

EPISODE SIXTY-ONE OF "ARMED WITH SCIENCE: RESEARCH APPLICATIONS FOR THE MODERN MILITARY," A DEPARTMENT OF DEFENSE WEBCAST GUEST HOST: LIEUTENANT JENNIFER CRAGG, OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE FOR PUBLIC AFFAIRS PRESENTERS: DR. JOAN FULLER, PROGRAM DIRECTOR, AIR FORCE OFFICE OF SCIENTIFIC RESEARCH AEROSPACE, CHEMICAL, AND MATERIAL SCIENCE DIRECTORATE; MAJOR MICHELLE EWY, PROGRAM MANAGER, AIR FORCE OFFICE OF SCIENTIFIC RESEARCH AEROSPACE, CHEMICAL, AND MATERIAL SCIENCE DIRECTORATE SUBJECT: DEVELOPING TODAY'S BREAKTHROUGH SCIENCE FOR TOMORROW'S AIR FORCE TIME: 2:00 P.M. EDT DATE: WEDNESDAY, MARCH 31, 2010

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LT. CRAGG: So without further ado, my name is Lieutenant Jennifer Cragg. I will be the moderator today for "Armed With Science." Sorry we had a late start today. Our two guests again are Dr. Joan Fuller, program director and Major Michelle Ewy, program manager at the Air Force Office of Scientific Research Aerospace, Chemical and Material Science Directorate. And they'll be discussing how basic research plays a crucial role in the development of future Air Force technologies.

So without further ado, I'd like to just turn it over to both the ladies and I will start with a brief introductory and then we'll go right into some questions. And thank you again for calling in. I appreciate it.

The floor is yours and we'll go straight into questions.

DR. FULLER: Well, thank you for having us, this is Joan Fuller. It's a pleasure to be part of the series and we look forward to answering your questions.

LT. CRAGG: Great. We'll go ahead and get started. Also, for any of our listeners, if you want to follow Armed With Science, follow "Armed With Science" on Twitter, Armed With Science -- the hash tag (ph). So I hope to get any questions while we're discussing today.

So first question, Dr. Fuller, as a program director and also, ma'am, as a program manager in the same directorate, you receive scientists or principal investigators all over the country who design new technologies.

Can you explain how you find these researchers or actually do they find you? Can you explain?

DR. FULLER: Well, actually, it's a little bit of both. We have a pretty aggressive group of program managers to go out and seek new areas and new researchers to explore new areas that are relevant to the Air Force. But at the same time, you know, people find us. We have a pretty good web site and our program managers' e-mails are linked there. And so people contact us with some of their out of the box ideas and then we explore them that way.

Michelle, who's actually a program manager, though, can talk to you a little bit more about the specifics.

MAJ. EWY: Well, I think it's really just as Joan said, they come to us and we go to them. The broad agency announcement on our website really explains by each different program what we're interested in in funding. But then as program managers, we also go out to the pertinent scientific meetings and conferences that make sense for our particular discipline, as an example and the surface and interfacial science program manager here at AFOSR, and most of the work that I fund deals with materials, research, chemicals, physical aspects of surfaces and interspace systems. So the meetings that I typically attend are the American Chemical Society, the Material Research Symposium, meetings like that where we actually go out, listen to the science that is being presented and come up with good ideas of what we need to fund to continue to meet the needs of the Air Force. LT. CRAGG: Well, thank you, ladies. And either one of you, if you can ask this question, what is the ensuing process for funding and a second part of that question is what is the typical duration of these relationships? Can you explain on both questions?

MAJ. EWY: This is Major Ewy. I'll go ahead and jump in as well. So if we fund some research that seems interesting or might be promising for future Air Force technologies, typically, we either contact the researcher, the PI or they contact us and we'll usually have a discussion over the phone or over e-mail about their research and where we think it might fit in with our particular program. And then from there, they actually submit what we call a white paper, which is usually a two to five-page paper describing the research that they wish to accomplish, the funding that they would need to do that and how it might apply to meeting Air Force needs and the program managers review that and if that looks like it is a good fit for our program, we'll go ahead and ask them to submit a full proposal. And they'll submit a proposal through a website called grants.gov and from there, it will come to us.

