, lists of publications, and budgetary or accounting information.

Artefact — Distortion in an image, video picture or sound signal. With digital video, artefacts can result from overloading the input device with too much signal, or from excessive or improper *compression*.

66 http://www.cim.co.uk/cim/ser/html/infQuiGlo.cfm

B

B-roll — Secondary or duplicated footage of a fill or secondary nature. Formerly played from the B source player in an A/B-roll linear editing system.

Bandwidth — Amount of information that can be carried by a signal carrier. Usually measured in units of information per unit time, for instance MB/second (for digital signals).

Betacam — A *tape format* and a transportable combination camera and recording (camcorder) system.

Betacam, digital — Improved version of *Betacam* with the advantages of digital quality, such as no loss when using material that has been through many generations. Superior to *Betacam SP*.

Betacam SP — Improved version of *Betacam*. Betacam SP has good picture quality and a high signal to noise ratio, a metal particle tape and increased *bandwidth*.

Bitmap — *Image* comprising individual *pixels*, each with individual values that define the relative pixel brightnesses and colours.

Blogging — Verb or noun derived from the word weblog referring to a web-based publication with simple and unpolished diary-type or thematic articles posted in reverse chronological order.

Bluescreening — Video technique using a surface behind the main subject that is "a uniformly monochromatic blank" that can be deleted digitally from the footage later using video editing software. Also known as keying. The purpose is to "cut" out the main element (often a person) and place it in another context, for instance in a *virtual studio* or in a remote location.

Brand — Set of attributes of a product including the associated beliefs and expectations— a unique combination that the name or logo of the product should evoke in the mind of the audience.

Broadcast quality — High quality standard for video signals. Signifies material that can be used by *television* broadcasters.

Broad communication — *Communication* aimed at a wide *target group*. In contrast to *narrow communication*.

Brochures — Printed products that use a blend of *visual communication* and *written communication*. Can be aimed at different target groups. Especially suitable for longer lasting background information.

C

Caveats — Cautions and qualifications included by scientists in their scientific presentation of a result. Often omitted in communication *products*, as a first step to simplifying the result.

CD-ROM — Abbreviation for Compact Disc Read-Only Memory.

CMYK — *Colour space* used for printing. An abbreviation for the four parameters: Cyan, Magenta, Yellow and Black; the inks used in process printing. Has a different *gamut* from the *RGB* colour space, so there is no unique way of *converting* between these two colour spaces. Represents the *subtractive colour model*, where a combination of 100% of each component yields black and 0% of each yields white. Cyan, magenta, and yellow are the subtractive complements of red, green, and blue respectively.

Co-release — If more than one organisation is involved in releasing the same material, they are said to co-release. Usually one organisation leads the production and other organisations submit contributions.

Codec — Contraction of compression/decompression algorithm. Codecs are used to encode and decode, or compress and decompress data, such as sound and video files. Common codecs include those that convert analogue video signals to compressed digital video files (e.g., *MPEG*), or that convert analogue sound signals to digital sound files (e.g. *MP3*).

Colour conversion — Converting between different colour spaces, for instance *RGB* and *CMYK*.

Colour space — The part of the visible range of colours that a given model contains.

Communication — The process of exchanging information, such as knowledge or experience.

Communication-niche — Features of a given project that best enable the communication of its unique advantages over other projects.

Communication office — See *education and public outreach office*

Communication products — See *products*

Communication strategy — Set of visions and objectives allocated by an organisation to its *communication* function to support the overall organisational strategy, together with the broad methods (*products, distribution* channels etc) chosen to achieve these objectives.

Communicator — Person whose job it is to communicate information and, to some degree, to *promote* certain *products*.

Competition — Fighting the "battle to be heard" against *competitors* in the same communication environment.

Compositing — Combining different digital clips or images, for instance by superimposing layers on top of each other to create scenes or images that could not be created in one piece (or were not economically feasible).

Compression — Translation of audio or video data into a format that requires less storage space than the original data. Can be destructive (lossy), or non-destructive (lossless). Destructive refers to a data compression method where data is lost through compression and compression *artefacts* are introduced. *JPEG* is a commonly used lossy compression method for images. Non-destructive refers to a data compression method that retains all data from the uncompressed file. LZW is a commonly used lossless compression algorithm and is commonly used for *TIFF* and *GIF* format files.

Consumer — Individual who buys and uses a *product*.

