How should chemical scientists and engineers talk to the public? (Talk delivered at the Council for Chemical Research Annual Meeting April 27, 2008)

Bill Hammack teaches Chemical & Biomolecular Engineering in the School of Chemical Sciences at the University of Illinois - Urbana. He has created over 300 pieces for public radio, and is a regular commentator for public radio's premier business show Marketplace*. Many journalism, scientific and engineering organizations have recognized his work. He's received the top awards in science journalism: The National Association of Science Writers* Science in Society Award*, the American Institute of Physics* Science Writing Award*, and the American Chemical Society's* Grady-Stack Medal*. In addition he was recognized with the American Society for Engineering Eduation's* President Award*, the IEEE* Award for Distinguished Literary Contribution Furthering the Public Understanding of Engineering*, the American Society of Mechanical Engineers* Edwin F. Church Medal*, and the American Institute of Chemical Engineers* Service to Society Award*. He may be reached at hammack@netbox.com, his radio work is collected at* www.engineerguy.com*.* This document may be downloaded at www.engineerguy.com/ccr*.*

Introduction

I START WITH a story. The woman shown here is Luzaida Cuevas. She is holding a photo of her 10-day old daughter. Not long after this photo was taken a house fire destroyed Cuevas's house, killing her infant daughter.[1] The fire fighters and clean up crews searched the wreckage for the child's body, but found nothing. Perhaps they had just missed the remains of such a tiny being. But as a mother Ms. Cuevas had this feeling that her daughter had been kidnapped, rather than killed in the fire. Six year later, she attended a birthday party which this woman - Carolyn Correa - attended with her daughter. Immediately on seeing this girl Ms. Cuevas realized it was her daughter. As the party progressed she found a moment alone with this child. She told the girl that she had gum in her hair, and in making motions to remove the gum Ms. Cuevas took several strains of hair. She knew that from hair one could get DNA and thus determine paternity. The tests showed the child to be hers; the police arrested Carolyn Correa - a court later sentenced her to 14 to 30 years in prison after she confessed to the kidnapping. Here's a picture of Cuevas reunited with her daughter.

I want you to look at that smiling mother and daughter - and to keep in mind this concrete image during the abstractions that will follow. This story illustrates one of the main areas where science or

Luzaida Cuevas reunited with her daughter after six years. A DNA test revealed her child had been kidnapped.

engineering literacy impacts the public. I've listed them here - this story, of course, illustrates applying science as a parent. Generally, we all agree on these basic reasons for a level of literacy - to apply to personal life, to aid democracy, and to power our economy - but the question is how to do this. That "how" is my subject today. In doing this I'll draw on my own experiences communicating to the public: I've done over 300 pieces for public radio, including many for *Marketplace* their business show.

Overview

SO, HERE'S an outline of the talk. I'll spend ten minutes on content, then ten minutes on the equally important part Understanding today's media landscape. It's an old truism from Marshall McLuhan that the "medium is the message." So, although I've listed it separately it is tied up with the form or content of the message. As scientists and engineers we focus on content, yet the real problem lies in how we fit into today's media landscape. I'll close with a five minute call to arms for science and engineering communicators.

Content & Form

SO, LET'S START with content and form. The first question that our technical training makes us ask is "What should we tell the public?" Instead, though, we need to ask "What do we want the public to do?"

Let's return briefly to Ms. Cuevas. She needed to know only the essence of what DNA testing could do,

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[1] *Philadelphia Inquirer* March 7, 2004

not how to do it, or even exactly what DNA was -- it was the technological aspect, its purpose that was most important. She may well have picked the knowledge up from a crime show like *CSI* (Crime Scene Investigation) or the Maury Povich show, which often does DNA testing for paternity. She did not need to be a "miniature" scientist or engineer with a full toolbox of technical skills. What we usually call hard scientific literacy. To a scientist or engineer that seems clearly the proper goal, but it isn't when we're reaching out the public. In fact, as practitioners of science and technology we get very, very caught up in defending hard literacy. Yet its the wrong debate to have. It distracts from the main problem: We battle, instead, technological determinism.