We'll send that proposal out to be peer-reviewed by other researchers that are well known in that particular field, and if it comes back with positive reviews and, again, it makes sense for us to fund in our particular area of interest, we'll go ahead and fund it.

A typical grant is usually three years, somewhere between 150 (thousand dollars) to 200 (thousand dollars) a year for each individual

researcher, but that really can depend, depending upon the research that they're doing and the kind of impact it'll make in the field.

LT. CRAGG: Thank you, ma'am, very much. Now, going back, Dr. Fuller, your program is titled, "High Temperature Aerospace Materials," and Major Ewy, yours is "Surface and Interfacial Science," and I understand that the AFOSR's mission is to make current technologies actually obsolete. So, in other words, you're funding basically 6.1 research that will lead to new technologies that replace the ones used in today's Air Force.

So getting to my question, what are your individual roles in making this happen in your particular research areas? Can you elaborate?

DR. FULLER: Sure. I'll go first. This is Dr. Fuller or Joan Fuller.

I started the high temperature aerospace materials portfolio in 2001 when I became a program manager here at AFOSR and this portfolio is unique in that it's the only basic science portfolio in the world that focuses on materials that can survive oxidizing environments above 1,400 feet. And this environmental area, it's important for the Air Force because of the future desire to have hypersonic platforms -- reusable, sustainable hypersonic platforms, unlike a NASA Shuttle which has to be brought back in and undergo pretty expensive and time-consuming refurbishment before the next mission.

The Air Force would like any time, day or night, rain or shine, have a hypersonic platform that can fly. And so the class of materials that you need for that are very specific and we are pretty much the only ones who are going to make that happen if it is to be achieved.

And so for nine years, I've focused on building a community in this country that can work on that challenge and it's gone everything from building a very fundamental academic program all the way now to having industry and other government agencies sponsoring work in this area. And it's pretty much transitioned away from basic science. And I think you'll see some more applied and more engineering advancements coming out in the next five or ten years that are a direct result of the work that we started here at OSR nine years ago.

LT. CRAGG: That is amazing. And I'm sorry, ma'am, I know you're going to talk about your interface with surface and interfacial science. Go ahead, please.

MAJ. EWY: Oh, I apologize. This is Major Ewy. So I've been a program manager for about a year-and-a-half, and again, the portfolio I run is surface and interfacial science and it's a very broad title and because of that, it made sense to focus down some. And so, really, the portfolio has for about the last two, three years, focused on understanding degradation of surfaces and interfaces, both understanding the chemical and the physical processes or forces that cause surface and interfacial degradation. And that can -- and even that is sort of a broad range, anywhere from tribology, the study of friction, adhesion

wear of the surfaces and contact, to really looking at macro-scale degradation, looking at micro-organisms and how they can degrade different surfaces and what those affects are throughout, from going from the surface through the interfaces of materials.

So using, I guess, funding for molecular dynamic simulations, as well as experimental research, really trying to probe and understand what are the forces, particularly at the nano-scale, what are the forces that cause degradations in nano-scale? And that's important because as we move towards using more complex and hybrid materials, you hear about nano-materials and nano-tubes all the time. Well, if we want to start using those really enabling materials in our Air Force assets, we need to understand how they survive in the environment that they're exposed to, both the environments within the materials themselves, so if we have two materials rubbing against each other, how is that going to affect the overall material itself, as well as exposure to the external environment if a material is sitting on a flight line on an aircraft or a couple of weeks at a time and it is exposed to the environment, what are the affects going to be? So that's sort of the area that the portfolio focuses on and why.

LT. CRAGG: Thank you, ladies, both, for going into that. I'm sure that's going to be very interesting for a lot of our listeners. And on that same vein, Major Ewy, why don't -- I know you talked about your program manager responsibilities, but go into more of your major responsibilities. And can you tell, tell our listening audience or tell me a little bit about your academic and professional background leading up to your current work at AFOSR?

