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This interview continues our series of discussions with business executives, government officials, academics, and project managers published in the PMI NAC Newsletter.

Our goal is to present leading ideas and insights on the practice of project management for our readers.

***Mike Griffin** is the King-McDonald Eminent Scholar and Professor of Mechanical and Aerospace Engineering, and Director of the Center for System Studies at The University of Alabama in Huntsville. From 2005 to 2009 he was the Administrator of NASA. Prior to re-joining NASA he was Space Department Head at the Johns Hopkins University Applied Physics Laboratory.*

In this interview – Mike discusses his work on behalf of the Center for System Studies and addresses the opportunities and challenges facing the field of systems engineering with a focus on the design and development of large complex systems.

Mike Griffin was interviewed for the PMI-NAC Newsletter by Don Ross, PMP

The new **Center for Systems Studies** will involve groundbreaking research into complex engineering systems, which include smart power grids, space launch vehicles, robotics, aviation systems and missile defense, to name a few. The center's focus will involve understanding how complex systems interact and developing engineered solutions to system problems.

As center director, Dr. Griffin will leverage his experience and relationships to set the tone and direction for the center's academic and research endeavors, and will provide students and faculty with opportunities to work on some of the most complex system challenges of our day.

Plans call for the Center for System Studies to be a three-phase project that will include research labs, training space, classrooms, and a rooftop experiment area. Phase One of the project will be about 60,000 square feet. When fully completed, the center will occupy approximately 160,000 square feet.

Look for more information on the center at <http://www.uah.edu/systemstudies/>

PMI-NAC: *For our readers who may have missed your visit with the PMI-NAC chapter in May, can you give us an overview and some key takeaways on your goals and plans for the new Center for System Studies at UAH??*

Griffin: The Center for System Studies here at UAH was established to provide a focal point for what we think is a great thrust area and area of concentration for the university. The goal is to provide a focal point which enhances the profile and the reputation of the university and brings a certain synergy to our efforts.

Now, why are we doing that?

Let me back up, UAH is a good local school with a good local reputation and a good reputation among technical people for the engineers it turns out. I think I can safely say that. But it does not have a strong regional, and certainly not a national, reputation other than for a small "in group" that knows particular graduates. The University of Alabama system trustees know that and three years ago they hired a new president, Dr. David Williams, with the explicit goal of raising the stature and profile of the university.

So then you have to ask the question "How are you going to do that?" Well, you clearly must find some area in which the university can excel relative to others. The easiest way to do that is to find a thrust area that takes advantage of the natural strengths of the university and the region in which it finds itself as other great schools do, and also if you can, you want to find an area where there are not a lot of other people pursuing the same goal.

Based on this, there would be a number of candidates as this is a very high-tech region. But, it's mostly high technology focused around aerospace and defense, and if I add energy systems I think you have it all for the Tennessee Valley.

As a consequence of focusing on aerospace and defense and energy systems, I think the common theme there is "systems." We're talking specifically about large-scale systems, usually involving billions of dollars, sometimes many billions of dollars of federal money. That money is taxpayer money – our money – for which the citizens of this region exercise, in large measure or small, the responsibility for designing, developing, integrating, testing, and fielding these large complex systems.

Now these things have an interesting characteristic: *they're usually very important things.* They have to work. Something over \$32 billion a year of federal money goes through this region. It's a statistic we all know. What we do here is important. It's important though in an interesting and maybe not unique way – but unusual way – that while we are a high-tech region, we are not by and large the builders of components, widgets, specialty parts and things of that nature.

We are not Silicon Valley with microdevices and nanotechnology, although the university has one of the better nano-fabrication facilities in the country and certainly the best in the southeast. But, it's not by and large our forte to invest in microdevices in this area. We don't build nuclear reactors. We don't build steam turbines. We don't build widgets.

What we do is integrate the contributions of others from all over the country and all over the world. *What we do is systems design, development, integration, and engineering for large, usually publicly-funded systems, which have to work.*

Now, the university has, by and large, not been part of that. That hurts both the region and the university. It hurts the region in the obvious way that if you look around the world you will be hard-pressed to find any of what has become the fashion to call a "cluster." You would be hard-pressed to find any high-tech cluster that doesn't have a truly prominent university at its core.

I will just assert that. I've done the research. I will allow others to look if they don't believe that, but I think just thinking about it for a moment or two will acquaint folks with that fact.

