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SCIENCE COMMUNICATION TO THE MEDIA

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Preface

This booklet is the reader for the lectures Alun Lewis, of Royal Holloway University of London has carried out in Ispra during seven consecutive years in a course organised by the Joint Research Centre called “Science Communication for Public Engagement” (2006-2013).
The skills learnt through these lectures can help with, not only popularisation of science activities, but also with many other forms of interaction between the scientific researcher and other spheres of operation where science is a relevant input. Including ethical discussions about science and technology developments, policy making involving science and technology, and in other non-specialist public engagement in science and technology settings. The ultimate aim of these exercises is to improve empowerment and agency of our society.

Enjoy reading.
Enjoy practicing.

Ângela Guimarães Pereira

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"Scientific matters need to be explained and understood. Our curiosity and appetite for knowledge are even keener when you consider that our present and future are in the hands of scientific laboratories." *Kathleen Van Damme, the founder of AthenaWeb explaining why EU funding cuts forced her to close the organisation[1] in July 2011.*

"It is recognised that specialist scientists and technologists cannot operate without a knowledgeable supporting society." *Wynne Harlen writing about equal opportunities in a scientifically literate society. 1992*

1 "**AthenaWeb** was a unique service for all those who produced films of a scientific nature in Europe. For users, journalists, producers, documentary makers, scientific explainers, students and science fans it was a reference site with reliable information and documentaries, providing precise facts on all aspects of European research."

It is part of a scientist's duty "to make available to the lay public the facts and theories of their science." *Julian Huxley "Essays in popular science". 1937*

Do scientific matters really need to be explained?

Yes they do. For a variety of reasons. Many think that it is your duty to explain to tax payers why you are investigating, measuring or trying to understand something. Why are you doing this and how might it help society? Society today in most of the world depends heavily on science

and that dependence will only increase. Some of it is good science and some is debatable. It is vital that that public debate should be "well informed" - and we all know how we construct meanings out of scientific jargon* used to describe many aspects of life. And most scientists seem to be keen to communicate[2].

But you[3], a scientist, have several major problems to overcome. The language you use, the words you use and the way you

* A common statement is " I am not going to eat that - it is full of chemicals!" It drew this concise and thought provoking response from an eminent chemist "No chemicals - no universe!" However, it is obvious that the meaning attributed to the word "chemicals" is not contained in the simplistic version of its scientific definition, but it contains more complex meanings. These encompass ideas of manufactured substances, toxic substances and substances that we do not like to be fed with.

[2] 91% of German scientists agree that there is an "obligation" to communicate to the public. (Kruger and Peters, 1985) Most American scientists thought that "educating the public" was the reason they agreed to be interviewed in the mass media. (DiBella et al, 1991)

[3] I will refer to the reader as "you" throughout this booklet. I want you to feel that this is a dialogue, not the absolute answer to managing the media.

order your ideas when trying to communicate them. And many of you have real trouble knowing what an average person does and does NOT know, is or is NOT concerned, is or is NOT interested in. Oh yes and there is your unwillingness to tell “stories”. This is perhaps the biggest hurdle most scientists have to overcome. I am sure you think that a “story” seems somehow to be something inexact, something fictional, a fairy story for children or something like that. Just for a moment think about something outside your field, history for example. Now very “interesting” history is in fact just a well-told story BUT (and this is important) it is easy to read but very accurate. We all enjoy reading a well written and accurate article in a newspaper, magazine or on a web site. And the writer will always refer to it as a “story”. So by asking you to learn to tell a story I mean simply that you need to try to think of the most interesting and easy to understand way to convey your ideas to others - not just the most complete and scientific way. The great physicist and science

communicator Richard Feynman, based his success on “explaining things not just naming them.”

I hope that by the end of the booklet you will agree that you can use plain clear language in an everyday way of speaking to engage your audience by learning the art of story telling and applying it to your message. It is not that easy at first so you will have to practice.

I will give you a *formula* (well sort of …) and some mysterious sounding acronyms that will help you when discussing communication problems. There is a list or two and some dos and don’ts. Ideas, and things to think about… By the end of this booklet, if you have absorbed some of the messages you will have a new set of skills. These skills, used by all good communicators are extremely transferrable. You will be a better manager, research group motivator, fund raiser, conference speaker, or teacher. Oh yes and those skills will help you get a job that you really want - or you

might just become a famous TV personality and professional science communicator!

But first try to understand the difficulties that I say that most of you have.

Language: The language of science is not exact and clear despite what you have been told. You have been trained to use special terms and expressions as they are said to be “unambiguous”. Nothing is further from the truth. Of course there is an important difference between atom, element, molecule, material and so on. But depending on the context it might be best to just refer to a “material”. But more of a problem is that the same word can mean very different things to different scientists. Worse, many of these words mean absolutely nothing to a non-scientist even though they may have heard them. What is a *cation*? What on the other hand is a cathode? A proton, a protein, a petal or a sepal… black hole, dark matter, is it mass or weight, a bit, a byte, a quark, an olivine, DNA or a gene. And talking of genes - does “gene expression” mean that a

chemical is produced or, perhaps it means that your trousers have ideas of their own and want to tell the world about them. Not good! Keep a bit of paper on the desk and jot down words that YOU use daily and yet you think that people outside your field of research would not understand. Try to think of an accurate, but easier-to-understand word for each one. Try out the list on a non-scientific friend. You will be surprised. Show them a paper in your specialist journal and ask them to underline the words they understand - you will be even more shocked. Try also to read a paper on a field you are not familiar with and do the same exercise. But this is the measure of the problem.

Try the test on the side to see what I mean*. This all may sound silly… but it is not when you consider your words from the point of view of your audience. The listener or viewer is the single most important

* Think of the first thing that comes into your mind when you read the word “cell”.
STOP. DO NOT READ ON. What was the first image? Now read on: Was it a biological cell? A room in a prison? Something to do with your mobile/portable/handy or cell phone? If you have been working on MS Excel recently where did you add the data? A cartoon book has drawings in cells. If however I had spoken the word it could have been “sell” - to ask for money. And if you are French you might think of salt!
Now try “jet”. A stream of water? An engine? Or a pretty black mineral used in jewelry.
A “vector” means one thing to a physicist (something that has magnitude and direction) while a biologist would say that the vector of malaria is a mosquito and for rabies it is a warm-blooded animal such as a dog, meerkat or even certain parrots.
These are examples in English – try to find similar words in your own language

person[4] to consider. → When working with broadcast media or print that is someone you will never see or meet. It is easy for you to sound knowledgeable and clever by using long and complicated words. But at all times remember that you are not trying to impress your colleagues with your vocabulary, you are trying to make ordinary non-scientists understand what you are talking about. What have you discovered? In fact it is more impressive if you can think of a simple way to describe your idea or findings than just repeating what you wrote in a science paper or for a journal. And once again remember that good science communicators are often also very successful at getting grants or funding for their work.

[4] Always think about one imaginary person as "The Audience" (viewer. listener, reader, browser, student etc.,) you cannot imagine a large group of people. For the BBC World Service, with an audience of 120 million, presenters such as me always spoke to one person - for me it was either my mother, or the highly intelligent Zulu clerk I once worked with on a building site in Africa. We had great conversations as he wanted to learn to speak English better and to improve his knowledge of the world - while I wanted to learn about his life and traditions. He was easy to conjure up and I could "see" his reactions as I tried to explain scientific ideas on the radio.

This of course does not mean that you cannot use the actual scientific expressions; the message is that all “jargon” must be explained in your communication.

It is vital to talk to non scientists with **real world examples** - do not talk in abstract ways.

“Satellite images taken from NASA’s MODIS Aqua Sensor can measure parameters such as horizontal changes of surface chlorophyll content which gives vital clues about feeding habitats.”

Great, perhaps you know or can work out what that means. It is scientifically accurate of course - but what does that sentence mean to a non expert? **Nothing**. However, if we re-word it this way:

“We can even see from space where fish such as the endangered blue-fin tuna are eating in the Mediterranean sea!”

It is now easy to understand and says the same thing. So, before trying to communicate try to think how to explain your work in terms and ideas that **everyone** can understand. A very powerful tool to use is that of "**analogies**". That is, explain something that is obviously complicated by using a well understood effect or phenomenon, and then say that the complex concept is like this. Perhaps when you first learned physics at school you were told that in some ways electricity is like "water". That is a good way to understand such complex ideas as electrical resistance and voltage. This is a simple analogy.

Think hard about the language and ideas that you use but be careful of numbers, graphs and statistics.