Contacts —*Scientists* and *public information officers* involved in the production of a given *product*. Contacts should be available to journalists for elaborations and quotes etc.

Contractor — A possible external contribution to the staffing of an *education and public outreach office*. Needs well-defined tasks.

Copywriting — Term used in marketing for the creative process whereby written content is prepared for advertisements or marketing material.

Corporate visual identity — Graphical character that an organisation seeks to establish for itself in the mind of the public, reinforced by consistent use of *logos*, colours, typefaces etc.

Customer — A person who purchases or receives *products*.

D

Darlings — A *writing* concept describing unusual ideas for which authors develop an unjustified affection (in the eyes of the target group).

Decision-makers — *Target group* with political and funding influence. Needs to be targeted with *narrow communication* products.

Direct communication — *Communication* directly with the *end-user*. Contrasts with communication through *mediators*.

Direct mailing — Delivery of a product to *customers* or potential customers by post, or email.

Distribution — The process of getting the product from the supplier (the *communicator*) to the *end-user*.

Distribution lists — Lists containing address information (mail, fax, email) of *target groups*. Can be internal (your own) or external (maintained by someone else). Distribution lists are usually in the form of *address databases*.

DVD — Short for "Digital Versatile Disc" or "Digital Video Disc". An optical medium for the storage and playback of data and high-quality hour-long movies. The movie DVD (more correctly known as DVD-video) is an excellent medium for bringing high-impact science communication directly to the *end-users*.

E

Editing — Process of *rewriting* and adapting raw material to fit certain pre-specified needs. Usually the responsibility of a very experienced *communicator*.

Editorial board — Group of selected experienced people, often *scientists*, that act as reviewers, advisors or even validators of communication *products*.

Educational material — Special *products* targeted towards the special *target group* of (school age) children.

Education and public outreach office — Department or group in an organisation that deals with external and internal communication. Also known as a *communication office*, an *outreach office*, a *public affairs office* or a *science PR office*.

Edutainment — Contraction of education and entertainment: Learning by playing.

Embargo — An informal agreement that media refrain from reporting certain information until a specified date and time, in exchange for advance access to the information.

Embargoed press releases — Releases sent to selected target groups (journalists) before the public release with the tacit agreement that news organisations and journalists refrain from reporting the embargoed material to the public until the embargo expires.

End-consumers — See *end-user*

End-target — See *end-user*

End-users — *Target groups* that are expected to benefit from the product. Principally the *general public*, but may also include *decision-makers* and other *scientists*. End-users usually receive the information from *mediators*.

Ending — The final sentences of a story. Important for the image left in the mind of the consumer.

Evaluation — Analysis that takes place after the publication of a *product* and gives the *public information officer* the basis for making proper choices for the *communication strategy*. Can be qualitative (estimates) or quantitative (based on numbers).

Exclusive story — Story distributed only to one selected medium or journalist.

Exhibitions — Specialised *multi-stringed product* involving nearly all types of products: written, visual, video etc.

External communication — *Communication* with the outside world, in contrast to *internal communication*.

F

Factsheet — Additional information for a *press release*. Elaborates on a selected topic.

Feedback loop — Communication loop between funding donors and scientists. This loop is particularly strong in the US, where *scientists* are expected to share their results with the public.

Field — A still image in a video. Fields have half the resolution of a frame and are displayed twice as fast. Videos composed of fields are called *interlaced*.

Flicker — The blinking of a video signal due to a low *frame rate*.

Footage — Raw clips of video material that may be combined to form an *A-roll*.

Four colour printing — Four colour printing uses cyan, yellow, and magenta (CMY) inks. In *subtractive colour theory*, combining 100% of each cyan, magenta, and yellow should produce a pure black. In practice, however, the combining of cyan, magenta, and yellow inks does not produce a pure black due to impurities in the inks. For this reason, black ink (K) is used in addition in the print process, which is thus called four-colour CMYK printing.

Frame rate — Number of frames per second displayed in video material during playback.

G

Gamut — The total range of colours produced by a device. A typical CMYK gamut is generally smaller than a typical RGB gamut.

General public — Typical *end-user* with no specialist knowledge. Also known as "the man in the street", "R-Ps" (Real People), taxpayers or "Joe Sixpack".

GIF — A 8-bit (one byte per pixel or 256 colours) non-destructively *compressed bitmap* image format. Mostly used for the web. It has several sub-standards, one of which is the animated GIF.

