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SCIENCE AND COMMUNICATION: FRIENDS OR ENEMIES?

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It's a great honor to be invited to give this keynote speech. The ARCS Foundation is a vibrant organization. In this academic year, you'll award $4 million to over 400 graduate and undergraduate scholars. I commend all of you for your dedication to passionately pursuing the vital goal of keeping America strong in engineering, science, and medical research. It doesn't surprise me at all that the ARCS Foundation was selected for the distinguished CASE Award in 2009 based on the commitment and engagement of ARCS members to its scholars.

This morning I'd like to speak about working with scientists, communicating science, and finally about the ARCS Foundation itself.

I. Working with Scientists

In 1986, marine scientist Greg Marshall invented the crittercam. Attached to an animal, this little camera enables biologists to gather new information, such as feeding patterns, mating behavior, and migration routes.

Greg Marshall hired Nick Caloyianis, a veteran filmmaker specializing in sharks, to go to the east coast of Mexico to shoot underwater scenes of Greg attaching a crittercam to a shark.

A few weeks later, out at sea, the team hooked a bull shark. These sharks are aggressive and dangerous even when they are calm and free, but this one was stressed and confined.

While Greg Marshall was attempting to attach the crittercam to the shark, its handlers, mistakenly thinking Greg was done, released the creature prematurely. A producer asked Nick Caloyianis to get shots of the free-swimming shark, and though Nick knew it was a risky situation, he agreed, resolving to keep his distance. He dove in and began filming. But what Nick didn't know was that shark handlers in another expedition boat had decided to recapture the agitated bull shark and finish attaching the crittercam.

As he was peering through his lens, Nick suddenly noticed a dark shadow in the upper right corner of the viewfinder. He didn't realize that this was the shadow of a shark handler diving in, hooking the bull shark in its mouth, and hightailing it back to the surface.

The shark, now extremely agitated, lashed out at the nearest creature, which happened to be Nick. He turned the camera toward the shark to push it away, and as the animal thrashed and bit at the camera, Nick's hand went into its mouth. Reflexively, he pulled it out, splitting his thumb and forefinger to the bone. He dropped the camera. As he continued to pound and push the shark away with his hands, it lashed out at his legs. He could feel the shark's teeth sinking into his flesh, tearing it open and crushing his anklebone.

Nick somehow got his leg out of the shark's jaws, but the angry animal charged at him again and again as they both headed for the surface. Nick was now badly injured. He and the shark surfaced right next to the shark handlers' small skiff, and Nick was pulled into the boat, his silver wetsuit streaked bright red with blood. Nick spent weeks in the hospital and months more recuperating. He still has nightmares about the incident and suffers chronic pain from his injuries.

This tragic accident happened because of poor communication between scientist and filmmaker. Often such communications are highly effective, so that both filmmaker and scientist mutually benefit. The filmmaker can make an exciting film, and the scientist can get his or her research conveyed successfully to the general public. Take these examples. The first is a clip from an IMAX film on whales.

Show clip from Whales. We couldn't have made this film without whale biologist Dr. Roger Payne whose work we feature in the film. He told us where the whales were, when they were likely to breach, sing, tail-slap, and perform many other intriguing behaviors. He taught us how to interact with the whales to ensure mutual safety and minimal disturbance.

Here's another clip from an IMAX film on wolves. ***Show clip from Wolves***. We couldn't have made this film without wolf biologist Dr. Steve Torbit. He told us where to find wolves, what behavior to look for, how wolf packs function, the vital role of play, how wolves mentor their young, and how wolves collaborate when hunting.

Here's a third clip, this time from an IMAX film on bears. ***Show clip from Bears***. We couldn't have made this film without bear biologist Dr. Sterling Miller. He told us where to find bears, what their behavior meant, and how to film in a manner that was minimally intrusive on the bears' behavior. It wasn't always smooth going. I wanted to include a scene of a bear attacking a man in a bear-resistant suit, and he was vehemently opposed to this, saying that it would simply encourage the public to see bears as menacing and man-eating. I listened to him respectfully, realized he was right, and dropped the idea.

By the way, when filming grizzly bears, I always tell my film crew to wear tiny bells to warn away bears. I also told them to look out for bear scat, readily recognizable because it contains tiny bells.