Numbers. Keep these to minimum and keep them simple. Ask yourself "Is it important that 69% of the bees have a disease?" Or should that be two thirds or nearly three quarters? As my father (a very popular engineering lecturer) used to say "0.5 is approximately a half." Do not use powers such

as 10^{-12} or 10^{0}. “An order of magnitude” is ten times bigger or smaller - so say that. Tera, giga and so on are not usually well understood. Angstrom and pica mean little to the person who does not deal in these numbers daily. [Do not do what this scientist did*]. “As thick as a human hair”, “the size of a credit card”, “as heavy as a small saloon car or a brick”. These mean

* I once interviewed an astrophysicist about his latest findings on the energy of particles emitted by supernovae. He had published a paper in “Nature”. He referred to finding particles with “energies of 10^{12} eV” (pronounced eevee and not even referred to as electron volts) and he continued by saying “and to give you some idea that is one GeV.” He could not find a simple way to explain. He thought everyone listening would be used to electron volts, whatever they may be. He could not imagine that almost everyone listening would have no idea what he was talking about. We could not use the interview on the BBC. We were desperate and getting close to a deadline so I turned to a well-known astronomer who was also a fine science communicator and asked him to explain the science. He said “we have seen what we call energies of 10^{20th} electron volts and to give you some idea that is the same energy as a tennis ball traveling at 60 miles per hour (100 kph)”.

something to most people. For fun I suggest that you look up this web site[5] - though whether you choose to use any of the ideas is your choice.

Graphs. NO! Though there are exceptions. But most importantly never talk about graphs on radio. “Normal distributions” etc., mean nothing to people. Be careful about giving a graph to a journalist. Just make sure they really understand the importance of it and which bits are most important. If necessary help them to redraw it to make sure it is correct.

Statistics. Be very careful here. Statistics as we all know can be produced to prove whatever you want to prove.

These are some general guidelines and more examples will emerge as this conversation progresses. So now you have a few “do nots” how about something more positive? And very different.

5 www.weirdconverter.com

First a little exercise. This concerns your ideas about what is a medium and how the different media are relevant to communicating science.

So far I have mentioned in the text, four distinct media. That is a good start as it forms the basis of the answer. If you can't be bothered to find them, they are: **television, radio, newspapers (including magazines) and the Internet**. This could be extended to become six quite easily.

Let me explain. In English, newspapers are called "Print" - which is strictly short for "newsprint". This includes daily or weekly newspapers, magazines that publish once a week, once a month or even less frequently. And it includes annual publications[6]. A book, however, is "publishing". It has an intended long "shelf-life[7]". But what sort of book

[6] "The Guinness Book of Records" is a very good example.

[7] Literally this means that you will buy a book and when you have read it you will put it on a shelf with the intention of re-reading it, or referring to it in the future. It has a long "shelf-life". But this is variable. For example a book on designing web sites will become less relevant when the technology changes - though the main principles might be true. Readers will hope that the information remains up to date. With a magazine

are we talking about? Science reference book for schools or universities? A popular science book or even science fiction? The first category is only of limited interest to us (but of course textbooks should be interesting to read - and that is a major challenge to the writer). Good popular science books are a very important tool in communicating.

So now the list reads "**print, publishing, radio, television and the Internet**. Look hard at the **w.w.w.** and you will see that much of it is a copy of print, publishing, radio and television, but it is available in a different way with extra features. However, within the web there are **podcasts**, and these are a distinct medium. **They are not radio though they should use the same production values if they are to be any good.** They are a separate medium and a very new one that is still not always being used to the best effect. So, that makes your starting list up to six.

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however you may well do the same thing, but we know that the information is correct "now" and may not be in the future.

Keep this exercise running to the end of the booklet without looking up the “answers”. Just keep another scrap of paper and note them as I mention them or when you think of them. A good list would be about 20 to 30. You may think of things that I have not included and you will probably disagree with some of the ideas that I have.

So now it is time to learn some of the very few basic tools of communication.

The 5 Ws

In journalism we use the **5Ws** to work out how to start a story. It is our mantra. In English they are **Who? What? Why? Where? and When?** So any news story should start with a short and clear explanation of "Who did what and why did they do it then, and where did it happen"? In some ways this is like an abstract at the start of a science paper but there are some huge differences. Take this real example from a science journal:

A Melanocortin 1 Receptor Allele Suggests Varying Pigmentation Among Neaderthals.

Carles Lalueza-Fox of Univeristy of Barcelona and Holger Rompler University of Leipzig. + 15 other researchers

Abstract: The melanocortin 1 receptor (MCR1) regulates pigmentation in humans and other vertebrates. Variants of MCR1 with reduced function are associated with pale skin colour and red hair in humans primarily of European origin. We amplified and sequenced a fragment of the MCR1 gene (mcr1r) from two Neanderthal remains. (...) The impaired activity of this variant suggests that Neanderthals varied in pigmentation levels potentially to the scale observed in modern humans.

A little exercise: BEFORE you read how a journalist summarised this for a newspaper, try this exercise. Ask yourself "Who? What? Why? Where? and When?" If the information is irrelevant leave it out. (HINT: where and when matter less than the other two. Why is obvious and can be left out.) Now underline or highlight only the words that are important to help a non-scientist immediately understand what has been found out .

Now read on.

The News report:

"Some Neanderthals were probably red-heads according to a DNA study. Writing in the journal Science a team of researchers extracted DNA from the bones of Neanderthals and fond out that these short physically powerful hunters were as likely to be fiery headed as modern humans."

(N.B. The report goes on to add more and more detail)

So here is the analysis:

Who? = a team of researchers

What? = discovered that Neanderthals could have had red hair (and were so sure of this that they published a paper and had that peer reviewed and so on.)

Why? = because these researchers study ancient remains through studying DNA. This leads to many new insights into evolution. And it has a potential impact on medicine. It is also what tax payers pay them to do. We do not have to say at the start of the story as it is of lower interest to most readers.

Where? = at universities all over Europe. Again this is not interesting to start with. (Of course this information might help a reporter in Leipzig or Barcelona to make the story more exciting to the local readers. “A scientist at our University has discovered that ….”)

When? = a few months ago as the paper has just been published.

So, in this example only Who and What are important and you can see which order they appear in. And it is important to note that this story was published and broadcast in many countries around Europe and the rest of the world. Now look back at the abstract and the news report and see how much they differ. So when talking to the broadcast media (print, radio, TV and web) be aware of how they will try to tell the story to their audience in the most attractive way. They need to grab the attention of the audience immediately.

That is why all journalists use the 5Ws.

[

The 5 Ws in some other European languages, French, German, Italian, Icelandic and Portuguese. There may be better words to help memorise the list and to make it more of a chant.

Qui	War	Chi	Hver	Quem
Quoi	Was	Come	Hvad	O quê
Comment (pourQuoi)	Wann	Perché	Hversvengna	Porquê
Oú	Wo	Dove	Hvar	Onde
Quand	Warum	Quando	Hvenær	Quando

]

But you can use them too, in two ways. As I have just stated, you can anticipate what a journalist is looking for. You can also use the concept in a much more interesting way before you ever talk to a journalist[8]. And we can (in English) have one more W. This, I

*As a film maker and the science communications expert at my university I was often asked to help "Make a DVD about our work/department to promote us." (Note not a web site or a brochure) I would sit down with the Head of Department and others and work through the Lewis Equation. Only once was "DVD" the best answer. (We made a 5 minute film about nano-technology research in the Physics department). The enthusiastic scientists thought that anyone would watch a free DVD which had cost us thousands of Euros to make. But why would they? The money was far better spent on other forms of direct communication

[8] Although we call all the people who create stories for the media "journalists" today, this is not strictly correct. A journalist is someone who writes about things with an opinion (which is obvious from the way they write and where and how their work is presented). Most so called "journalists" are reporters who should be trying to tell the reader/viewer/listener what has happened, in a balanced report. In past times a reporter hoped to become one of the few famous and respected journalists - now they are all journalists as soon as they join the media.

like to call “Lewis’ Equation*”:

Who
What
Why = hoW
Where
When

You would use this simple set of questions to work out “What is the best way to tell people about my ideas or new findings?” And note that the example from my own experiences shows that sometimes the answer might be not to communicate that idea at all. In which case you can work out what you should be talking about.

Who? Perhaps the most critical and most forgotten question. Who needs to know? Who would like to know - in other words who is your **TA - Target Audience**. Is it one policy decision maker in the government? Is it a group of scientists in your field? Is it school children? Is it a selected part of the

public? Is it everyone in your country or in the whole of Europe? Is it potentially everyone in the world?

For example why use the BBC World Service with its global audience when you only want the ruling party in your country to change its policy? You have to think very hard and deep to identify your real TA. But it is vital. After all it will determine the way in which you tell your story and the language you use.