PMI-NAC: *Being from Seattle – I can certainly agree with your assertion.*

Griffin: Right. And thank you. You don't find a Cal-Tech or a Stanford or an MIT in every cluster, but you find a good, very prominent nationally – and internationally – recognized university, and sometimes more than one. If you look at the Baltimore-Washington, DC area, you have Johns Hopkins University, a truly elite school in certain areas; the University of Maryland, a truly elite state university; The George Washington University, an elite private school; and also George Mason University an up and coming element of the University of Virginia system. You have a plethora of choices.

Frankly, we don't have one of those here yet. And so it hurts the region. It hurts our ability to compete as a region when we can't, if you will, put on our business card, even a virtually great research university. It hurts the school that we are not closely involved with what goes on in our region, because we miss the opportunity to tie our intellectual contributions in the university to what goes on in the region.

The "coin of the academic realm" is graduate students, PhDs, published papers, and advancements in the state of the art; and if our region's contribution to the world is design, development, integration, testing, and fielding of complex systems, and the university is not closely involved in that area of research, then frankly, we're missing the boat.

Our academic researchers may be advancing the frontiers of knowledge in their academic silos, but they are not contributing to what's being done here. Now, that's the bad news.

The good news is that, by and large, other academic institutions aren't doing so either.

Systems research, despite more than a half century of practice in the field, is not yet a major academic thrust. There are reasons for that. I just finished saying that the coin of the academic realm is PhDs, publications, research, and advancement of the state-of-the-art.

Academics are generally strongly incentivized to work within a given specialty area. A really well known, nationally known, internationally known, national-academy quality academic is a person who becomes a world expert, generally, in a very narrow area. That is exactly the opposite sort of incentive and behavior from that which is required to understand the characteristics, design, efficiency, operations and robustness of big systems.

Big systems operate across technical, cultural and even psychological discipline areas. They are about integration, context, and connection versus excessive depth in any one area.

PMI-NAC: *To prepare for this interview I turned up several examples of complexity research across a wide range of fields...*

Griffin: Right. And you can look at it from any given perspective and certainly I don't mean to imply that there is zero awareness of this field outside, and indeed the National Science Foundation is spinning up a new effort in "complex engineered systems" as they call it. But it is new.

So the NSF has been in existence since the years just after WWII. We've spent 60 years and more designing, developing, and engineering complex systems and the NSF is now, very recently, beginning to regard this as a thrust area for research.

So my point is that it's relatively new – not that it's nonexistent in other places, but relatively new and there are not a lot of universities that have established this as a big area where they will build a reputation.

That's precisely because most academic incentives work against it as I was just saying.

So this is an area where we in the university can compete effectively with other universities. It's an area where, if we get into it, we can be more closely matched with the kind of work going on in our community. That in turn will help us make a better contribution and I think then it's a win-win all around.

PMI-NAC: *Other points on this topic?*

Griffin: The discussion I've just had with you of course is something I've had with many other people to include the governor and the state legislature. They've responded very positively as we all saw back in April. Governor Riley and several state legislators came up to announce the award from the state of \$8 million dollars as seed money as part of what will be required for a new, iconic building at the other end of campus. The building will be sort of a "bookend" for the Shelby Center.

Senator Shelby has pledged a contribution from federal funding to that building. Buildings themselves don't do academic work and make intellectual contributions but they can serve as gathering centers for those who do. That's what I think the governor was recognizing. So we were very grateful for that contribution. That may be the most significant update for now.

We've also received a couple of research grants so far from the Missile Defense Agency and the Draper Laboratories. We anticipate more of those to come.

But our real focus is not on having a center that hires a bunch of people, but rather having a center that serves as a focal point for systems-oriented research at the university and for tying our academic folks into that activity.

PMI-NAC: *A quick look at the field of systems and complexity reveals a dynamic environment spanning many scientific, technical and social fields. Given this rich information base, do you see opportunities and potential synergies for the center?*

Griffin: I don't yet know what synergies are available. That, in part, will depend on who wants to partner with us. One difference I would say we bring to the table is – you can talk about studying complex systems and complexity on a mathematical or a scientific basis. It's another thing to look at it from the point of view of actual systems engineering.

How do you build things that work when you're done? I'll put "work" in quotes meaning that they satisfy the user or customer's real objective as opposed sometimes to just the requirements that are written down. And how do you know that the system even meets those requirements? When we are building very large systems, very complex systems, it can be extraordinarily difficult to know on the design and development end whether the thing is actually going to work when you're done.