When scientists and filmmakers work together, scientists need to understand what it takes to produce entertaining, compelling, and informative footage, while filmmakers need to understand that a scientist has to speak very carefully and accurately, lest he be criticized by his peers for exaggeration, hyperbole, or lack of rigor.

So far I've talked about scientists and filmmakers communicating. What about communicating science in general?

II. Communicating Science

My father was a renowned engineer in the Royal Navy. He built aircraft carriers and nuclear submarines. The Queen made him an Officer of the Order of the British Empire and later a Companion of the Bath for his pioneering ship and submarine design work. But, as his youngest son, that isn't how I remember him.

As a Dad, he encouraged his four sons to work hard, particularly in science and engineering. I can still remember him covering our dining room table with grapefruit, apples, and grapes. He would hold them in his hands and twirl them about, as he attempted to teach us how the solar system worked. He would talk to us about gravity, magnetism, and other concepts.

It is thanks to my father that I studied science and engineering. He was like my very own personal ARCS Foundation! I absorbed his interest in science and engineering with its disciplined and logical inquiry after truth.

Barry Greene, a professor of physics at Columbia describes my late father's philosophy well in his essay "Put a Little Science in Your Life":

> "Science is a way of life. Science is a perspective…To be able to think through and grasp explanations—for everything from why the sky is blue to how life is formed on earth—not because they are declared dogma but rather because they reveal patterns confirmed by experiment and observation, is one of the most precious of human experiences."

Science helps to separate fact from superstition. It helps us to think for ourselves and find the truth.

Troublingly, science illiteracy in the US seems to be getting worse by the day. Under half of US adults know that atoms are larger than electrons, or know that the earliest humans did not live at the same time as the dinosaurs, or know how long it takes for the Earth to circle the sun.

This widespread lack of scientific knowledge is shocking, but even more worrying are the things people choose to believe as fact for which there is no scientific evidence or proof. I'm thinking

of witchcraft, astrology, alien abductions, ghosts, the prophecies of Nostradamus, and a severed rabbit's foot bringing luck. The list of glittering, meretricious superstitions and supernatural beliefs is dismayingly and astoundingly long.

These ideas lack scientific backing, yet they are popular and believed by millions of people. All the above ideas fail the test of evidence. Of course, that attitude is typical of Virgos like me!

ARCS stands like a heroic bulwark against this choking flood of tawdry pseudoscience because of its wonderfully generous support of real science.

The consequences of scientific illiteracy are more dangerous today than in earlier times. Everybody needs a basic understanding of climate change, water pollution, radioactive waste, and exponential population growth. Rational, evidence-based principles seem to be on the wane. How well our country does in the future rests to a large degree on scientific education and evidence-based thinking.

I was lucky to have a father who taught me to be skeptical and not to accept ideas just because others believed them, until there was testable, verifiable evidence.

Dr. Michael Lauer at the National Institute of Health tells a story my father would have loved. He says that as early as 1662, a few pioneering doctors questioned the efficacy of bloodletting to cure diseases. Over the years, evidence mounted against it. Yet bloodletting was popular and strongly promoted for hundreds of years. As recently as 1920, doctors recommended it as a beneficial treatment for pneumonia. Without question, says Dr. Lauer, countless numbers of patients died at the hands of medical professionals who eagerly employed the lancet, thinking, with no evidence, that they were doing the right thing.

As you saw from the clips, I have had wonderful experiences with scientists. But I've found that far too many of them do not realize how important clear communication is, not just in the field so accidents don't happen like the one with the bull shark and Nick Caloyianis, but also when talking to the public about their work. Doing the research is only half the job. The other half is communicating it clearly to the general public. Scientists have to become better communicators.

As a film producer, I'm continuously exasperated at how weak scientists are in television appearances. They often lack enthusiasm, energy, and passion, and they tend to come across as boring, colorless, and cold.

The problem isn't just that scientist are bad communicators. Many scientists don't think it is really their job. Media attention is seen to compromise their scientific authority. How can you have time to be a media star and be doing great science? Many scientists simply are not motivated or truly don't have time to communicate their science other than the occasional interview. They stay aloof in their academic safe houses and ivory jails.

Scientists are poor communicators not just on camera but also in writing. Scientists are forced into a colorless mode of professional communication where style, flair, and verve is actively

discouraged. Style is perceived by their colleagues as editorializing and anathema. Scientists are taught to be precise and not go beyond what their data say unequivocally. There are relatively few scientists who are able to break out of that mode. Carl Sagan was one. Others are E.O. Wilson, Aldo Leopold, Brian Greene, Jane Goodall, David Suzuki, and Neil deGrasse Tyson.