What? Quite simply what are you trying to say? Determine the one message you want your TA to understand and remember after you have stopped speaking or when the article ends. We call this the **THM - Take Home Message**. And it is just that. Identifying and clarifying your single most important message will ensure that you have a reason to speak to the media - or directly to your audience. (Note: ONE message, not a lot of messages)

A hypothetical example and an exercise:

A team of scientists including professors and post doctoral researchers from several different universities and commercial organisations have been funded by the government and their commercial partners to develop a GM plant to use as a replacement for petrol used in cars. After many years of working in laboratories equipped with the latest tools and some new inventions, they have developed the new crop. The research team leader has calculated that within one year of planting 100,000 hectares it could provide a fully sustainable source of fuel for all the cars in Europe. They now need to communicate their findings.

Let us fill in some answers to the Lewis Equation "Who?" and "What?" based on this example.

If the TA = Government policy makers

Then your THM is: “Your investment has paid off and you now have to persuade users to use the new fuel and you have to work with the oil companies who will not like this development.”

Try this TA = Commercial and financial sector executives

Now the THM has changed: “Hey you lot! There is a new industry developing very fast. The initial investment has been made but now it will need a lot of financial backing. But the potential returns are huge. Get on board now”. (Or you might want to warn the oil industry that they have a potential profit problem if they do not invest in the new technology.)

More examples

1: TA = Environmental organisations and political parties

THM = Here is what you have been waiting for and it works.

2: TA = The public in one specific European country or region

THM = We have a poor agricultural system but we could grow this crop and make lots of money if we get going now.

3: TA = The public in Europe

THM = This new GM crop will work to solve greenhouse emissions and although it is genetically modified it is safe.

Now try to devise some THMs for TAs such as farmers, school children, Governments from other countries, carmakers, construction companies and any others you can think of. You will see how much the THM changes according to the TA even though the bare outlines of the story are the same.

Why? The second most forgotten question - because most people think they know why they are doing something even if they do not. You need to publish your research to remain in your field of science and at your institution. But why should you look for a wider audience for your findings and new ideas? Some answers are: “to promote myself”, “to promote my laboratory/my team”, “to advertise how good my university is”, “to attract scientists into this new field”, “to attract young students to take up science - especially your one”, “to give the public information they need in order to debate new issues in an intelligent way”, “because it is interesting”, “because people need to know how science really works”. And so on.

If you do not know why you are doing something it is nearly impossible to know how to do it well to achieve the best and most productive result from your all your hard work.

Where? Where will my TA hear, see or experience my THM? The best place may well be in their homes when they are relaxed and most able to concentrate on the ideas. At a place of work a TA might be able to concentrate even better (no young family that wants to watch a different programme on the television). Should you go to a school and try to tell them about the equipment you use, the way you work and how exciting it is. You could show the students a video or a slide show or a very good data projector show. But it might be much better to take an interested group to your laboratory and let them ask the questions that occur to them. If you are going to talk and make things happen in a demonstration you might chose a lecture theatre with a stage. This is where this sort of thing is usually done so you will follow tradition. A better venue could be a small room where the audience can get close to the action. If you are mounting a poster campaign where would you put the posters to reach the largest number of your TA (not just the largest number of people)?

When? This might be simply now or as soon as possible. But it might be better to time the delivery of your THM with another event. Obviously a very good time to talk about evolution and Darwin's ideas was during an anniversary: His birth, death, the voyage of the Beagle or publication of his book. Now turn things on their head. Let us suppose that you want to inspire young people to enter a science career. Your THM is "there is science in everything and the more you know about how and why things work the more beautiful the world is". (Richard Feynman thought this way) Now think of a "when?" and create a science lecture/book/print article/television programme to make the most of it.

Try these examples. "The Science of Christmas/Halloween/St Valentine's Day." "The Perseid meteor shower in mid August." "The Olympic Games (both winter and summer)". "The Tour de France cycle race". The anniversary of the Oosterscheldt Barrage in the Netherlands. At the end of the booklet I have listed a few ideas suggested by these "Whens?".

Once you have a clear idea of your: TA, a THM, why you want to tell a story, where would be best to do it, and when is the best time, it will be much easier to decide hoW you should deliver your message with maximum impact and effect.

hoW? Your first thought might be to get a television company to make a documentary about your work. In fact this may not be the best way - only the one that sounds the most exciting. (Though in fact, as you might have found out, making television documentaries is generally not exciting at all). If you want to get young school children to consider science as an interesting career - then perhaps it would be far more effective to create a series of eye catching posters - "a campaign". Where? then would be "in the school corridors". (NOT in the corridors of the physics laboratory in a university. That is where I once found a set of such posters!) Lectures and demonstrations could be in the schools or perhaps on a river bank, up a

mountain, at a car racing track or in a gymnasium. Get this one right as “The wrong “hoW?” is a total waste of effort and hence money*.

So far I have considered in general terms the basis of what and why you are trying to communicate and to which audience. Once you have decided on this it is now down to you to work out how to tell your story.

*For example consider these options: Open Day, a lecture, a YouTube film, a television/radio documentary. A lecture involves maybe one or two people and a lot of hard work - but once created it can go to place after place and be effective for little extra work or cost. An Open Day is far more expensive and complex to arrange but has the advantage of being far more interesting and appealing to a wider audience if you get it right. A YouTube film is OK but appeals to a much more limited audience - I know that huge numbers can watch or hit the film but how many of these are your TA. And to make a good film by yourself is very hard to do. You need experience to make it interesting to watch. However if you can interest a TV production company or channel in your idea they do the hard work and you get the exposure - but again how much of your TA will see and understand your THM?

Story Telling - the basics

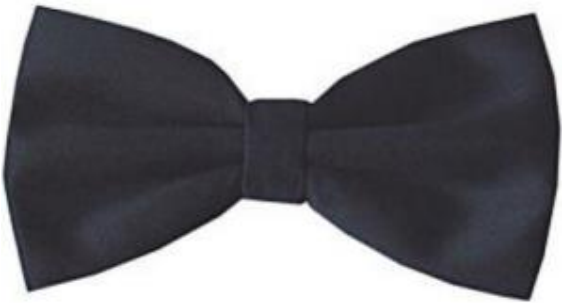
For our purposes a story is much the same as a presentation, or a good lecture. You may well have been told that a good communicator always follows this rule when devising and writing a script for a presentation. The three sections are:

- Tell the target audience what you are going to tell them right at the start
- Tell the target audience in sufficient detail what you want to tell them
- Tell the target audience what you have told them in the conclusion[9]

In this way you should get your message over. This is what you do for an audience who has paid to attend a conference and has come to listen to your talk. So if you are trying to attract a general non-scientific audience you will have to work very hard to make them listen. Another way of writing this is the conventional:

Start (introduction) Middle End (Conclusion)

[9] This is usually shortened to "Tell them what you are going to tell them. Tell them. Tell them what you have just told them.



The “bow-tie” model is the same thing – a big interesting wing to draw attention, then the complicated and dense information in the middle - followed by another big wing on the right to draw attention (this is the conclusion and should always be memorable.)

These are the conventional models BUT I find them very lacking. You may well have been told this in basic communication skill lectures. But there is a much better model. By expanding the ideas a bit we have something that is much more useful and by the way easier to understand. The construction of any argument, drama, well-told story, or even presentation is the one used by Hollywood scriptwriters through to authors of popular fiction and popular science communication. Ancient Greek play writers followed the template. Here it is…

INTRO

HOOK

EXPLAIN

TENSION

DEVELOP

CONCLUDE

It works for anything. You grab the TA's attention immediately in the introduction (Intro) and then create a hook to make them want to hear more of the story*. This Hook is vital and takes a bit of thinking about.

Then you have to **Explain** some things to the TA. We are just concerned here with a non- science audience but it also works very well for an audience of scientists from different disciplines at a conference or workshop. So think about that audience.

*A word of warning. Just because you have spent years studying something which is important does not mean that your audience will immediately understand why your research was necessary. Unless it is very obvious you will need to think of a few words which will give the TA the reason behind your work. A lot of people think that most things have been "discovered" and are well understood. An example: In 1993 Suji Nakamura published a paper titled "InGaN blue-light-emitting diodes". Few people outside the communications and electronics industry automatically understood that this invention would lead directly to the creation Blu-Ray discs. It was the start of a revolution in media and data storage

What do they know? Do not tell them what they already know. DO NOT tell them everything you know about the subject but BE PREPARED to answer all questions you know how to answer, including reference material which will allow the audience to explore the issues further, as well as acknowledge your lack of knowledge whenever this is appropriate. Think carefully about what the audience must know in order to understand your story. Be very careful here as the average audience will only listen to and remember about two or three points of explanation. This is a vital part of the story-telling process. Think of how good writers of fiction grab your attention with the opening words and then quickly "set the scene". In other words they start to make the story easy to understand by filling in the details that explain what you have just read. Go and look at the first few pages of a favourite book and see how it is done.