The Real Battle: Technological Determinism

BY TECHNOLOGICAL DETERMINISM I mean a belief that technology shapes our lives with a ruthless logic all its own. In fact, who doesn't carry an image of a great whirlwind of innovation that sweeps through our world, creating blessings and havoc? Its forces us to upgrade from Windows XP to Vista, or our cell phones become outdated and we're obligated to buy a new one. This view makes people passive about shaping technology, and so promotes a dangerous apathy. It focuses minds on how to adapt to technology, not how to shape it. Thus, it removes a vital aspect of how we live from our public discourse. So, to first order the purpose of outreach needs to focus on getting people to exercise the civic responsibility of shaping the technological forces that in turn shape their lives so intimately, deeply, and lastingly.[2]

This issue of *Time* magazine features Lewis Mumford -- likely the one and only historian of technology to make the cover of *Time*! In this wonderful quote he notes that technology and science have meaning "only in relation to a human and social scheme of values." With this he drives home the take away message: Technical aspects cannot be construed apart from their social context. So, in reaching out to the public, we must present the entire technical, social, political, economic, and cultural context of the things that surround us. This includes the innovators, inventors, engineers, entrepreneurs, and business people who

The work of Lewis Mumford, a pioneering historian of technology, highlights that to first order the real battle is with technological determinism, rather than hard scientific literacy.

make technology happen.

Look for a moment at the scientific disciplines that are extremely popular: Astronomy and evolution. I find them to be disproportionally popular, especially given their direct impact on people's lives. What accounts for their success? First, they both had superb popularizers - Carl Sagan and Stephen J. Gould - but, more importantly, they seem to the public to place us in the world. They address questions like: Who are we? And what is the purpose of life? So, the message to any technologist who wants to reach out, is to place technology in context.

Now, since I'm an engineer I get very excited about how things work mechanically, and so I'm often tempted to only explain that aspect. And so I keep this quote posted on my file cabinet near where I write. Its from Ambrose Bierce's 19th century *Devil's Dictionary* which is essentially a list of literary barbs. He defined "inventor" as:

"*Inventor, n. A person who makes an ingenious arrangement of wheels, levers and springs, and believes it civilization.*"

This is what we must avoid when talking to the public.

To overcome this in my radio work I often tell the story of an inventor or innovator who created some everyday object. I've talked of the invention of the microchip, scotch tape, the Ping golf putter, and nylon. I'll use a story that reveals how technology is changing the listener's life, or has dramatically changed our society. I've discussed the impact of the typewriter, the match, and how color film is embedded with cultural bias. Whenever possible I like to link up technology with art, music and especially literature. I've shared how J.R.R. Tolkien felt about technology, and what his *Lord of the Rings* might mean for us today; I've delineated how the creative process of an engineer is closely linked to that of a painter.
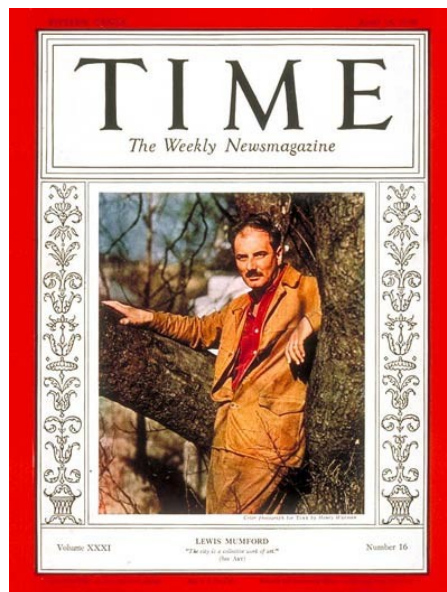
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[2]This phrase is adapted from Thomas Hughes - I recommend looking at his work! This comes from his paper "The Order of the Technological World" in *History of Technology* Vol. 5 edited by A.R. Hall et al. (Mansell, 1980)

So, that's one key aspect: Place our work in context all of the time. Now, likely this strikes you as somewhat unsatisfactory because the basis of engineering and science lies in a particular skill set and style of thinking. So, in addition we need to emphasize some kind of skills. In my own work I practice something proposed by Herb Simon, a Nobel Laureate in Economics.

