Questions for *Women in Aerospace*, a book under development through SAE

Karen M. B. Taminger
Senior Materials Research Engineer
NASA Langley Research Center

Bio:

Karen Taminger is a Senior Materials Research Engineer at NASA Langley Research Center in the Advanced Materials and Processing Branch. She currently serves as a technical lead for structural efficiency in one of NASA's transport aircraft projects, and she has led additive manufacturing work for several in-space and for-space manufacturing projects. Throughout her career at NASA, she has worked on various aspects of processing-microstructure-mechanical property characterization related to metallic materials for aerospace structures. She has led development of the Electron Beam Freeform Fabrication (EBF^3) technology since 1999; a large-scale metal additive manufacturing process for high performance, low cost fabrication of metallic structures for aircraft, launch vehicles, and spacecraft. One of the highlights of her career was the opportunity to conduct parabolic flight testing of EBF^3 for compatibility with the space environment. As a result, she has spent 3 hours in zero-gravity (in 15-second increments!). She is the co-inventor on five issued patents and four other patent disclosures and was the lead or co-author on more than 35 papers and 100 presentations. Personal awards include the NASA Exceptional Achievement Medal in 2007 and the NASA Exceptional Technology Achievement Medal in 2014. Her team's work in metal additive manufacturing was recognized with the NASA Langley's Whitcomb-Holloway Technology Transfer Award in 2008, and selected as the runner-up for NASA Patent of the Year in 2016. She earned her BS in Honors from Virginia Tech in 1989, majoring in Materials Engineering, and her MS degree from Virginia Tech in 1999 in Materials Science and Engineering. She was employed at NASA Langley Research Center as a co-operative education student from 1986-1989, and she has been there full-time since graduating with her BS in 1989. She is married and has three sons.

Personal Career Insight:
What inspired you to choose a career in Aerospace and what has given you the most satisfaction during your career?

I enjoyed mathematics and chemistry in high school and was intrigued by the bourgeoning world of computers (it was the early 1980's). However, I was skeptical when my guidance counselor recommended I study engineering. You see, when I was growing up, my father was in the Navy so my introduction to engineering was in the boiler rooms on his ships. It was a hot, challenging environment and women were not allowed to serve on ships at the time. My mind was changed the summer between my junior and senior year in high school when I was selected for an 8-week program at NASA Langley Research Center. I was assigned to do computer programming of algorithms to analyze wind tunnel data, but I was also immersed in

a world of aerospace engineering. Throughout that summer, I spent my spare time visiting the worksites for the other students in my program. I learned I wanted to do more experimental work than computational or theoretical, and that there were many different types of engineering to choose from (none of which required working in a boiler room!).

I decided to major in materials engineering and was hired as a co-operative education student at NASA Langley Research Center early in my undergraduate studies. After graduating with my bachelors of science degree, I was converted to a full-time engineer and have been at NASA ever since. I have had the opportunity to work on many different projects throughout my career. One of the most satisfying ones involved developing a portable metal 3D printer for performing tests in zero-gravity. The project focused on demonstrating the feasibility of electron beam/wire directed energy deposition in a zero-gravity environment. We conducted these experiments in NASA's C-9 aircraft, which flew in parabolic trajectories to create periodic simulated microgravity conditions. Besides the thrill of experiencing zero gravity, the greatest satisfaction came from building this entire project from advocacy to demonstration. I had to start with obtaining the funding and assemble a team to design and build the hardware. The camaraderie, focus and dedication of the team was inspiring, and we overcame numerous hurdles to successfully perform a series of cutting edge experiments on metal additive manufacturing in microgravity more than a decade ahead of everyone else.

Work / Life Balance:
Did you ever have to make a move to advance your career (within your company or changing companies), that impacted your family life, and how did you balance the two?

I have always taken a slightly different path from my peers. For me, changes to my family life came first, and that move enabled me to advance my career. My husband and I are both engineers, and after the birth of our second child in two years, we were exhausted from trying to maintain two careers and two kids. We did the calculations and realized that one of the two of us was basically working to pay for the daycare bills and other services like maintaining our cars, mowing the lawn, and take-out meals – all things that we could do on our own but didn't have the time. Most important, we were too tired to enjoy raising our children. Since my job had the better benefits, my husband made the sacrifice to put his career on hold and become a stay-at-home-dad. The decision was not made to advance my career so much as to put family first, but that has made all the difference.

The outcome of that decision took me to places I never envisioned at the time. With the children at home (we added a third three years later) and my husband there to nurture them, I could take on more responsibilities without having to worry about getting the call to pick up a sick child being sent him from daycare or school. I began to travel more and to develop a wider technical network inside and

outside of NASA. I tried hard to balance meetings and trips and not to miss events like sports games or school assemblies, which sometimes led to crazy travel schedules. I was comforted knowing that my husband was there with my three sons, videotaping the occasional event that I did have to miss. That support at home gave me the stability and confidence to take on the challenges of leadership at work.