So, after we have done the minimum of explaining we now need to turn the attention of the TA back to the main story - this is called **Tension** in the model above. In drama writing you often plan to keep surprising the audience in subtle ways with a moment of tension on a regular basis. In the Hollywood formula the filmmakers plan to have something exciting, challenging or surprising happening every 2-3 minutes. This keeps the audience watching and hooked to the tale*.

*Go and watch a good film or documentaryand see how it is done. Analyse what the director/writer is doing rather than just immersing yourself in the plot. Try it on a favourite film first.

For your purposes you will have to work out a new way to re-introduce the main point of your story. Go back to your attention grabbing first sentences. Re-read them. Think about a different way of stating the THM. A simple way to do it is to ask a question. Sum up the two points of explanation in a few words - one sentence! “So given that A is true and B happens how can my findings

save the planet?" Something like that if you have promised the audience in your first words that you have discovered a way to save the human race! Obviously you will have to alter the idea to fit your presentation. So now that we have the audience gripped with our story, and we have given them some vital background detail, as well as bringing them back to thinking about our story with the Tension, it is time to **Develop** the argument. Using the facts given to the TA in the Explanation and what they already know, how does your work affect them or make their life better? And once we have fully developed the story fully we have the **Conclusion**. This is vital. The last words they read or hear will be what the audience will remember. Make sure that this is the THM. (This is why we call it the Take-Home-Message as it is literally the message that they will take home - after a lecture for instance). This must be clear and easy to understand and should be worded in a way that relates to the opening sentence and yet is different.

A simple example: You have done some important work that proves that if each individual in your country turned off one just unwanted electrical device that would save a certain amount of global carbon emissions. You might start by saying that each TV on standby is drawing electricity all the time - equivalent to so many light bulbs. And producing that electricity emits so much carbon. Explain, first of all, why a TV or any other electrical device on standby draws so much electricity. Then tell the audience that there are carbon emissions from creating that electricity. Your tension might be - "can you really make a difference by altering your habits and just switching things off". Develop the argument a bit more with more examples and how a lower demand will allow generators to run differently. You might add that alternative power sources still require carbon emitting energy to make them and keep them running. Reducing demand is the only solution. Now for the **Conclusion**. At the end you should answer any question posed (the Tension) by saying finally "So now - at home or in the office - turn off something that really does not need to

be on - and start to help improve/save our planet!" Then stop. Leave them with the thought. Do not say things such as "thank you for listening." They should be thanking you for telling them things they did not know! What you can do is ask for questions if it is a public event.

Now that you have the outline of how to structure your story to make accessible and interesting we need to concentrate again on that first and most difficult part - the INTRO.

The INTRO

How long have you got (in minutes or seconds) to attract your audience's attention and make them want to hear the whole story? Take a guess and read on.

There have been several relevant studies - one relates to people trying to cross a busy road and the other is the challenge facing a sales person. It

seems that when people try to cross a road they will decide that a busy road is “too busy” after quite a short time. They will then start to look for another way to cross - traffic lights or a bridge.

And when you enter a shop where there is a choice of assistants each will have a short time to form a bond with you to make you buy from them. In both cases the time span is just seven seconds! **7!** It seems we – humans being in general - start to get bored after 7-10 seconds. So if your audience might start to loose interest and decide not to listen to you after such a short time you had better make your first sentence or two (the INTRO) very good. Don’t start with the least important fact and work your way through the story in order - tell the TA something exciting, interesting, unusual, or funny, straight away. Think of a newspaper to see how this works. How much can you or anyone read in 7-10 seconds? About 60 words. Two short sentences. Now if you look at a newspaper you will generally see that there are about 40-50 words in the first

paragraph. **These will be enough to convey the answers to the 5 Ws.** Listen to or watch a news report on radio or television. Count the seconds to the end of the introduction of a new item. If professional and expert journalists are doing this to capture an audience - then so must you. Writers of great books do it. And some of the most memorable opens of books are even shorter,

"It was a bright cold day in April, and the clocks were striking thirteen". *George Orwell, "1984"*

"I am an invisible man". *Ralph Ellison, "Invisible Man"*

"Someone must have slandered Josef K., for one morning, without having done anything truly wrong, he was arrested". *Franz Kafka, "The Trial"*

"Many years later, as he faced the firing squad, Colonel Aureliano Buendía was to remember that distant afternoon when his father took him to discover ice." *Gabriel García Márquez, "One Hundred Years of Solitude"*

"Mama died today. Or yesterday maybe, I don't know." *Albert Camus, "The Stranger"*

None of these opening sentences spoiled the reader's enjoyment of these great stories. But some of them give almost everything away… But not quite. This is the art of the HOOK. For example Marquez tells us the end - probably - as Buendia is facing a firing squad. How did he get there and what is the ice about? Oh yes and does he get shot? This will keep you reading for a bit. Equally Kafka tells us that Joseph K is arrested, but not that this will necessarily lead to a trial - but the title of the book suggests it will. The **HOOK** is the idea that he had not "done anything truly wrong."

But, what about your more factual attempts to communicate ideas and findings to a wide audience? Well you should try to adapt the ideas used by good communicators and make them work for you. Your challenge

however is that over years you have been trained how to write what your fellow scientists regard as a good science paper. And it is almost exactly the opposite of what is needed for clear general communication through the media.

The **title** will be full of keywords and for most of you will be the thing that you do last - and a chore. It has as few words as possible - so the temptation is to use jargon. This means using one technical word to replace a few simpler words. The title will often have been sent backwards and forwards between a lot of scientists who all appear in the **List of Authors**. Then we have the **Abstract**[10], which is often also written by a group of the researchers. As this is often seen as an extension of the title so the same criticisms apply. Then the introduction which usually

[10] The best and funniest words written on the failure of the Abstract are by Kenneth K Landes in "BULLETIN OF THE AMERICAN ASSOCIATION O F PETROLEUM GEOLOGISTS" VOL. SO. NO. 9 SEPTEMBER,1966). It is called "GEOLOGICAL NOTES - A SCRUTINY OF THE ABSTRACT," Do not worry that it is by a geologist - you will all understand it.

leads straight in the **Methods** section; the **Results** will follow and lead to the **Discussion** and then there are the **Acknowledgements, References** and **Appendices**.

For our sort of communication the THM will most likely be in the Results or the Discussion. So, this is all we need to concentrate on. But your background and training will tend to make you want to mention all the other stuff first. DO NOT. Resist the temptation*!

For your story you can get rid of the list of authors unless one of them is especially important to the outside world (this is very unlikely). The abstract, on the other hand, if it is really well written, is what your whole story should be - as long as it includes a clear statement of the conclusion.

* Many of my academic science colleagues admit that when writing a paper they usually do the results first - it is the most recent thing they have done, it is fresh in their minds and it is very important and often exciting. Then they do the discussion which is interesting. Then the other bits, all of which are essential for a published paper, are seen as a chore. Does this sound about right?

The Method might be very tedious and complex. But there are striking examples of when your techniques can be interesting. If you convey this to the journalist who is interviewing you they can make that decision. If you are using some other form of media and you are preparing the story yourself you will have to make the decision yourself. Remember, it might be an everyday occurrence for you to dive into an underwater cave, attach a radio tracker to a fish or a rat, or maybe you fly in an airplane through storm clouds, or develop drones, manipulate genes or create lightning in a laboratory. Or even trap individual atoms in a magnetic field and move them around. But this is not the everyday experience of your audience, so remember to tell them about it. If it is not interesting or exciting leave it out.

Next, the results: if you try to mention them all you most likely will overwhelm the non specialist audience so only pick out the most important if it really conveys some sense of what you have discovered (for

example “we studied thousands of patient records and we found that if you really do eat an apple every day you will live 5 years longer than someone who does not eat fruit”). Only put a result in the opening sentence if it is that good.

The discussion in a science paper can be quite tedious as well as being very qualified (that is when you include words and phrases such as “probably” “indicate” “infer” “with some degree of certainty”). Ask yourself what is the conclusion? **In one sentence.** Most likely this will be at the end of your science paper Discussion - but should be at the start of your science communication - AND at the end.

OK that is an outline of how to create a winning structure. The more often you practice doing this, the more natural it will become. Remember one method for the journal and a completely different one for the public.