And how can we make improvements in that?

Then, for an engineer, the question that immediately follows is "if it works, well is it robust? Or is it fragile?" I think everybody understands intuitively what we mean using those terms. But engineers like to quantify things. They like to be able to measure it. If you can quantify and measure it, then you can study how it varies and possibly construct an algorithm or a theory that will help you.

In my line of work, which is of course aerospace, a few years ago we had a tragic accident that resulted in the loss of the space Shuttle Columbia, which affected everyone in that business who lives here in this town. Well, when a piece of foam falling on a wing can take out a \$3 billion-dollar vehicle and seven crew – that system is not robust. It works and it's marvelous. What the space shuttle does is a set of things no other group of vehicles in the world can do. But it's not robust and engineers like systems that are robust.

So we know what it means, but we don't always know how to design for it. I think that's an interesting research topic.

If a system works and is robust, then is it efficient?

Does it make good use of the resources put into it? Does it give a good output for the resources put into it? And how do you know? What's your measure of efficiency?

Efficiency could mean different things to different people, and how do we design for that? We don't really have a good measure for that. It's a word we use but I'm not sure we really know what it means.

Now if it does those first three things – what about the unintended consequences?

No matter whether you think that human-generated global warming is a major factor or a minor factor, or is good or bad, certainly the production of carbon dioxide by systems that generate energy is an unintended consequence. We usually don't think about unintended consequences until they hit us in the face.

Yet, an important characteristic of good design is that while doing what you ask it to do, it should also do a minimum of other things that aren't asked for in the design. Usually, we don't have good ways to measure that.

We don't study it. We don't ask those questions when we are designing systems and we should.

So, what I'm trying to do is approach this overall topic of complex systems and the study of complexity from the point of view of somebody who has to produce an engineered system that does those things I just mentioned.

I think that's a little bit different and we'll look for partners and enterprises that share that vision.

PMI-NAC: *The center's business model appears to emphasize grant-based, funded research efforts supporting corporate and government entities. Will the Center also conduct pure research into complex systems studies, and will related courses be developed that will be helpful to students and professionals?*

Griffin: I'm probably not looking at pure research. Our focus will be on applied research because that's what we do here in this region. That's important for folks to understand.

Also, while the center is not going to be offering courses, we at the university are looking at revamping our systems engineering curriculum. I would like to help build the university into a place where we offer a systems engineering degree, which we do, but that is clearly differentiated from other such offerings.

PMI-NAC: *Given the interest level our readers have in project management and management science topics – do you see the center as primarily a consumer of management knowledge – or potentially contributing to its knowledgebase?*

Griffin: Certainly. Entirely apart from my role in the Center for System Studies, I have taught a two-day short course for Continuing Education in program/project management and I will be doing so again this fall. It is provided through UAH Continuing Education.

I have my own views about program and project management and I share them in that course. So I hope your readers will find those insights beneficial.

In brief, program and project management is about managing complexity in a practical sense rather than in the interesting theoretical sense when we talk about complexity.

PMI-NAC: *Given your experience and knowledge of engineering, technology, space science, and related disciplines – what do you see as the most challenging and / or potentially beneficial results we could see from the center in the years to come?*

Griffin: What we are trying to do is add to the body of knowledge on how complex systems can be effectively designed, developed, engineered, managed, and put into production.

A point I would like to leave your readers with is the following: *much of what passes for formal instruction and formal practice in systems engineering today is what I would call "very checklist oriented."*

And I make that point deliberately. I'm talking about a checklist as in a pilot's checklist.

Now I'm a pilot. I own a pretty nice airplane. I like to fly it. I try to fly it carefully. And as such, I have a very careful checklist that I go through before I fly it. And it's extremely important that I do that.

Nothing on that checklist, however, has anything to do with the actual flying of the plane.

You can execute everything on the checklist perfectly and crash the airplane if in fact you don't know how to fly well.

I think the analogy with what I see going on and what passes for systems engineering is very appropriate. You can do everything involved in verifying a compliance matrix, tracing requirements from parent to child, and following all the "ilities" of systems engineering.

But if you don't actually know how to do it – you'll still fail.

We see too many cases where everything which was supposed to have been done was done and the system doesn't work as intended. That's the intellectual thrust that I think is missing from the current practice of systems engineering. That's where I'd like our center to make a contribution.