Glossy prints — Special prints used in *press kits* or for *decision-makers* and photo editors in *newsrooms*.

Golden questions — The six golden questions that should be answered as quickly in any story are:

- Who? = who did the research
- What? = what is the main point
- Where? = location of the research organisation or event
- Why? = why is it news?
- When? = time of the research publication or event
- How? = how the research was done

H

H.264 — Widely used digital video codec, also known as *MPEG-4* Part 10 and known for its high quality and small file size.

Hype-threshold — Upper limit at which the need for public visibility starts to affect the credibility negatively.

I

I/O rates — Amount of data a hard disk system can exchange with a computer. Important for *video editing* as a too low an I/O rate can result in a jerky picture.

Image — A collection of *pixels*, each with an intensity level and a colour value.

Image credit — Essential reference ensuring that the *scientist* and the scientific organisation are credited for their results.

Image resolution — Number of *pixels* in a digital *image*. The higher resolution, the better the image quality. Resolution is usually measured in pixels per unit length (for instance DPI — Dots Per Inch), but raw pixel numbers are a simpler measure that is independent of physical size.

Impact — The success of a *product*.

Impact estimation — See *success metrics*

Impact statistics — See *success metrics*

In-depth science programmes — Television programmes that offer greater insight into the scientific work process. In contrast to *edutainment*.

Information management — The collection, organisation and distribution of information in a form that lends itself to practical application. Information management often relies on information technology to facilitate the storage and retrieval of information.

Interlaced video — Method to increase the quality of a video signal without increasing the *bandwidth*. In interlaced videos every frame is split into two interlaced *fields* that have blank lines every second line and are shifted one line respectively. The fields thus fill out each others "gaps" and one can seemingly get the double *frame rate* (ie less *flicker*) without doubling the amount of information. Interlaced videos are in contrast to progressive videos.

Internal communication — Information distributed within the different parts of the organisation itself. In contrast to *external communication*.

Interview — Private conversation between journalist and subject. The journalist usually uses one or more recording methods: pen, paper or an electronic recording device. Two types of interviews are close-ended interviews and open-ended interviews. Close-ended interviewing is a form of interviewing where the interviewee has a fixed number of answering choices eg yes/no questions. Open-ended interviewing is a form of interviewing where the interviewee is not limited to a determined set of answers.

Inverted pyramid — Going from the most important to the least important fact. Enables the *communicator* to communicate the most important messages first.

J

Jargon — Language used between experts (e.g. scientists). Should be avoided in science communication.

Journalist — The core mediator. Has tremendous decision power concerning the distribution of *products* to the *end-user*.

JPEG — A very efficient (ie much information per byte) destructively *compressed true-colour* (16 million colours) *bitmap image* format. Widely used, especially for web (*bandwidth*-limited) image *distribution*.

K

Keying — *See bluescreening*

Knowledge management — See *information management*

L

Large format printers — Printers that print large, poster-sized prints. Useful for exhibitions etc.

Layering information — As *products* often target different *target groups*, from almost-*laypeople* to specialised *science writers* it is useful to provide information with several layers of increasing complexity, but decreasing importance of the messages from the most important to the least important fact (also known as the *inverted pyramid*).

Laypeople — See *general public*

Lead — Opening sentences of a story (for instance an article or a book). The lead determines whether the reader will be "caught" or "hooked" and continue reading.

Lead time — The amount of time a publication (e.g. a *newspaper* or a magazine) needs after receiving a product before it can be printed.

Linear editing — Traditional videotape editing systems were linear because videotapes were edited sequentially, from beginning to end. In contrast to *non-linear editing*.

Line art — See *vector graphics*

Line of products — Part of the methods chosen to meet the communication objectives. Determined in a *communication strategy*.

Listener — Target group for radio.

Logo — A graphic, usually consisting of a symbol and/or group of letters that identifies an organisation or brand.

M

Market research — The gathering and analysis of data relating to communication environments or *customers*. Market research should lead to more knowledge of the communication market and the *consumers* and to better-informed decision-making.

Matte — Used in digital video when part of a foreground *image* is inserted onto a background image.

Media — The most important *target group*. Part of the *mediator* group. The media are usually split in electronic (*television*, *radio, podcast*) and print (*newspapers*, *magazines* etc). They act as *multipliers* and *distribute* the *products* to a wide audience.