Now consider another challenge that you have. It is using, what is called in grammar, the “passive voice”[11]. In everyday speaking we usually use the “active voice” but many journal editors still insist on the “passive voice” in scientific writing as it is supposed to “achieve an objective tone". But for the reader which is clearer? “The human genome was sequenced.” or “We sequenced the human genome.”? In the first case it is impersonal but why does that make it clearer. Who did the sequencing, or did it just happen? “Several conclusions can be drawn when the results are analysed”. This could be better put as “The results led us to several conclusions”. But there are times when the passive is far better. “1000 tonnes of polluting chemicals were found in the reservoir” starts with a strong idea - “1000 tonnes” is a lot! Also note in this short sentence that we are saying that we do not know who did it. Of course if we do know then we can make it more powerful by naming the guilty party all in one

[11] Identifying the passive voice. The active voice is “Someone does something.” The passive “Something happens”. In grammar it is more technical than this but that is the general idea.

go. So we have “1000 tonnes of polluting chemicals have been dumped by Corporation X in the reservoir”. Or “1000 tonnes of polluting chemicals have been dumped in the reservoir by Corporation X”. But do not be tempted to word it like this: “Investigations involving the sampling and detailed laboratory chemical analysis have revealed that 1002.4 tonnes of DDT and Polychlorinated biphenyl combined have been released into the reservoir. Tracer agents imply that the pollutants were released either accidentally or deliberately by Corporation X.” By the end of that I was asleep - were you?

Once again this is all about deciding what is the THM… and then delivering it in the most powerful way. Obviously you may well not be a native speaker of the language in which you are supposed to communicate and you might think that this will make things even harder for you. But in fact it is not. Some of the clearest explanations I (as an English native speaker) have ever heard came from scientists using English as a second language

and sticking to the simple words. Hence, while you are speaking, always use the simplest words that you know without patronising your audience, of course. They are usually the most powerful. For example "utilise" is a silly way of saying "use". "At this point in time" is not only impossible (as there are no points in time) but only means "now". And there are many more. Your language is probably littered with such examples - trying looking up neoplasms – French for example has many. People mistakenly think that using a more complex sounding word or several words makes them sound clever. It does not. Please also consider that the audience is not a *tabula rasa* even in issues that are very specialised; your audience has a great deal of resources - besides also the Internet making it easier to explore further the meanings of scientific stories.

In order to overcome these *handicaps* you will have to practice reducing your ideas and the importance of your work into a few sentences. Imagine that your parent or a friend just asks you in conversation "what are you

doing at the moment?" They do not want a science paper or the sort of thing you deliver at a conference. Try to answer them so that you keep their interest. Communication experts like to set the challenge this way.

The lift challenge: You get into the lift in the large organisation where you work. You are going to the 8th floor. As the door closes the managing director jumps into the lift. You are alone with the big boss. You have only met him once briefly at an event (the Christmas Party?). Turning to you with a smile, the question posed is "Hello who are you and what do you do here?" The lift starts to go up and the manager will get out on the 12th floor. There is a board meeting to decide the budget for next year. What do you say? Try to tell them about your work in such a way that this person is interested in what your plan is - what research you are doing or want to do. Or why more should be invested in your department. Your challenge is to be so good that when the door opens at the 8th floor the boss bars your exit and says "come to the board room with me and

present your argument to the directors of the company. (Simple and unrealistic I know but this makes you concentrate on the main message.)

The party/bar challenge: Same idea but more fun perhaps. You meet someone at a party, a function, or in a hotel bar. They ask you "Hello who are you and what do you do?" Attract their attention so well that they buy you a drink or say " do not move I will go and get you a drink." And so on. It is just another way to help you refine your story telling skills.

So by now you are practicing how to tell a story based on your work, or the work of others. You could be working out how to convey interesting and important concepts or startling findings to an audience. You might even be thinking about telling people about the history of some piece of science which is becoming more and more useful in everyday life. How can we use this skill?

The Mass Media

The most obvious way is to tell the world (or at least the important target audience) through the media. Get a reporter interested.

1. Decide if you have a good story to tell and clear that with anyone involved(the head of department/your press office or media centre/your co-workers). Do others want the publicity? Will your story influence politics? Will other people respond by offering to help (perhaps a public survey of garden birds or new allergies).

2. Try to write a press release - the main story. Do not try to make a headline unless you are good at this (it is a difficult skill to acquire).
3. Contact the press officer. Agree to let them work on your words. They will then send you what they think would attract the attention of a journalist. They may well ask you for a quote. This will appear as speech in “quotation marks” followed by your name and title. The journalist can reprint this quote and will do so if it is strong enough. Finally you agree on something that both meets your needs and the needs of the press officer. (They want to publicise your organisation - you will want to put out something that is more like a science paper. See the appendix on Press Officer). Agree on a date for posting the press release. For example it should coincide with a journal publication date, so do not start to think about a press release a month after your work is published. Give the press officer who is preparing the release dates of your next holiday, or when you will be out of the office or very busy

in the laboratory or in the field. It is a very bad idea to create interest and then disappear but we journalists have been let down this way many times.

4. Wait for a call from a journalist. During this time imagine what sort media might approach and how you will "sell" your story to the person who contacts you.

5. Pick up the phone …… and if there is a journalist on the other end of the line start to think. First make sure you know who the person is and what organisation they represent. Do you want to speak to someone from the newspaper "X". If you do not know the name of the magazine, television or radio programme, or web site, ask for details. Then ask what they want.

6. (a) If it is a print or web journalist they may just want to clarify something in the press release. They might want an extra quote (see above) so be ready to give one. Think about the magazine or the

newspaper and its readership when you prepare your quote. They will often ask for this as it proves they contacted you (this is what they are supposed to do) and talked to you about your work as opposed to just reprinting your press release and leaving some bits out. They may also have an “angle”. Does your work or do your data have an influence or affect on something that is in the news? (Be careful as they might be asking you indirectly to comment on someone’s work. Ask direct questions to find out if this is so and then decide whether you want to do this. Remember you have the power to refuse to comment.) The conversation that you have may well be the interview but if not it will lead to section 7

6. (b) If it is a broadcast journalist (radio or television) this is not an interview it is an audition. They have read what you have to say and want to hear if you can tell your story in your own words in a way that will be interesting to listen to. If after a couple of questions they thank

you for your time and say goodbye then you know that the story might be good but your delivery was not! If they like what they hear they may well ask to interview you.

6. (c) It might be an organiser of a conference or workshop and they might just want to see if you can get involved and be a speaker or something like that. Many "print" companies have a commercial department, which organises conferences to make money. The editorial department will hand over press releases to the conference department. Make your choice now.

7. An interview: Who? What? Why? Where? and When? If you are asked for an interview use the 5Ws.

   Who will do the interview? Is it the person you are talking to? (For radio and television we use producers and researchers as well as presenters to do the initial calls to people that we want to use in a programme.) What do they want to talk about? Is it your current

research, something that you have done in the past or something that is in your field?

Why do they want to talk to you? Is your work the focus of the programme or part of a programme they are making? Will it be a documentary about your field of work/expertise? Will it be a discussion? Who are the other people in the programme? Are you the good person or the bad - or even a victim?

What exactly do they want to talk about. Current work, old work or the future? Are **you** happy with what **they** want. You can ask for a list of likely questions in advance but be prepared for extra questions based on what you reply and how well you do it. For television and radio be prepared to answer far more questions than you expected and for very little to be used (especially television documentaries).

Where will the interview take place? Your office, laboratory or in the field? Perhaps in a studio… Be prepared and willing to suggest

interesting locations. Think about when you are next doing something that will add to the journalists understanding. For example, a big experiment in the lab, a field trip, or even a conference where a lot of other interesting researchers will be gathered in one place at the same time. If you offer good locations (good for photographs, or for background noise or good television) you are more likely to be used this time and in the future.

When will the interview take place? Is there a better time that the one suggested? An event such as at a conference, or a field experiment, or in the lab may well add value to the finished interview? A conference that is just about to happen will have more experts to add more variety to the interview.

But the sad truth is that many scientists are worried about talking to journalists. They have heard from colleagues who have had a bad experience. Why is this? Sometimes it is the fault of the journalist sometimes a lack of clear explanation from the scientist (who will rarely admit this) or just a case of the story not turning out the way the scientist wanted it to. So, apart from applying the 5Ws it is very important to understand how the various types of journalists will approach you and what they want. This summary is based on UK journalists and I know fully well that in other countries there are great differences in ways of working. So read these comments with care.