How do we fix that? Now I'm asking a question. If I had the answer I think I would just announce the answer. I'm not claiming to have the answer. I am pointing out that our current practice as well as our current style of teaching, what we think of as systems engineering, is really all about process. And process is important.

In a world where you didn't have process, you would have to invent it. But we have process and we're still building complex systems that overrun, take too long, don't work when they are done, and have hidden failure modes that are in some senses generally dissatisfying.

So there's something incomplete. Something we are not doing that we ought to be doing. What is that?

PMI-NAC: *This is your gap analysis?*

Griffin: That's my gap analysis. How do we close it?

PMI-NAC: *And a holistic approach is insufficient?*

Griffin: That leaves too much to intuition. I'll use an analogy I've used before, in that it is exactly like structural designers who want to design a building by intuition instead of using a design tool like CAD. Before CAD was invented that's how people had to design, but we don't do it that way anymore. Today, we have more rigorous methods.

That's what we're looking for with the Center for System Studies.

Michael D. Griffin

Michael Griffin is the King-McDonald Eminent Scholar and Professor of Mechanical and Aerospace Engineering, and the Director of the Center for System Studies at The University of Alabama in Huntsville. From 2005-09 he was the Administrator of NASA. Prior to re-joining NASA he was Space Department Head at the Johns Hopkins University Applied Physics Laboratory. He has also held numerous executive positions with industry, including President and Chief Operating Officer of In-Q-Tel, Chief Executive Officer of Magellan Systems, General Manager of Orbital Science Corporation's Space Systems Group, and Executive Vice President and Chief Technical Officer at Orbital.

Mike's earlier career includes government service as both Chief Engineer and Associate Administrator for Exploration at NASA, and as the Deputy for Technology at the Strategic Defense Initiative Organization. Prior to joining SDIO in an executive capacity, he played a key role in conceiving and directing several "first of a kind" space tests in support of strategic defense research, development, and flight testing. These included the first space-to-space intercept of a ballistic missile in powered flight, the first broad-spectrum spaceborne reconnaissance of targets and decoys in midcourse flight, and the first space-to-ground reconnaissance of ballistic missiles during the boost phase. He also played a leading role in other space missions in earlier work at the JHU Applied Physics Laboratory, NASA's Jet Propulsion Laboratory, and the Computer Science Corporation.

Mike previously taught for thirteen years as an adjunct professor at the University of Maryland, the Johns Hopkins University, and George Washington University, offering courses in spacecraft design, applied mathematics, guidance and navigation, compressible flow, computational fluid dynamics, spacecraft attitude control, astrodynamics, and introductory aerospace engineering. He is a Registered Professional Engineer in Maryland and California, and is the lead author of over two dozen technical papers and the textbook Space Vehicle Design.

Griffin is member of the National Academy of Engineering and the International Academy of Astronautics, an Honorary Fellow of the American Institute of Aeronautics and Astronautics, a Fellow of the American Astronautical Society, and a Senior Member of the Institute of Electrical and Electronic Engineers. He is the recipient of numerous honors and awards, including the NASA Exceptional Achievement Medal, the AIAA Space Systems Medal and Goddard Astronautics Award, the National Space Club's Goddard Trophy, the Rotary National Award for Space Achievement, and the Department of Defense Distinguished Public Service Medal, the highest award which can be conferred on a non-government employee.

Mike obtained his B.A. in Physics from the Johns Hopkins University, which he attended as the winner of a Maryland Senatorial Scholarship. He holds Master's degrees in Aerospace Science from Catholic University, Electrical Engineering from the University of Southern California, Applied Physics from Johns Hopkins, Civil Engineering from George Washington University, and Business Administration from Loyola College of Maryland. He received his Ph.D. in Aerospace Engineering from the University of Maryland.

Mike was born in 1949 in Aberdeen, Maryland. His hobbies include golf, flying, amateur radio, skiing, and scuba diving. He is a Certified Flight Instructor with instrument and multiengine ratings, and holds an Extra Class radio amateur license.

Thanks to Mike Griffin for discussing his plans and activities at the Center for System Studies. The description of the center on page 1 comes from Alabama Governor Bob Riley's May 20, 2010 release "*Governor Riley Announces New Research Center at UAH Moving Forward*" available at <http://governorpress.alabama.gov/pr/pr-2010-05-20-01-newresearchcenteruah.asp>

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