MAJ. EWY: Sure. So, really, as a program manager, I think I touched on a fair amount of what we do. Our real mission is to go out and find the science that it makes sense to fund the basic research specifically, fund to fulfill the Air Force's future needs and then to make sure that whatever science is actually accomplished it's reported out into the scientific community so that the scientific knowledge base is expanded and that research that we funded is really going to make an impact in the particular field.

So I think those are my primary responsibilities as a program manager sort of from a big picture point of view.

I guess to give you a little bit about my academic and professional background, I actually attended, I was a Navy brat, I attended Thomas Jefferson High School for Science and Technology here in Northern Virginia. So my interest in science started out pretty young. From there, I received an undergraduate degree in chemistry and was commissioned through ROTC. And in the Air Force I've had quite a few different jobs, but I've also had the opportunity to get my Ph.D. from the University of Virginia through the AFIT, the Air Force Institute of Technology Civilian University program, which was a really, really wonderful opportunity. And from there, I was a research scientist, research chemist in the fuels branch, propulsion director of the Air Force Research Lab.

While I was there, I had the opportunity to deploy to the Middle East and be in charge of the aerospace fuels lab where we actually tested fuel for the entire area of responsibility in the Middle East. From there, I taught at the Air Force Academy, I taught biochemistry at the Air Force Academy and spent one year at Oregon National Lab as an Air Force national technical fellow and from there was able to move into the program manager job here at AFOSR.

So I feel that I've been very, very lucky in my Air Force science career. I've had lots of really wonderful opportunities, and I think it has given me a pretty good vantage point for sitting here as an Air Force program manager, specifically as an active duty program manager to have a good idea of how important the basic research is for our Air Force and to ensure that we continue to be the preeminent Air Force in the world. LT. CRAGG: What an amazing background all starting with Thomas Jefferson High School, teaching at the Air Force Academy, ROTC background and then where you are present today. What a great run down and great role model for other women in science, so other women starting who have an interest in science. So thank you for going through that so eloquently. I really appreciate it.

Now, Dr. Fuller, you know, I've been told that you have five scientific focus areas, aerospace, chemical, material science directorate and a whole litany of them from aerostructure, interactions and control, energy, power and propulsion, complex materials and structures and some other areas.

You know, to turn it over to you, can you tell our listening audience about a few recent breakthroughs or milestones from these areas? Can you elaborate?

DR. FULLER: Sure, I'd be happy to. It's a phenomenal portfolio. We have 11 program managers who cover the spectrum and our motto is if the leaves the surface of the Earth, we have control over the research that makes that possible. So it's an exciting portfolio.

The first focus area that we have that's near and dear to my heart is the aerostructure interaction and control. And what's at the heart of that is really understanding how we can exploit the characterization modeling and experimental tools to probe the interactions that occur between, say, a flight structure and its environment, the fluid environment. And pulling back to the hypersonic portfolio, the materials portfolio that I managed for nine years, that's critical because it turns out above Mach 6 -- excuse me, above Mach 6, there's a lot of chemistry that occurs in flow field and understanding how that chemistry impacts the boundary layer has significant impacts on both being able to communicate through the plasma, but also being able to control the vehicle while it's in flight and in operational environment.

It also has a pretty big impact on the materials themselves because if you have chemistry that's occurring on the surface as it's flying at Mach 6 or higher, that actually can create localized hot spots, which will trip the boundary layer and will cause the vehicle to spin out of control, so to speak.

So it's very important that we understand what the chemistry is and how it interacts with the materials system that we ultimately hope to build our platforms from.

The other areas, the complex materials instructors is an evolving thrust area in our group. OSR has for years supported work in the traditional metallic polymeric and ceramic materials system. And what we've been attempting to do for the past three or four years is really try to push beyond the traditional domains of stovepipe chemistry, you might want to think of it that way. But Major Ewy brought up a really good point. If we do hope to exploit some of the advances in nano- materials, nano-tubes and some of the complex structures that nano- tubes might enable, it's important that we understand how to make them in large scale, but also how do we control them in an operational environment that they would work in ultimately.