Media advisory — Information sheet sent to *television* broadcasters concerning an upcoming *satellite uplink*. Contains time, content information, satellite frequencies etc.

Media alert — See *media advisory*

Mediators — Target group that actively takes part in the distribution process. The term "mediators" is an umbrella for some of the most important *target groups*: *media*, *teachers*, amateur scientists etc. See *direct communication*.

Medium — Singular form of *media*.

Merchandise — Items such as stickers, pins, badges, mugs, pens etc. Usually carrying the *brand* of an organisation or a project and given away at events like *exhibitions*, conferences etc. Has a high price per unit, but may be useful in bringing out the brand to carefully selected *target groups*, eg *decision-makers*.

Metaphor — A figure of speech in which a word or phrase literally denoting one kind of object or idea is used in place of another to suggest a likeness or analogy between them (as in "drowning in money").

MJPEG — Acronym for Motion JPEG. A video *codec* where each frame of video is a JPEG image.

MP3 — Abbreviation for MPEG-1 audio layer 3. MP3 is a popular audio *codec* that reduces the amount of data needed to represent audio.

MPEG — Motion Pictures Expert Group of the International Organization for Standardization (ISO). MPEG is also the name of some frequently used video *codecs*. The most well-known MPEG codecs use lossy *compression*.

MPEG-1 — A much used compression *codec* for digital video and audio. MPEG-1 was initially designed to deliver near-*broadcast* quality video through a standard speed *CD-ROM*. Playback of MPEG-1 video requires either a software decoder coupled with a computer or a hardware decoder.

MPEG-2 — The MPEG-2 *codec* is an extension of the *MPEG-1 compression* standard designed to meet the requirements of *television broadcast* studios. Broadcast quality video found on DVDs is in *MPEG-2* format and requires either a software or a hardware decoder (eg a DVD-ROM player) for playback.

MPEG-4 — The next-generation, global multimedia standard, delivering professional-quality audio and video streams over a wide range of bandwidths, from cell phone to broadband and beyond. One of the most used video *codecs*, *H.264*, is part of the MPEG-4 standard.

Multimedia — Combines different computer-based media — usually audio, text, graphics, and animation — into a single presentation. Audiovisual multimedia presentations are typically played back directly from a computer.

Multipliers — See *mediator*

Multi-stringed products — Has multiple products available to the *customer* at the same time. An *exhibition* is a good example as the visitor has the choice between many different communication products. In contrast to *single-stringed products*.

N

Narrow communication — Pinpointed communication *products* individually tailored to individual targets such as *decision-makers*. In contrast to *broad communication*.

News agencies — See *wire services*

News criteria — A list of the criteria that improve a story's chances of publication.

Newsletters — Printed or electronic product, most often of a technical nature. Newsletters communicate from scientist to scientist within the scientific community.

Newspapers — Printed *media* product printed on low quality paper with fast and efficient print presses. Can be divided into international, national and local newspapers. Each has special requirements for science stories.

Newsroom — Office where media editorial staff are located.

Non-linear video editing — Random-access editing of video and audio on a computer, enabling edits to be processed and reprocessed at any point in the timeline. In contrast to traditional *linear editing* systems.

NTSC — Abbreviation for the National Television Standards Committee that standardised the NTSC colour broadcasting system currently used in the United States.

O

Off the record — Journalistic term used when the source cannot be quoted.

Old news — If a *product* (e.g. a press release) is not delivered on time — at the latest by the time of the public release — it will be considered old news by *journalists* and ignored, wasting effort all round.

On Demand — The principle of *distribution* where the *end-user pulls* the (electronic) product at will. On Demand is opposed to products such as radio and television that are *pushed* to the end-user at pre-determined times.

On the record — Journalistic term used when the source can be quoted.

Opacity — The opposite of transparency.

Outreach office — See *education and public outreach office*

Over-simplification — When (scientific) concepts are portrayed in too simply (for instance by the *media* or by *PIOs*).

P

Packaging — Literally material used to protect a physical *product*. In a wider sense, the context that presents the product, for instance the graphics design.

PAL — The Phase Alternating Line television standard used in most European and South American countries. PAL uses an interlaced display with 50 fields per second, 25 frames per second.

Peer reviewing — A form of scientific quality control where other expert scientists read the paper and assess the scientific method, factual accuracy and the conclusions of the author. This process of checking, criticising and improving research increases the chance that errors and inaccuracies that might not have been caught by the scientist herself are found before the paper is published in a journal.