Simon felt we should produce citizens who are more effective questioners and cross-examiners than they would be without training in science and technology. He used the analogy of courts and legislatures as models of deliberation. They do not rely on experts to make the final decisions, but they do make use of them. Simon emphasized the "nature of scientific evidence." Thus I do commentaries that reflect, for example, life-cycle analysis: Looking at the impact of a technology from cradle to grave. This highlights that there isn't often a simple technological quick fix to every problem, and shows how to analyze a new technology.

In sum, then, what do we we expect from this "awareness" that I've proposed? The objectives of this approach are to help society in general, feel more comfortable with new developments in science and technology. They need not so much to understand the details but to recognize the benefits, and the possible risks of technology, and to identify scientific frauds. We would like adult learners to understand how the scientific enterprise works in our political and economic climate. We want to encourage an appreciative public, one that at least understands how much needs to be spent on science and technology. I think the science and engineering community would be well served by a society that, while perhaps illiterate in science in the formal academic sense, is at least aware of what science is, of how it works, and of its horizons and limitations.

So, we see the general message we want to deliver, or rather the kinds of actions we want the public to take. Let's look at the form of that message.

Content of Message: Framing

I SHARE WITH YOU now the work of two communications experts - both journalism professors - who've discussed in detail how scientists (and by implications engineer) should reach the public.[3] They first tackle

[3]This discussion of framing comes from *The Scientist* vol 21, issue 10 page 38 "The Future of Public Engagement" by Matthew C. Nisbet & Dietram A. Scheufele; see also the exchange in *Science*: "Science and Society: Framing Science" Matthew C. Nisbet and Chris Mooney *Science* 6 April 2007: Vol. 316. no. 5821, p. 56 DOI: 10.1126/science.1142030 And *Science* 31 August 2007: Vol. 317. no. 5842, pp. 1168 - 1170 DOI: 10.1126/science.317.5842.1168b

the most common idea: That scientists and engineers tend to believe that facts will win out -- they call this the popular science model, which is a version of the hard scientific literacy I mentioned earlier. The authors cite amble evidence, that this doesn't work. They review sixty years of research that suggests citizens prefer to rely on their social values. So, these authors argue for what they call "framing." In the abstract this means tailoring messages in ways that make them personally relevant and meaningful to different publics. Its best to look at some examples.

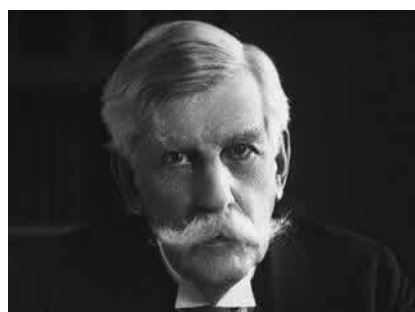Let's start with the negative - the ways framing has been used against science. Greenpeace's idea of "Frankefood" has been effective in opposing all manner of genetic modifications. (I find the image of the "Frankenfrog" to be so repulsive as to be nearly impossible to look at!) This clearly shows the power of framing: Of having an idea that resonates deeply with some fear or social value that people have. What this means for technologists to reach out effectively is also to frame using what a group values. For example, when scientists talk to a group of people who think in primarily economic terms, that they should emphasize the economic relevance of science. An example might be embryonic stem cell research, pointing out how expanded government funding would make the US, or a particular state, more economically competitive. Here's another example. They mention E.O. Wilson's book *Creation: An Appeal to Save Life on Earth*, praising him for recasting environmental stewardship not as a scientific matter, but also one of personal and moral duty; noting that this book has generated a discussion among a religious audience that might not otherwise pay attention to popular science books.

The movement opposing genetically-modified food has effectively used framing; that is, tying the scientific issue to something that the public has already placed firmly in political, social and cultural context.

Finally, let's look at an example for nanotechnology. I've shown here the masthead from Brown University's alumni magazine. It reads "Could Today's Wonder Fiber be the Next Asbestos?" They echo here something that buzzed across Europe. On the Continent the opponents of nano push it as the "the asbestos of tomorrow" or the "new asbestos." This is, of course, framing in action. The public has placed asbestos in context - they have situated it in their political, cultural and social landscape. This framing of nano ties it into their social judgment. European companies have responded with their own framing of "nano is nature" to try and tie into something else that citizens have already made a social judgment about.