A science journalist is a specialist who might understand a little of many fields of research. Their background may be in your field. Whichever background they have they will understand some fundamentals. They should know that science is not absolute - this is the best guess that you can make at the moment given the research, data and currently accepted

theories. Science progresses in small steps (though sometimes there really are startling “breakthroughs”) and with caution. But of course you must also expect them to ask very basic questions. They want to hear the story told by you in simple terms for their target audience. Do not assume they are familiar with your particular area of work. They will not be insulted if you make it easy for them to get the story right and accurate. Above all they are probably on your side! There are however national differences at play here. In some countries so called “science” journalists are working scientists who want to write on the side. In this case they may well have opposing ideas and will write the interview in that way. I cannot give a country by country breakdown of this as it is a very complex situation and changes a lot over time. Ask around and read papers and look at web sites to find out such information.

A general journalist is taught how to find any story, how to ask the best questions and how to write any story. They may well cover crime one day,

and science the next day. Though for a larger newspaper, web site or broadcast media this is not often the case. Local or regional newspapers are quite likely to only employ general journalists. When dealing with them do not assume they know anything about your subject and be prepared to teach them what they need to know to really understand the importance of your work**. Do not treat them as ignorant or ill educated**. They are the same as their audience - they are not scientists and are not specialists in your field - so explain things clearly.

On the whole a journalist will want to do one of three things. Write something interesting and positive about you, your organisation or your work. Write about two opposing views of the same subject. (Is global climate change man made or natural? What causes certain illnesses? Where does the human race come from?) They should be unbiased but it is hard for most to be completely without bias. Or in the most extreme case they will be trying to cause your organisation harm - by representing

your work or ethics in a negative way. Perhaps you or your organisation deserves this attack – you must decide[12]. You must establish the journalist's "agenda". What are they after? Please do not assume that they all want to make you look silly or say something wrong - though there are some famous examples of this[13]. If you are deliberately and

[12] When working for the BBC radio some time ago, a researcher from BBC television called me to ask for some help on a programme. The field was the environment and involved petroleum exploration. The researcher knew my interests and expertise areas from my programmes. I was asked if I could recommend someone to talk to about one particular idea and area of technology. I gave a great deal of background help and a contact name in a petroleum company. The reply was "Oh I could not ask them for an interview - they are all bad - they want to destroy the environment!" I protested that this company and these scientists were the only people working on this technology, which promised to help the environment. The researcher kept saying "All petroleum companies are inherently evil and their science is bad". I could not help and could not persuade them to change their mind and so I rung off. The programme was never made as there was no one else to talk to.

[13] Some stories are however deeply flawed and should be avoided. Ask the right questions and you should be able to find out exactly what story angle the journalist is looking for. In 2005 one of my academic colleagues, an renowned Austrian isotope chemist, was working on part of the preserved Stone Age man found in the Alps in 1991 (named Oetzi after the glacier in which he had been deep-frozen). A journalist who was writing a story about "The Curse of the Ice Man" approached him. Apparently several scientists researching the unique corpse

genuinely misquoted then you can take legal steps against the journalist and their employer. Nearly every journalist wants to avoid this. I am afraid that in the many instances when I have listened to academics complaining I have come to the conclusion that the academic was at fault for not explaining their story well. I am not taking the side of the journalist. I am asking scientists to think very clearly about their communication skills.

When something is published there are a range of reactions from the person interviewed.

Positive: You cannot have the whole of your work explained in detail and you not get a mention for everyone who worked on the project, where they worked and where the funding came from so do not expect it. If your

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had died in odd circumstances. A bit of scientific or just reasonable analysis shows that as the remains were extraordinary they were mostly given to older and more experienced scientists! Read the article at: http://www.independent.co.uk/news/world/europe/curse-of-the-oetzi-the-iceman-strikes-again-513991.html There are some very interesting comments contained in the article.

main finding is well presented to a general audience you have done well. Do not worry about what was not reported but make sure that what is reported is what you wanted to tell the target audience.

OK: Fearing the worst you read/watch/listen to the result of your interview and think “It could have been worse!” And then wipe the memory from your brain. This is not helping you to understand the process and how you could improve. How can you give value to the journalist while getting your message across? The better your explanations the more you will be used.

Negative: A range of emotions when seeing or listening to your contribution: from “I hate the sound of my voice” to “I was seriously misquoted.” The first is pointless. The last needs very careful consideration - if you were genuinely misquoted then contact the paper/channel/reporter. I have often found that when I suggest this to my colleagues they withdraw and make excuses. What they really mean is

that their peers and fellow academics have criticised their contribution for not containing the names of fellow workers or the full name of the laboratory or the funding source. Or something minor like that. Or perhaps they have been accused of "dumbing down" the science. This is a serious accusation and needs careful thought. If indeed you or the media producers have written as simply as possible to minimise the complexity of an argument **at the expense of factual accuracy, completeness, depth, and/or logical validity**, then this is genuinely "dumbing down"[14].

[14] This is a ghastly piece of 'new speak" English. There is no verb "to dumb" and "down" is a neoplasm/redundant word - (how can you "dumb up"?).

Communicating

Finally when you have absorbed the lessons in this booklet it is time to think about how to use them in practice. First and foremost think about your next conference or classroom presentation.

Presentations:

There is much written on the subject of clear technical or scientific presentations. After reading many books I have only one to recommend[15]: all you need is in this very informative and often entertaining book.

My own guide adds this checklist:

1) Determine the THM
2) Identify the TA
3) With both of these firmly in mind go to the computer - DO NOT OPEN PowerPoint or Keynote - but open a word processing document. Now write a script. Not the complete word-by-word but the INTRO, HOOK and so on - outline the explanation etc., as per my structure model presented earlier. Get a powerful CONCLUSION and write that out and

[15] "The Craft of Scientific Presentations" by Michael Alley. See: http://www.writing.engr.psu.edu/csp.html

learn it. Now do the same for the **INTRO**. By learning the start and end of your speech, word for word, you will make a confident start and a memorable finale. Also by scripting you will get an accurate idea of the length. It is vital to get all your ideas over in the allotted time. If you find a great way to describe something with examples, then work it out word for word to make it easy to understand and memorable. Don't rely on being able to make it up during the presentation.

4) Review the script and ask this question " where would an illustration/data or key words" ADD VALUE to the presentation and help the audience to understand the THM. Mark them in the margin of the script
5) Find the material
6) FINALLY Open PowerPoint or Keynotes and create only the slides you have imagined.

Most of you will open the slide generator first and that is where boring presentations are born.

Let's turn now to your work and think about your next publication. This step should be happening, as you are finishing work on the final draft of your next "paper". Do not leave it until it is published. You should think about creating interest in the press via a media release. (This has different titles in different languages and cultures so ask a press or media officer what it is called[16]).

Press Release:

Look at the abstract. Think about the message - who else might be interested in your findings? As you are writing your paper also work on

[16] "Communiqué de press" "Pressemitteilung" "Comunicato stampa" "Comunicado de prensa" "Pressmeddelande" "priopćenje za tisak" and so on.

the draft of a press release. If you are going to go for a wider audience you must contact the journalists at the same time as the paper is released.

Think wide and narrow. What about local media? Would this idea form part of an interesting article or radio programme or television documentary? Use the press office.

That's the conventional media taken care of.

Now look at the media list at the end of the booklet - the "answers". Work you way through them and see if any of them lend themselves to more thought. Discount nothing and be creative. For instance you may have no interest in "clothing or fashion" - but think about what images or ideas might look good on a T shirt, on a tie or scarf… Or anything else. What might make a great sculpture? Do you see images regularly that make you

think and would make non-scientists think too? This is an exercise in lateral thinking but you will be surprised at how it frees up your thinking and makes communication an exciting challenge rather than something you just “have to do”.

The end or the start?

Above all remember that none of the art and craft of good clear communication comes easily. You will have to work at it. Even such greats as Richard Feynman had to work to improve. His biography tells the story of his efforts while here is a transcript of the opening a very famous lecture that he once gave. This example illustrates many of the points I have been making in this booklet in just a few words.

(The background: Professor Richard Feynman was asked to give a lecture to a large audience comprising husbands and wives in their 50s. He was a

Nobel Prize winner, physicist and famous communicator. His challenge was to talk about a strange particle called the Neutrino to an audience of non-scientists - and to keep their attention…)

He was introduced to the audience and started with these words…

"I'm going to talk to you tonight about something you are all going to understand. It's going to be easy. I want you to imagine something that does practically nothing… almost exactly nothing except EXIST! (the audience laughs a little and he waits a second or two)

Now you can take your son-in-law as an example.