We need to teach scientists to be effective communicators who can speak lucidly, convey their passion for the subject, and talk without resorting to jargon. Scientists need to be more than just experts in their narrow field. For them to convey science as the exciting and dynamic area it genuinely is, they need to be enthusiastic, energized, and passionate.

The problem is not just with scientists who are unable to connect with ordinary people when they speak. Carl Sagan writes on page 369 of his book *The Demon-Haunted World* how commercial and public television revolves around money. Sagan's contempt for this system is richly justified. Television is profit motivated. The biggest barrier to more science on television is the desire by broadcasters to make money and to get high ratings. Under this system, science, engineering, and education are marginalized.

The way out of this challenge can be found by observing someone like Carl Sagan. Through diligence, determination, and a passionate commitment, he became a highly respected popularizer of science, particularly astronomy and cosmology. His television programs won high ratings because he shared with his audiences the incredible sense of joy and fulfillment he himself had found in pursuing science and using the scientific method. We need more scientists like Carl Sagan. The ARCS Foundation, to its everlasting credit, finds them and funds them all the time. My hope is that ARCS Scholars will be the scientists that media outlets go to when they need expert advice.

III. ARCS

For over 53 years the ARCS Foundation has been passionately pursuing the goal of advancing America's standing in engineering, science, and medical research. The ARCS Foundation is in the business of transforming lives.

When I first got to know Mary Snitch over a year ago, one of the first things she gave me to read was Dr. James Diorio's June 3, 2010 speech to the ARCS Lights luncheon at the Cosmos Club in Washington DC. Jamie is an ARCS Scholar alum. In his beautifully composed, moving, and poignant presentation, he said (and I want to quote him at length):

> I was in a classroom at the University of Maryland, and I found myself talking to women from the ARCS Foundation. I just remember being so struck by the level of genuine enthusiasm that they all had. Women whom I had never met, yet there they were willing to support my education, to learn about my work, to ask tough questions, and not for any self-serving or possessive reasons, but purely because they *believed in* and *understood* the value of that education.

> And as the years went on, I was extremely grateful to remain an ARCS scholar, and I began to look forward to the annual spring ARCS visit with that same excitement of a family holiday. We would joke how Mary Snitch was my "Space Mom" or Toni Scherling was my "ARCS Mom", how I'd share books with Angie Delaney or talk local restaurants with Di Alexander. And in thinking about it all now, it becomes perfectly clear – this *is* a family – ARCS is a family.
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> In my opinion this is where the power and uniqueness of the ARCS Foundation lies. Yes, you provide financial support – actually you supply *remarkable* financial support – but as a foundation you all go well beyond that. You also provide a level of personal support that is truly unprecedented.
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> There's not a doubt in my mind that I wouldn't have been able to get to this point without your support – certainly financially, but emotionally and personally as well. To provide that personal connection to your scholars, to affirm the value and benefit of their work, to help re-ignite "the dream"; these are all things you're doing with this foundation. I know that I'm reminded of them every day in my work. And I won't ever forget it.

Life's most heroic figures are often not those who achieve great personal fame and glory, but those who help others soar to new heights. The ARCS Foundation does this to perfection.

Albert Schweitzer said, "Sometimes our light goes out but is blown again into flame by an encounter with another human being; each of us owes deepest thanks to those who have rekindled this inner light." This is why Jamie was insightful to mention by name Mary, Toni, Angie, and Di in his speech a year ago at the ARCS Lights luncheon.

I'll take some questions, and then I'll finish up with brief final thoughts.

Q&A

I want to read you a short extract from my book. (*Read butter story and reference back to my father and science experiments*).

To remind you how much wisdom there is in the natural world, the domain of biologists with whom I work closely making films, let me give you the wolf credo by Del Goetz, which could also be the ARCS Foundation's credo:

> Respect the elders
> Teach the young
> Cooperate with the pack
>
> Play when you can
> Hunt when you must
> Rest in-between

Share your affections
Voice your feelings
Leave your mark

I commend everyone here for being part of the ARCS Foundation and for helping to advance its vital mission of supporting so generously young scholars in engineering, science, and medical research. By doing this, all of you are leaving your mark on the world.

Thank you.