Perfect world — Imaginary, simple, trouble-free world: Technical problems never occur. Employees are never ill. There are no public holidays, and no vacation days. In the perfect world deadlines never seem to cluster together, and work comes in neat little well-defined parcels that never take longer than the time assigned to them. In contrast to the *real world*.

Physical services — *Products* that are physical and are physically distributed. In contrast to *virtual services*.

PIO — See *public information officers*

Pixel — Contraction for picture element. The smallest computer display element represented as a point with a specified colour and intensity level.

Planetaria — Plural of *planetarium*, see below.

Planetarium — Museum style facilities, often with a strong multimedia component. Contains *exhibitions* and planetarium shows that are edutainment-style multimedia programmes aimed at taking the visitor on a journey among the stars.

Planetaria are often combined with large-format cinemas.

Planning — Preparatory phase where the *product* production is defined. Often a feasibility analysis (formal or informal) has to be carried out to clarify the details of the production: the right choice of medium, how the product fits into the communication strategy and the line of other products and whether the product can be used strategically to solve other needs in the long term.

Podcasts — Type of audio product available *On Demand* on the web for convenient listening or viewing offline on an iPod or a similar device. Podcasts usually contain a smaller magazine-style theme oriented piece of mixed speak and music.

Popular book authors — Target group that uses *communication products* in a long-lasting and intense way. Since much consideration goes into the production of a book it is a privilege to have the products of an EPO office included in a book.

Poster — Exclusive presentations of impressive images or illustrations available with limited text. Often used to brand an organisation or to advertise events.

Postproduction — Stage of a project (most often film or video) during which footage or stills are edited and assembled and effects, graphics, titles and sound are added.

Postscript — Standard vector graphics format, abbreviated PS, file extension .ps or .eps. Has numerous sub-standards and can be difficult to transport across platforms and operating systems. Is very efficient for vector data, but ineffective for bitmap data.

Preprints — The first publication of a scientific paper is usually a preprint. This may even appear before the refereeing process has finished. Preprints are almost exclusively electronic today.

Preproduction — The *planning* phase of a project. This phase is usually completed prior to the production itself.

Press clippings — Clippings from *newspapers* or magazines where a given *communication product* is mentioned.

Press conferences — Meeting called by an *education and public outreach office* between *scientists* and *media*. Usually only held at the announcement of an important scientific result, or if there is a major institutional event, for instance if a Nobel price is awarded to an employee.

Press officer — Part of the staff in an *education and public outreach office*. Handles *media contacts*, press lists etc.

Press packs — Handed to journalists at events such as *press conferences*. A press pack typically contains a *press release*, *glossy prints*, background material and more.

Press releases — A press release is one of the main tools used by a *communication office* to promote scientific advances. One of the most important *products* as it is directed towards *media*.

Press release visibility scale — Scale describing the different levels of *communication* efforts that a *science communicator* may use to emphasise the importance of a scientific finding to try to convince the *media* to run the story.

Principle of a Thousand Ways — The principle that any communication product can be produced in a thousand different ways. No one will ever be able to prove which is the best suited for a given target group, or for the collective ensemble of target groups.

Production chain — Chain of events in a production flow. Each link of the chain (for instance the technical production or *distribution*) is a potential single point failure.

Production flow — Sequence of events in the *production chain* from product planning to evaluation.

Products — Means, vehicles, services or methods used by an organisation to *communicate* and interact with its *customers*. Can be *virtual* or *physical*.

Progressive video — Method for displaying video where each frame is shown in sequence. In contrast to *interlaced* video.

Promotion — The process of interacting with the media to encourage the use of a *product*. Often happens at a personal level.

Proof reader — Part of the staff in a communication office. Handles the nitty-gritty of correcting language, grammar. Can have an additional editorial role and work actively on the communication aspects of a product.

Public affairs office — See *education and public outreach office*

Public information officer (PIO) — Person who works in *an education and public outreach office*. Often only the science communicator and/or head are called PIOs.

Public observatory — Observatory, usually relatively small, open to the public. Guides operate the equipment and explain what the audience is looking at.

Public talks — Talks that are open to a wider audience. The level is low and often incorporates significant audiovisual content.

Public understanding of science — Very broad concept, usually adopted to describe the interface between science and the public in its widest sense.

Pulling — Action whereby the customer, or *end-user*, plays the active role in the distribution process and retrieves the product him – or herself. In contrast to *Pushing*.