The two journalism professors that I've mentioned stress that they aren't talking about Framing as "false spin", suggesting that the content must be true. They argue, convincingly to me, that scientists do framing all the time. When writing a grant proposal, or a journal article, or providing expert testimony, scientists and engineers often emphasize certain technical details over others, with the goal of maximizing persuasion.

Supreme Court Justice Oliver Wendell Holmes Jr in his great 1904 Dissent reminds us that "Great cases, like hard cases, make bad law." The same holds true when communicating science and engineering the public. The hot button issues on evolution, biotechnology and other areas should certainly be fought, but we must keep in mind that communicating on less controversial issues can help our cause as well.

So, I suggest keeping an eye on this site. *http://scienceblogs.com/framing-science/*, which is regularly updated with the author's thoughts on framing.

All that said, I find their approach too often focuses on only the value-laden scientific questions. Whenever I read their work I cannot help but think of this quote from Justice Oliver Wendell Holmes from his great dissent in a case before the Supreme Court in 1904. Its that famous phrase "Great cases like hard cases make bad law." He spells out the reasons in this quote, which later goes on to cite the "hydraulic pressure" applied by these interests. We need to apply framing to less controversial and more everyday things. I share with you a very good book that is about framing, but much less manipulative sounding than the work I've just described. The book *Made to Stick [* by Chip & Dan Heath, Random House 2007] doesn't focus on science, but its techniques can be easily applied to

communicating science. My advice: If you want to really reach the public, stop reading for a few days technical literature and spend that time with this book. If every member of our community understood what's in here and applied it we would not have any communication crisis! I like it so much that I've made a four page summary of the book, which I use when writing. I would be glad to send you a PDF. Just send me an email.

So far I've talked about the message, and about the form of that message, but without distribution neither of these is of much value.

The Medium: Understanding the Media Landscape

A KEY ASPECT to my career has been the realization that we need to make mass media an integral - perhaps *the* integral - part of our outreach. We have many great programs that work at the local level - Physics vans, high school programs, and the like - but what we really need is to dramatically leverage our time. That calls for mass media.

Often when I talk about the media landscape people don't see why this is part of our role as scientist and engineers. I argue that we must understand this in order to be able to truly reach the public: We need to know how best we can fit into the media. So, I'm going to show you some graphs of audience size, what I want you to grasp is two things: One, what size audience we should be aiming for realistically, and two what directions media is going.

Now, in a sense here I'm over reacting to a comment by one of my colleague's in the chemical sciences. I mentioned in conversation that I'd been on public radio's *Marketplace* last night, and thus had reached about eight million people. He said "That's all?"
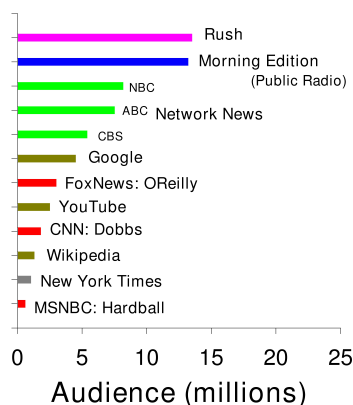
So, let's take a look at audience numbers in order to get a feeling for what the media landscape looks like and what kind of goals we should aim for.

Because of the average age of this group, let's start with the National News. (How many of you still watch this? I stopped in 1984!) ABC, NBC and CBS have about six to nine million viewers. That number alone isn't interesting, but this figure is: Over the last 25 years Network News has lost one million listeners a year -- that's half their audience in the last 20 years.[4] This fact reveals an essential truth about the expansion of the television dial. I've have developed a new statistic to illustrate it: Fragmentation as measured by sitcom finale. The final episode of *M*A*S*H* in 1983

[4] http://www.journalism.org/node/943, State of the News Media 2008, Journalism.org

had 106 million viewers[5]]; in 1998 *Seinfeld* has 76.3 million[6]; and in 2004 *Friends* final episode had 51.1 million viewers.[7] You can see that since MASH the final episode of very popular shows have lost about 25 million viewers each decade or so. Is *Friends* 50% less "better" than *M*A*S*H*? It isn't that *Friends* is a lesser sitcom than *M*A*S*H* - I mean neither of these are *Charles in Charge* - but that the dial has fragmented.