Mentorship / Sponsorship:
How important was mentorship/sponsorship for your career? Have they been men or women? How was the relationship established?

Mentorship, both being mentored as a young engineer and now providing that mentorship to young engineers in our group, has been key to learning on the job and navigating how things get done within a big, ever-changing organization. As a co-operative education student at NASA, I had formal mentors assigned to me. In the co-op program, I alternated quarters between taking classes at Virginia Tech and working at NASA Langley. I spent five quarters at NASA before graduating with my undergraduate degree. Since I was a student, I was learning the practical aspects of how we performed different tests on different materials. I rotated through different branches covering the breadth of disciplines within materials engineering. For these mentorships, three of my five different mentors were female engineers.

After graduating with my degree in materials science and returning to work at NASA full-time, I found the nature of my mentorships and my mentors changed. Although we have many formal procedures, policies, and training on how to follow them, there are many aspects of engineering that are not written down. Much of what I needed to know to do my job effectively was informal and so were the mentorships that helped teach me along the way. l learned about programmatic advocacy, how to manage people and team dynamics from my branch management and technical leaders, all men 20-30 years senior to me. They also helped me learn how the "system" worked and develop connections that have enabled me to grow my network and influence. In addition, I was fortunate to have several female engineers as colleagues only 5-10 years older than I am. Beyond the technical mentoring, I learned a lot about personal growth and balancing family and work from them. They also provided me with an outlet for comparing notes about our children's development. I have now progressed to being a mentor to our new hires, both young men and women, to share with them what I have learned along the way.

Avoiding a Stall:
Were you ever presented an "opportunity" you declined and did it hurt your career? If so, how did you overcome any negative impact?

NASA has a dual-ladder for advancing to more senior positions: this means you can attain promotions by continuing on a technical track or by switching to either a program or line management position. About fifteen years ago, I was a mid-

career engineer, leading and performing research on metals processing on the technical side of the ladder. I had worked with project managers for several years providing technical support, so I had learned how the project offices at NASA work. We had an opening as an assistant branch head in our line management track, so I applied. After discussions with the branch head about what the duties would entail, I had to make the choice between continuing to support the projects and personal research that I was performing or switching over to line management where I would be more involved with personnel development. I had already attained the same pay grade in the technical ranks as I would have received as an assistant branch head, but branch management is a stepping stone to higher levels of either program or line management. I opted to withdraw from the applicant pool to continue the work I had spent years cultivating.

Although I've preferred to continue to lead from within and have immediate technical influence over the programs and research, I find that I have now been doing more personnel development in that role. I have always mentored summer interns and am now mentoring new employees. I have been able to help build the pipeline and groom young talent as many of our branch members are reaching retirement age. In my technical lead position, I can advocate for funding and new positions that will form the future workforce within our organization without actually being branch management. I may not be eligible for a senior manager position without becoming a program or line manager, but I firmly believe that there is also the need for the strong leadership from within that I provide. From that perspective, I do not feel as though there has been a negative impact to my career by opting not to pursue the management track.

Powering On:
Was there a significant event that changed your career trajectory and what was it?

I started my career at NASA as a materials research engineer performing mechanical tests, microstructural analyses, and evaluating environmental effects on various aerospace metallic materials. In 1999, a new program was started at NASA Langley offering support for exploring nascent ideas with promise for advancing technologies relevant to future aircraft and space-based applications. At that time, the concept of solid freeform fabrication, which would eventually lead to what is now known as additive manufacturing or 3D printing, was emerging for polymeric materials. Sandia National Labs was developing the Laser Engineered Net Shaping (LENS) process using a laser and blown metallic powder to build three-dimensional metallic parts layer-by-layer. These developments inspired me to submit a proposal for developing a large-scale, rapid metal deposition process using an electron beam and wire feed we called "Electron Beam Freeform Fabrication" (EBF^3). That was my first technical leadership opportunity that launched me into leading the development of this technology for 20 years for a wide variety of different applications and projects for NASA. I served in the dual role of developing the

technology and continuing to advocate and support projects as a technical lead for the metallic materials area for many years.

As I continued in my career, I learned more about disciplines related to my field of materials. Materials and manufacturing processes require a knowledge of structures and systems to understand the geometries and operational requirements of components that are designed and built. Expanding my knowledge has also led to expanding responsibility supporting advanced transport technologies. I remain in a research role, but I have transitioned to more advocacy and technical leadership, generating new ideas and advocating for others' ideas to develop them into funded, executable project plans.