So being able to build a complex materials system, incorporate the hierarchical design that you would need in that material, understand the functionality of its use and how you might actually make a multi-function material, everything from nano-scale to mezzo- scale control is very important. And this is an emerging area of science. There are very few researchers in the world today that focus on making a complex structure -- and you might think of your skin as a complex structure in that it self-heals, it cools itself if it gets too hot. It senses that it's too hot if you put your hand next to a flame, you'll actually pull back without even realizing it. But ultimately, we'd like to have families of materials or classes of materials that have the same type of inherent intelligence that adapt to their environment that we can incorporate into future platforms.

And the final one is what is probably at the foundational structure of everything and that's energy power and propulsion -- to be able to actually power these new systems even from electronic materials, but all the way up from space access where we need novel ways of propelling things into space, requires that we have an exquisite control of the chemistry at the nano-scale, everything from being able to produce, store and then utilize those sources of energy so that we can harvest -- and one of the mantras of this program is harnessing the power of phonons is very important for really being able to achieve air and space superiority in the future.

So those are just a few of the highlights. We have well over 200 projects currently being supported in just these three focus areas, so I could probably spend the next two hours and I've promised not to do that.

LT. CRAGG: Thank you. You said have well over 200 projects. Is that what you said?

DR. FULLER: Just in these three specific focus areas.

LT. CRAGG: And you kind of alluded to my next question when you were going through all that. Why are these breakthroughs so important to

the Air Force and the private sector? And you kind of were alluding to that when you were explaining everything that you're going on it -- you know, explaining all the different areas you're responsible for. Do you want to elaborate anything about how important this is, again, to the Air Force and the private sector?

DR. FULLER: Well, I think, what you'll find with basic science, it is so foundational or so fundamental in nature that it's a synergistic effect. We don't really understand or we can't predict what research that we fund here at AFOSR, what impact it's going to have, say, 20 years from now. And many times it is the private sector that takes the first advantage of some of these technologies.

In terms of solar cells, which are becoming much more common in the mainstream and the commercial market, it turns out that most of that work was originally supported by AFOSR in the 1970s and the early 1980s with collaboration with some of our DOE counterparts.

And so it was just too expensive in terms of making it militarily useful until the commercial sector came on board. Now those technologies are becoming much affordable because of the scale of commercialization of those product lines. And so we're now able to take advantage of it.

So we have, I think, a pretty big interplay with the private sector, of course, most of our principal investigators are in academia, and so we do work closely with them in identifying what basic research areas that we should focus on and which ones are unique to the Air Force and we fund those primarily here at AFOSR. And Michelle could probably talk a little bit about her experience.

MAJ. EWY: Well, I think that one of the great benefits that comes out of the research that we fund is not necessarily just the fundamental knowledge that we gain, but also the collaborations that the funding builds, both with universities and small businesses, but also with the other DOD laboratories and DOE laboratories as well.

I think one of the questions before is how long the funding opportunities or funding relationships last, and I think one of the things that's really interesting is oftentimes when we fund principal investigators in our particular portfolios and we also fund Air Force Research Lab researchers in our portfolios, they will start collaborations or projects together that really have nothing to do with our particular portfolio, but that grow and become a solid relationship outside of AFOSR as well.

So I think one of the impacts, really strong impact of our funding is that we are building relationships within the different disciplines that aren't there, wouldn't be there, might not be there otherwise.

So I think that's one of the outcomes of our funding that people often may not think about unless they're directly involved. And so I think that has a large impact as well. LT. CRAGG: Thank you, ladies,

for both elaborating on those two points about the important breakthroughs for both Air Force and the private sector. I really appreciate it.

My last and final question and -- you know, I saved this for last because today is the last day of the month, March 31st and it's the last day of Women's History Month.