Here's how this affects us as science communicators: A show like *Nova* has seen its audience drop by a factor or two or more - now hovering around one and a half million, when sometimes in the past it was as high as six million! And other outlets for science program like the *Discovery Channel* have fallen 30% in the last four years - from 1.3 million in prime time to about one million today. Discovery drops every year because of the fragmenting dial.[8] The story is even worse because Discovery is barely a science channel today - that million rating is for their top shows like "Dirty Jobs" or "Shark Week."

Let's return to news media. I want to start comparing various media. So, let's put that on our plot at around 9 million or so the network news. Now, let's put on my favorite medium: Public radio. Their premier show *Morning Edition* garners about 13.2 million different listeners. Morning Edition has increased its audience by 40% in the last five years! Before we get too excited about this, let's plot the top radio program: Rush Limbaugh with 13.7 million listeners. *Morning Edition* is creeping up on Rush: A few years ago they were around eight million or so. For those with a sense of humor I put Rush's bar in pink. Make of that what you will.

Let's add in cable news. Typically they average over the whole day about a million views at a time, but I'll plot here their top rated shows. FoxNews (FNC) O'Reilly 3.04 million; CNN Dobbs: 1.227 million; MSNBC hardball: 0.6 million (600,000).[9] Note that when watching a cable show you may one of as few as 100,000 listeners at any particular time.[10]

Lastly, let's add a newspaper in there: *The New York Times* has a circulation of 1.037 million.[11]

Here's the punchlines: 1) Television has large numbers in aggregate, but it has completely fragmented; often you are one of 100K or so watching a show; 2) public radio has *not* fragmented and has gone gangbusters - this is an educated, voting, active audience whom we don't want to lose[12]; 3) printed newspaper are on the decline. The top 20 papers have *lost* about 10% or so in circulation in the last two years; and they drop every quarter. The printed newspaper lost its economic model when Craig's list took over the classified ads; online newspapers are doing better, but there is no economic model to make as much revenue as the printed papers. And 4) we need to look at economic ways to get chunks of 100,000 listeners, and, when it can be done, a million or so.

So, audience numbers are well and good, but in terms of reaching the world we need to look at another parameter: Demographics. Here's the demographic of the public radio audience. If you are over 40, you might well listen to public radio, under 40 almost no chance! This is an exaggeration because the cutoff is much fuzzier, yet it captures a great deal of truth. What I really want to show you, though, is a spike at ages eight to nine - 3rd graders. For some reason I have a third grade contingent who are regular listeners. It is not uncommon to be sitting in my office, and heard a tiny knock at the door, and there standing with a somewhat sheepish parent or uncle is a nine-year old child. They want an autograph, or to talk to you. Still, where are all the young people?

New Media

Lᴇᴛ's ᴛᴜʀɴ to an expert on new media: A man who has just bought his first web cam. This is the text of the YouTube Video played during the lecture:

> I pity you folks. Here you sit in a seminar on using media to explain science and yet how old fashioned it looks. I mean powerpoint slides! And recommending books! Look

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[5]AP David Bauer Feb 4, 2008, story on Super Bowl

[6]*New York Times*March 16, 1998

[7]*USAToday* May 7, 2005

[8]Multichannel News August 14, 2006

[9]Data from March 17, 2008

[10]I should note that comparing television ratings to radio is pretty difficult: What we really want is the weekly CUME for the television,

but this isn't published. So, most likely the public radio audience is over-estimated here.