Purchase — Acquisition of a *product*. Need not involve pecuniary exchange (especially not in science communication).

Pushing — In contrast to *pulling*. The action whereby the *distributor* (for instance the *EPO office*) of a product actively pushes it to the *receiver* (for instance the *end-user*).

Q

Quote — Verbatim citation from a person. For instance when an interviewee is cited ad verbatim.

R

Radio — The second of the large electronic media. Relies heavily on written material.

Ratings — Measurements of the number of *viewers*/listeners for a given *television* or *radio* station. Ratings are important in measuring the impact of a product.

Real world — In contrast to the *perfect world*.

Receiver — The recipient of information, for instance a communication message.

Region codes — Technical code that is added to a DVD to restrict its distribution to certain areas. Regions are designated a region code comprising a number between 0 and 8. Region codes enable distribution companies to acquire the rights for the distribution of a commercial DVD in a smaller area, so saving costs.

Render farm — Set of physically connected computers (for instance clients in a network) rendering the same job or jobs. Requires some server software to distribute a job's individual components (for instance frames) to the different clients, and to keep track of the progress of the work.

Rendering — The process of generating an image from a model, by means of a software program. In 3D modelling it is the process where the viewpoint of a virtual spectator (a camera) viewing a modelled scene with a certain texture under certain lighting is mathematically calculated with a certain quality.

Requests — Can be both *external* (from the public or the *media*) and *internal* (from your own institution).

Research — Preparatory work enabling a *science communicator* to communicate a new result.

Resolution See *image resolution*

Resonance — Another word for *impact* of, or success with, a given product. Usually implies "resonance with the press".

Rewrite — Result of working a text over thoroughly and writing large and essential fractions anew. The editing work that takes place when a text has been written often involves rewriting some — possibly substantial – parts of the text. This can significantly improve the quality of the text.

RGB — Abbreviation for red, green, blue; the colours used in displays and input devices that use the *additive colour model*.

S

Satellite uplink — Main distribution method for video material, especially for *Video News Releases,* sending the video signal to a satellite for distribution.

Science attentiveness — The willingness of a given individual to absorb scientific information. A science attentive person is sometimes defined as a person who expresses a high level of interest in science, feels well informed about science and reads newspapers or magazines frequently. Science attentive people are more interested in science than "interested people".

Science communication — Exchange of scientific information, often in a simplified, or popular, form.

Science communicator — Person who communicates science as his or her profession.

Science journalist —*Journalist* specialising in writing about science. In contrast to general *journalists*.

Science literacy — Having a certain understanding of scientific terms, principles and ideas.

Science magazines — Specialised trade magazine dealing exclusively with scientific topics. Often have very impressive visual presentation with high emphasis on images.

Science outreach — See *science communication*

Science popularisation — See *science communication*

Science PR office — See *education and public outreach office*

Science PR — *See science communication*

Science writing — Communication of science via the written word.

Scientific awareness – See *Public Understanding of Science*

Scientific marketing — See *science communication*

Scientific method — Method used by most scientists. Is often described as scheme of 7 steps:

1. Define the question.
2. Gather information.

An iterative loop consisting of:

3. Form a scientific hypothesis.
4. Devise an experiment to test the hypothesis.
5. Analyse the result.
6. Interpret the result and its implication for redefining the hypothesis.

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7. Publish the result.

Scientific papers — Scientists publish results achieved by applying the scientific method in scientific papers that are usually published in *peer reviewed* journals or in conference proceedings. The single most important communication tool for scientists in the *scientific process*.

Scientific process — The method by which science progresses. This process works in incremental advances rather than in great leaps of profound insight and through fumbling trial-and-error. The scientific process relies heavily on the *peer reviewing* system.

Scientist — Person who applies the *scientific method* to gain insight into the deeper underlying mechanisms of nature.

Sexiness — Trivialisation to add appeal for the *end-user* (usually the *general public*) to a given product.

Simplification — Necessary step taken in *science communication* to reduce the complexity and amount of information of a scientific result.

Single-stringed product — In contrast to *multi-stringed products*.

Slate — Text slide used in video production to convey factual information such as names, affiliations, clip information etc.

Sound bite — Self-consistent, short messages of approximately 10 seconds.

Spin — Public communication that only emphasises the positive side of an often politically sensitive topic.

Storyboard — Descriptive document for a video that outlines its content and flow. Contains narrative text, images that show the visual content, shot descriptions etc.