(Huge laughter… and as it dies down he speaks again with perfect comic timing)

"And that is the neutrino!"

Here is a great example of INTRO and HOOK. Feynman does not say “How nice it is to be here” or anything like that. He grabs their attention and goes straight to the subject while also reassuring the audience that he will not confuse them because it is going to be “easy”… He then makes a joke that will only work with an audience of adults who: are likely to be married, have children that are old enough to be married or thinking of it, and understand that “son-in-law” reference. (This opening would not have worked with university students or school children.) And the joke provides a way of remembering the main feature of a neutrino!

Feynman in some way went through the 5Ws when preparing for this speech (whether consciously or sub-consciously). He was known to worry about every presentation he gave. So, he asks: “Who is the audience?” and what do they know about physics, neutrinos and life, “What do I want to talk about” - the neutrino. “Why?” - because he had a duty to explain to American tax payers what sort of work they funded. Where and When

dictated the way he delivered his talk as he had few good pictures that he could use and the hall was not set up for it. And in the end he produced one of the most memorable ways to start a talk on something that is so complex and beyond our understanding that it frightens most audiences. Yet here they are laughing twice before he has even introduced the subject of the talk.

Re-read and consider this example. You may not be able to equal this but you can try.

So now you need to practice your techniques. And practice and practice. And you will become a better communicator - maybe the best.

Appendices

The role of the Press Officer, the Press Office and the press release

You will find this job and organisation called many things. It might be a media office, and the workers might be called communications officers. The people might be employed by your organisation or they might be specialists called in from outside for one event or on a regular contract. But whatever they are called and however they are connected to you, it is important to know how to use them.

Press officers have a very specific set of talents. The first is that they are experts in the various media such as radio, TV, print and web. They know what magazines for instance would be interested in your story and which newspapers would not be interested. They are trained to think about your

story from many different angles. This is hard for you to do so use their knowledge. They have lists and contacts that you do not have.

Perhaps far more importantly they are usually the first person who is not a scientist in your field that will hear or read your attempt to connect with a general audience. This is a vital part of the process of getting your THM identified and getting the right bits of your story in the right order. You use them as you would use an editor of a chapter in a book or a paper.

They also know how and when to “market” your story. In fact whatever medium or media you choose you should include a press and communications expert at a very early stage. They see the world in a very different way and can have some hugely useful suggestions to make. They should not interfere with the science or the message but they will help make it reach the right audience in the most cost and time effective way possible.

The way they reach your audience is to create a “press release” - just a piece of A4 paper with the story clearly explained, a logo to identify the organisation that you work for and a means of contacting you. This is sent to a range of media and usually to a specific person in each newspaper, magazine, tv or radio station and so on.

A simple model of the press “industry”

Think of some very simple industrial process such as turning a precious metal into jewelry.

A) First someone has to find and then dig out the ore from underground. This is a very skilled job and is a mystery to most people. The workers are “miners”.

B) There is then a long and complex process involving separating the rock and the metal, transporting it to the right person who will work with the metal to make jewelry, and finally getting it into a

shop and advertising to attract a customer. All along this process each stage “adds value” to the original material. This is the jewelry “industry”.

C) Finally a person who wants a piece of jewelry buys it. This is the “customer”. They will generally not know how any of the previous stages work but they do want something pretty and stimulating and are prepared to pay for it.

All very obvious. Now to turn this into the “press/journalism industry” dealing with your story and ideas.

A) You, the scientist/researcher, replace the “miner”. You dig for things that are hard to find - data and ideas. You are very skilled and what you do and how you do it is a mystery to most people.

B) There is a long and complex process, which involves turning your raw ideas, findings and data into a story that will attract a

journalist. The journalist will then turn your story into something that fits into their medium - a magazine for example will have different sections and your story might be news, a feature or part of a feature. The press officer and the journalist and editors are there to add value to your work to make the story attractive to the audience.

C) When the magazine for example goes into the shop there will be people who want to find out about the world and how it works - so they will buy the magazine. For a newspaper the only difference is that the "customer" will usually buy their favourite paper and then the job of the journalist is to "sell" the science story to the reader.

In all of this we have two crucial events - the second is the way in which your story is presented to the audience via the media. You have little or no control over that. The point where you <u>can</u> get involved is the creation of the "press release". Working closely with a <u>good</u> press officer will

greatly improve the chances of your story reaching a wider audience via a journalist or a television or radio producer.

There are experienced scientists who prepare and send out their own press releases - but they are rare. This a difficult skill to acquire as it involves seeing your work from the outside and from the point of view of the journalist. But if you can learn how to sell your ideas in this way you will be able to create and place a release about your next presentation at a conference - this will attract any journalists who are attending and who knows what might result.

But at the point when a journalist makes contact - that is when you have to be able to tell a good story that makes the points that you want to make.

When is a good time to tell my story through my chosen medium?

It is best to work on the idea of the surprising science of the everyday world.

Example 1: **The Perseid meteor shower**.

Who might be interested? Anyone who has looked at the night sky and wondered about it. Mostly it is pretty static but meteor showers are very exciting.

What can we say about it? What is it that is making these short bright streaks crossing the sky at the rate of one every minute? Where the material comes from and where it ends up. Why only during July and August? The history of observations and the myths surrounding the shower. It is associated with the path of the comet Swift-Tuttle - so what

is the difference between a meteor and a comet? We see more of them just before dawn for a very good reason.

When should we talk about this - after the middle of July but close to the height of the shower so that people can go outside at night and see the shower. To attract children, put the message out during the hours when they might watch television. But make sure that adults also know about it and how to see the shower - so they can help the children to watch and understand the phenomenon. Linking the event to a weather forecast is a good idea as we need a clear sky.

Where could we talk about it? - Almost any medium would be good but if you want the personal touch it should be in schools or at a pre-arranged site with a telescope and good warm shelter. Make an event out of it with a celebrity astronomer.

Example 2: **The science of Christmas**[17].

Obviously this is a good book to read before Christmas, or if you get given it as a gift - after the event. It makes good print articles as well as radio and television around the December time. The web is full of it too. Just two very different approaches here. (Lectures to students should be at the end of term to make the link between their science and the world around them).

http://www.interactivescienceteacher.com/Christmas-science-lesson.asp

http://www.labnews.co.uk/feature_archive.php/1528/5/the-science-of-christmas/

[17] One such book is called "Can reindeers fly?"

Example 3: **Anniversary of a person or event**.

The timing is obvious - birth death or significant date for a person and the start or end of an event. A day or even a year long celebration - such as the media interest surrounding Einstein and Darwin. There are Copernicus, Laplace, Euler, Newton, Volta, Fermi, Ochoa, Quevedo, Moniz, Lavoisier, Monod, Wegener, Onsager, Nygaard, Nobel, Angstrom, Granit and Virtanen. To name a few. Then there are pieces of research, findings, or the built environment or an experiment. Recent ones were the LHC at CERN in Genenva - the moment it was turned on. The last NASA shuttle launch and flight. Major engineering schemes that challenge science and technology. The invention of the TetraPak - which involves chemistry, physics and maths at the very least.

Example 4: **An event.**

Olympics and the science behind those sports. “When?” of course is during the lead up to it. Other sports have seasons or are a single event. A

new season might bring new rules that need explaining, for example electronic judges in tennis or football.

For these examples work out the best TA and the best THM. Then try to think of creative places to go to reach and inspire that TA - the “Where?”.

Exercise One

This section lists the types of media that can be used to communicate and popularize science to non-specialists. It extends the section on the main text of this booklet.

First, as I did with “print” and “publishing” let me expand a medium to show you how long the list could be.

Radio: is a distinct medium and there are different parts of it that you could imagine making a contribution to. A weekly or even daily science magazine programme - what is new in science? Or it might be a one-off documentary about the origins of the universe or global climate change. It could be part of series of programmes about the “science of food”. Or it might be a historical drama/documentary about a famous scientist, their work or even the story of how we discovered the true nature of disease or of time or even a new chemical or process such as lasers that we use everyday. You could be asked to talk to a general news reporter about the

latest discovery or idea in your field. You could be on a panel of experts answering listeners enquiries. And there are many more ideas. The point here is that radio is very good at covering some subjects in certain ways - you must use the medium in the best way to convey your message to the audience who listens to speech radio.

Television: is quite similar but has the disadvantage that you have to find lots of pictures to put on the screen. So as a medium it is very good at bringing some subjects to the public but less good at big ideas and theories. For instance "The Big Bang" theory of the creation of the universe is very dull visually and is much better suited to radio. In the same why much of psychology sits well on radio while nature calls for the camera.