[11]U*SA Today* November 8, 2007

[12]More Details on Demographics of Public Radio Audience: These listeners are intellectually curious and enjoy learning about the world around them. They are 33% more likely than the general population to express an interest in theories and 32% more likely to enjoy learning about art, culture, and history. This is an active audience. Over 70% voted in the most recent local, state or federal election. NPR listeners are 22% more likely to be involved in clubs and organizations than the general population. NPR listeners are more than twice as likely to have addressed a public meeting, written to an elected official or written to an editor of a magazine or newspaper. Approximately 9.3% of the NPR audience is African-American.

at your presenter: How can you trust him to understand new technologies. Look at him! No doubt he has on a blue suit, a blue shirt, and ... I'm sure .... a red tie - well that's exciting and new. I can picture the seminar: Blah, blah, blah, public radio ... blah, blah, blah newspapers ... As my 23-year-old nephew says "What's public radio?" Look folks the media world now contains things like YouTube, Facebook, and Twitter. This generations has replaced Descartes "I think, there I am" with "I have webcam, therefore I am." No one under 25 uses e-mail any more -- its all instant messaging. Facebook now dominates in every campus computer cluster. And 23 year olds use media communally: At parties five or six people gather around a laptop and share their favorite YouTube videos. So, in this short video I just want you to get an impression of how the Internet changes the media landscape. For example, why did Madonna give up her record company and turn to a concert promotion group? Because the age of the CD is over, music is now sold piecemeal by iTunes. In fact, the very popular band Radiohead shocked the music industry by releasing their latest album for free; yet when they later released the CD at stores it was the top selling album! You're probably thinking: Are these new media just toys? Here's a couple of thoughts: Every new medium starts as a toy. The first copyrighted motion picture in the U.S. was The Sneeze by Thomas Edison. We've been at these crossroads before, just with different media. In 1950 both television and 3D movies debuted. Many thought television to be a fad; some thought 3D movies were the wave of the future. That same holds true of the "new" media we have today. We don't fully understand this new landscape: some things will be duds, some will be fads, and some will become part of our culture. But if you think something like Facebook is a toy, keep this in mind: The New York Times and ABC News collaborated on a project using Facebook to deliver election news - including sponsorship of a debate. Here's the punchline: We have entered an era where the distribution of media lies in the hands of the public. The expectation of the Facebook generation is that they will be able to participate, create, and share multimedia: Science and Engineering communicators need to participate, even shape those media. Well, there's much more I could say, but now I return you to your blue-suited powerpoint-sporting friend, who will no doubt show you a graph. Enjoy.

Indeed I *am* going to show you a graph or two. Let's toss one or two points on there, and then discuss it in more detail. According to a recent Nielsen report in February 2008 Google was the top "brand" getting about 4.5 million a day; YouTube receives 2.5 million hits a day; Wikipedia has 1.8 million views. Now, one should be wary of this graph because we are comparing apples and oranges: The network news bars are viewers listening only to news; a google search might be for Paris Hilton. The point to be made here is this: 10 or 15 years ago these bars (for the Internet) were not there at all. My main punchline here is that the the web has potential to hit that magic

million level, but cheaper than television.

Lastly here is a useful book for getting oriented to the power and promise of new media: *The Long Tail* by Chris Anderson. Let me use new media to motivate my conclusions.

Conclusions: The Civic Scientist & Engineer

RATHER THAN summarize what I've said I want to chart a new direction that captures everything I said. In 1996 Neal Lane, the former Director of the National Science Foundation defined a new breed the "Civic Scientist" - using the word "science" to mean "all science and engineering, research and education." He called for the research community to send out its own to talk to the public about technology. He was very explicit that if we don't educate the public then we won't be able to continue our research mission, saying "science can only be funded if the electorate and their representatives remain convinced of its value and contribution.....Without this understanding among citizens and policy makers, science and the American dream may only be a memory from the past and not a part of our future." To my mind Lane was ahead of his time, but now the time has come because we have entered the age of

Neal Lane, former Director of NSF, proposed the "Civic Scientist" - which includes engineers. Because of the rise of new internet-based media his vision can now be achieved.

civic or participatory journalism: If you take a news-worthy video you can be part of the news cycle; if you start a web site and its good enough you can get millions of hits. To me as a person who works regularly in media this truly an exciting time. I'm working with our journalism school to pilot a program to create the Civic Scientists and Engineers to communicate with the public. A generation that uses *YouTube, Facebook* and other social networks to truly advance our cause.

I close with this slide. You can get a copy of my remarks at *www.engineerguy.com/ccr/ccr.pdf*. Also, I've brought some printed copies. Thanks for listening.