Subtractive colour model — Colour model in which colours are produced by combining various percentages of the subtractive primaries, cyan, magenta, and yellow.

Success metrics — Measurements quantifying the performance, or *impact*, of a given product.

Super-VHS — Also known as S-VHS a much improved version of *VHS*.

Supers — Graphics or text superposed on top of *footage*.

T

Target groups — The different sets of recipients of communication *products*.

Tax-payers — See *general public*

Teachers — See *educators*

Technical autonomy — The ability to make quick, independent decisions of a technical nature.

Technical brochures — Brochures directed towards the scientific and technical communities.

Technical production — Part of the production chain involving technical equipment: printing, production of graphical material, web etc.

Television — One of the most powerful *media*, giving quick access to news about world events, and allowing topics to be described very quickly on screen by means of animations, illustrative footage, sound bytes from experts etc. This medium serves or "*pushes*" information towards the (inactive) user.

Thumbnail — Term for a small *image*, for instance 100 pixels. A thumbnail loads very quickly, and gives a good overview of the visuals in a *product* or a production. Thumbnails are used in image archives, in *video editing* software, on the web etc.

TIFF — The standard *true-colour* (16 million colours) publication bitmap format. Is often *compressed* non-destructively with Lempel-Ziv-Welch (LZW) compression.

Timecode — Generally refers to the industry standard of SMTPE timecode that is formatted as four numbers separated by colons (e.g., 21:52:31:20). The numbers represent hours, minutes, seconds, and frames and are added to video to enable precise editing. There are two basic techniques used to record SMPTE timecode on videotape, longitudinal timecode (LTC) and vertical interval timecode (VITC).

Transmitter — The sender of information, for instance a communication message, to an observer (a *receiver*).

True-colour — Also called *24-bit colour*. The term is used for digital display systems that can display so many colours (16 million) that images look natural. Digital displays use the *RGB colour space* to display colour and each of the three components R, G and B have 8-bits of colour information (256 colours). 256 x 256 x 256 gives 16 million.

TV — See *television*

V

Validation — Procedure whereby the scientific and political correctness of a product are investigated by experts and it is approved for publication.

Vector graphics — One of two general groups of "image" formats. Uses simple and short coordinate and vector descriptions to characterise geometric shapes like lines, circles, letters etc. This format is less suited for pixel-based artwork. In contrast to *bitmaps*.

VHS — Abbreviation for Video Home System. A consumer video system that was very popular in the 1980s and 1990s.

Video editing — Selecting and arranging of video clips. Usually performed on a nonlinear video editing system.

Video News Release (VNR) — *Press release* in video form designed for use on broadcast television — as a news item or feature story. A VNR translates the printed word into the sound and pictures television newsrooms need. A Video News Release usually consists of an *A-roll* and a *B-roll*.

Viewers — The *target group* for *television*. The *impact* of television is counted in terms of the number of viewers as estimated by television *ratings*.

Virtual services — In contrast to physical services.

Virtual studio — A virtual, computer-generated indoor or outdoor setting where the main element, typically the anchor person, is placed. This setting is often of an exotic nature that would be difficult to construct physically in a studio.

Visual communication — Communication via images, illustrations and video. A very important part of science communication.

VNR — See *Video News Release*

Vodcasts — Analogous to a *podcast* but with visual (video) content.

Voice-over — Narration added over other material (for instance video footage).

W

Web news sites — Most of the large printed and electronic media supplement their main activities with news websites. Examples are CNN online and BBCi. These sites can react almost instantly to news events and are therefore "checked" briefly by many "normal people" who crave instant access to news. The importance of this medium will grow in the coming years.

Web statistics — Statistics that describe the use (and thereby popularity) of a website. Is usually measured in quantities such as hits, users and download volume.

Webpages — Combinations of text, images, video and other audiovisual elements made accessible via the Internet. Webpages are viewed with a web browser.

Weekly magazines — Colourful magazines with long lead time (weeks or even months). Examples are Newsweek, Time, Stern etc. They usually have a large circulation.

Wire services — Outlets and distribution partners for news stories. The largest wire services are AP (Associated Press, American), UPI (United Press International, American), AFP (Agence France-Presse, French), and Reuters (British). They can have a very large influence on the impact of a story.

Writing — The production of *written communication*.

Written communication — Textual communication. The backbone of most *communication products*.

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