So, here is my list in no particular order (with some examples to help - these are not recommendations only ideas):

Film: (An Inconvenient Truth, Outbreak, War of the Worlds, 2012, The Day After Tomorrow,)

Internet: This ranges from serious and excellent attempts to explain science and current issues surrounding new sciences or phenomena, to ill informed comments and personal attacks on individuals or organisations.

Social Media: This is a fast growing medium and requires a great deal of thought before using it. It is still open to abuse and the ground rules about how and when it is a useful tool are still being formulated.

Podcasts: Many good ones and some very bad ones about.

Print: Most good daily newspapers have a science editor or science section. Magazines such as “Focus” in UK, “Spektrum” in Germany, “Science et Vie” in France, “Focus” or “Airone” in Italy.

Publishing: Factual Books(serious - http://www.amazon.co.uk/Genetic-Modification-Food-Science-Edge or popular -

http://www.amazon.co.uk/Disappearing-Spoon-Sam-Kean), Science fiction - (Jurassic Park), Part Works (a series of monthly magazines which can be bound together to create a book). Books for children (http://www.amazon.co.uk/Dinosaur-Poems-John-Foster/ or http://www.usborne.com/catalogue/catalogue.aspx?cat=1&area=S&subcat=SSO&id=3356)

DVD: (http://www.thefutureiswild.info or http://store.discovery.com/cracking-the-ocean-code-dvd)

Lectures: (http://www.youtube.com/watch?v=y3q0mg54Li4 this is a typical lecture - and though they can be much better than this - this is boring)

Demonstrations: (Watch http://www.youtube.com/watch?v=4EABdAEt_fM&feature=related starting at 2 minutes - this is what a demonstration is - but note that this is a very boring introduction.)

Events: Science Olympics (http://www.ldstf.ca/olympics/index.html), Science Festival(http://www.sciencefestivals.org/), Science Film and Radio Festival (http://www.caid.gr/isffa/films.html and

Workshops: How things work, What is the science behind today's and tomorrow's technologies. For students and for teachers who want to keep up to date.

Lecturing: How do you make a biology, physics, chemistry or mathematics lesson more more engaging and memorable. How do you make students want to learn?

Public debate: Science café. (http://en.wikipedia.org/wiki/Caf%C3%A9_Scientifique)

Conference: Obvious to most but try this one (http://en.wikipedia.org/wiki/Molecular_gastronomy)

Seminar: (http://www.weizmann.org.uk/?node=123)

Open Day: (university - http://www.rhul.ac.uk/studyhere/educationaladvisorsandschools/scienceopenday2012.aspx, laboratory - http://www.npl.co.uk/open-day/)

Museum: Look at these examples and think of another subject for an exhibition (http://www.deutsches-museum.de/en/exhibitions/, and for a complete list - http://en.wikipedia.org/wiki/List_of_science_museums)

Exhibition: (A display of ideas and objects but not at a museum)

Roadshow: (traveling exhibition) http://www.extrascience.eu/ or http://www.sciencexpress.in/)

Competitions: In or between schools or universities. For the public. (http://www.thegreatbughunt.com/ or http://www.inds.co.uk/competition.htm)

Awards to media or scientists: Serious or humorous (Ignoble Awards, Darwin Awards, EuroPAWS awards)

Sponsorship: Commercial laboratory, manufacturer, institution or society. (http://www.gandhiforchildren.com/how-you-can-help/corporate-sponsors/)

Photography: Exhibition or competition (http://spc.milset.org/)

Art: (Paintings and drawing about the beauty of science, science as art, the the science behind art) Pink Floyd album cover for "The Dark Side of the Moon". (http://scienceblogs.com/art_of_science_learning/ or *ec.europa.eu/research/rtdinfo/pdf/rtdspecial_as_en.pdf)*

Sculpture: Look at the "Quantum cloud" by Joe Gormley 1999 or (http://www.julianvossandreae.com/work.html)

Theatre: (history, drama or comedy) "Leben des Galilei" by Berthold Brecht, "Copenhagen" by Michael Frayn or (http://scienceblogs.com/worldsfair/2007/03/science_theater_without_the_my.php) or for the young

(http://alessiobernardelli.wordpress.com/2009/09/19/rolls-royce-science-prize-2008-2009/)

Dance: Ballet **(**http://www.einsteinyear.org/press/Rambert/) Dance Club and concert back projections: Mandlebrot fractals are very popular - what else could be used to excite curiosity. Lasers for rock concert light shows were developed with money from the rock band "The Who".

Music: Serious to comic. Holst "The Planets" more recent (http://www.bournemouth.ac.uk/newsandevents/News/2007/september07/rock_music_inspired_by_antarctic_research.html) Rock - Pink Floyd - "Set the controls for the heart of the sun" and many more. Comedy: Monty Python's "Galaxy song" to several from Tom Lehrer.

Poetry: Many books of science inspired poems - but try reading John Updike "The Dance of the Solids. French poets such as Lamartine, Hugo and Baudelaire, Goethe in German etc.

Humour: More comedians today are using science based ideas to challenge their audiences.

Musical: Opera to Rock Opera (War of the Worlds, Repo Man)

Computer Games: "SimCity" "Spore" (http://fateoftheworld.net/) or (http://fold.it/portal/info/science)

Posters: There are many (http://www.scienceart.co.uk/page.php)

Clothing: T shirts (http://www.cafepress.co.uk/), ties (http://www.scienceteecher.com/Chemistry-Ties/?gclid=CJC9-v3V3qwCFQMPfAodqnfy6g), watch faces, earrings, etc.,

Household decoration: Wallpaper, (http://boneblogger.com/nature-wallpaper-for-fun/)

Murals: School or University, city, metro, household or your laboratory(http://sciencehax.com/2010/03/the-incredible-3d-murals-painted-on-the-sides-of-buildings/)

Lollipop stick: A simple message or fact on something disposable, from a pen or pencil (http://www.masterwholesalesupply.com/pencils/sciencepencils.html) to a lollipop stick. Packaging of any sort.

Newspaper or Magazine Supplements: strictly speaking this is print or DVD but it is not in the paper and is packaged to be kept as reference work.

Public dialogue: This is covered elsewhere and there is a wealth of literature in the field of science communication for public engagement.

Case Studies

Case Study 1

Professor Ian Fells has made more than 500 TV and radio programmes which he believes is one of the best ways to improve the popularisation of science. But he has also published more than 200 papers on a wide range of subjects, which is why he is Emeritus Professor of Energy Conversion at the University of Newcastle. Somehow, he also manages to run his own successful consulting company with his four sons. He has been science adviser to the World Energy Council as well as being an energy adviser to the European Union and European Parliament. He has advised a number of Foreign Governments on energy policy and is a consultant to various multi-national companies. As well as being an eminent scientist he is driven to communicate his ideas to the widest possible audience.

As Professor Fells says “A while ago I made a programme about Murphy's Law ("If anything can go wrong it will") for BBC1. We tried everything out, the other queue moves faster, even if you change queues; the last people to arrive at the theatre always have seats in the middle of the row, etc. We did all the necessary statistics of probability to get the science correct. It went out after the 9 pm news, a good slot, the day the first Gulf War started. Even then 8.6 million people watched it, more than any science programme since. Supposing only 5% paid any attention it improved their understanding of statistics and probability theory. That is many more than a university teacher lectures to in the whole of his career.
It is also fun to do.”
But the value of communicating ideas clearly to peers is also vital – “"Just as energy is the lifeblood of civilization; so science communication is what enables it to develop".

Case Study 2

Iraqi-born and UK educated Jim Al-Khalili is now a professor of physics at the University of Surrey where he also holds a chair in the Public Engagement in Science. His academic achievements (already nearly 100 papers) are matched by his considerable body of broadcasting appearances and published popular science work. He has pioneered a novel idea for "video podcasting" which a series of interviews with eminent science figures. The videos are posted on the University's YouTube channel (http://www.youtube.com/user/UniversityofSurrey) Apart from allowing him to explain the ideas of physics and science in general to as wide an audience as possible, he has found that his communication skills have helped in many areas of his work.

Apart from teaching undergraduate courses and doing research in a very well regarded university department (in the top 10 in the UK) Professor Al-Khalili has lectured at science festivals, literary festivals, and presents a

weekly programme on BBC radio in which he talks to scientists from all fields about their lives in science and their personal beliefs and ideas. He has a blog and tweets. He also sits on a government panel which revues funding applications. By first being a good communicator of science to both students and the public he has created a career which encompasses much more in the way of communicating. One of his most recent radio live appearances involved explaining Heisenberg's Uncertainty Principle to a very clever monkey – which was a ventriloquists dummy! It was informative and very funny.

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