So do you have any -- and I know both of you kind of alluded to this when you described your backgrounds. Do you have any words of advice for young women, young girls who are interested in pursuing careers in scientific research? Any thoughts for them?

MAJ. EWY: This is Major Ewy. I guess I think my first advice would be to read everything you can about what you're excited about, to get your hands on as much information as possible if there's a particular part of science that you're interested in. And then from there, I would say look for opportunities because there are so many opportunities for young women, girls, older women to get involved in science. They just need to do a little bit of looking. And I honestly think the Internet is a great way to do that, is to find opportunities for work in the summer, for internships, for getting your hands dirty in the lab.

So I would definitely recommend that. And the other thing I think is really important, particularly because sometimes girls tend to be a little bit more reserved in the classroom, don't be afraid to ask questions. Who cares if you feel like maybe you're going to look stupid. You don't. Other people are wondering the same thing as well.

So ask questions. Don't be afraid to put your hand up and get more information if it's something that you want to know and something you're excited about. That's my thoughts, I guess.

DR. FULLER: Yeah. And I would have to say I agree wholeheartedly. It's interesting that I started my career not as a scientist, but as a professional dancer. I actually have a liberal arts degree first and that allowed me to pay my way through undergraduate school to get an inorganic chemistry degree and then onto graduate school. And one of the things that I found just talking to some of the folks that I mentor now that I'm much older and I'm in a position where I can look back and actually provide some insights is that many of the folks out there don't realize that getting your undergraduate degree you pay for a lot of the time, but getting a graduate degree is most of the time paid for.

And so in my case, I had a chemistry stipend. It paid for everything, tuition, books and a pretty decent housing allowance and so my parents didn't have to incur any additional debt because of me. But AFOSR actually supports us through our grants. There is student support attached to those grants that we give to universities that pay for graduate and undergraduate stipends. And so if you're interested in science and you're afraid that it's just going to cost a lot to get an advanced degree, it turns out it's not actually very expensive at all and you can use some very creative ways of getting your education paid for.

I had some great advice by someone who I don't think realized he was giving me advice when I first started out, and he said, well, you may not think you need a Ph.D., but just be aware that if you don't get one, you'll always work for someone like me. And I said, well, I don't want that. (Chuckles.) So I worked very hard to get a degree that I figured would put me in a position that I could make decisions that would help the Air Force -- my research actually as an undergraduate was paid for by the Air Force.

And so you never know what opportunities are going to come from unexpected places; like I said, the dance paid for my undergraduate degree and I was very grateful to have that opportunity. And it gives me a slightly different perspective, I think, now that I'm at sort of the end of my personal research career and going more into management of science and policy of science.

There's a lot of opportunities. You don't necessarily have to be a bench level scientist to make an impact in research. Sometimes being an HR specialist and understanding what the skillsets are that you need to be a really good scientist, that's an important job. HR, recruiting the best and the brightest, looking hard for the people who believe in the mission and are dedicated to the people of the Air Force and to the United States. That's a really key job to have. And if you have an appreciation for science, it makes it a lot of fun.

LT. CRAGG: Thank you both, ladies. I'm sure your words of wisdom really will help a lot of future budding scientists who are looking at maybe making a career in science or research or whatever the path that may take them. So I really appreciate it.

With that, I wanted to wrap up today's "Armed With Science." Just inform everyone they've been listening to Episode 61: Developing Today's Breakthrough Science For Tomorrow's Air Force. And you've been listening to Dr. Joan Fuller. She's a program director and Major Michelle Ewy. she's a program manager at the Air Force Office of Scientific Research Aerospace, Chemical, and Material Science Directorate. And today, they discussed the process of finding the world's top researchers and some of the breakthrough technologies that have resulted, you know, from this basic research in their field and a wrap-up of Women's History Month.

So thank you, ladies, so much for taking time out of your busy schedules to talk about science and the important work you both are doing.

If anything else, I'll wrap up today and thank you very much.  
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