University Perspective on Elements of a Research Support Program

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Focus Session on ARMD and Supporting University Research

Aeronautics and Space Engineering Board
154th Meeting, Fall 2015
NRC Beckman Center, Irvine, CA
21-22 October 2015

Introduction

- NASA Aeronautics is under a lot of budget pressure
- Together, we have to find a way to support the Mission while maintaining the base for Future Missions

Benefits of University Interactions

- Pipeline for new hires, access to and incubation of good ideas, access to unique facilities often complementary and less expensive than NASA assets
- Some very good, creative researchers in Academe
- Faculty and PhD students need to be integral respected team members in the Aeronautics mission

Question 1: Is NASA asking the "right" questions of the university researcher?

“Need”

- Question 2: Is NASA doing well at identifying "the need" to get the right capability from the university research community?
  - Assumption: “the need” are those areas as defined in NRAs
  - Technology roadmaps do a good job, but NRAs do not seem to necessarily allow academics to respond to the full range of challenges found in the roadmaps.
  - To answer the question, it depends:
    - Basic research takes a while to incubate in some critical areas. Cannot just put areas on hold until there is a “need”
    - Capability (TRL, people, facilities) may or may not be there to respond to the current need if not sustained
  - Need balance between NRA "short-term efforts" and “longer term” base funding

Nature of University Research

- "University Research Funding: The United States is Behind and Falling" – Atkinson & Stewart, Information Technology and Innovation Foundation, May 2011. http://www.itif.org/files/2011-university-research-funding.pdf
  - "University-based research is of particular importance to innovation, as the early stage research that is typically performed at universities serves to expand the knowledge pool from which the private sector draws ideas and innovation. National economies increasingly compete on the basis of innovation, and , in the race for global innovation advantage, the United States will continue to trail countries that have placed university research and industrial collaboration at the forefront of their economic policy" (China, Europe).

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  - "As U.S. companies have shifted their R&D activities upstream, universities have taken on a larger role in the innovation system."
  - "While U.S. research universities are still a key strength, their future is uncertain given large cuts in state higher education budgets and slow growth in federal support for university research."
  - "…in the United States, government funding of university research exceeds business funding by an order of magnitude…trailing other nations when it comes to business support of university research."

Nature of University Research

- Research breakthroughs, by nature, require long-term, sustained support (including collaborations) and investment
  - Example: NASA Langley Aerodynamics Peer Review slides (14-16 April 2015)
    - Mission Agency: "…implementers of program/project goals". "Projects make priority decisions on programmatic needs not based on maintenance of NASA competency". "Individual work elements have trended towards smaller, shorter term activities".
    - "…want to be focused on longer-duration activities…" "Fundamental computational/experimental efforts for physics and understanding". "Develop new applications and techniques that expand the boundaries of tools and knowledge".

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    - Example: "The challenges that are faced by CFD (e.g., unsteady separation, boundary-layer transition) are such that they cannot be resolved by the mere availability of faster machines…The full potential of ever-increasing computer power cannot be realized without ***strategic investments in the computational infrastructure***."
      - "HPC, Physical Modeling (Turbulence, Transition, Combustion), Numerical Algorithms, Geometry/Grid, Knowledge Management, MDAO (Interfaces/Coupling)"

Nature of University Research

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  - Other examples that have been negatively impacted by the nature of the NRA process include
    - Eliminating the Aviation Safety program
    - Restructuring the UAS in the NAS program after only one NRA funding year
    - Creating UTM (UAS traffic management) without any specific funding for university research to-date (LEARN-2 doesn't count as it was about vehicle design not UTM per se).

Nature of University Research

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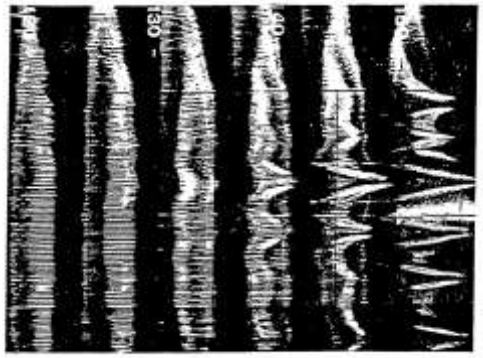
  - Example: Laminar-to-turbulent transition research has realized significant enabling ***breakthroughs on the order of every decade (since 1980)*** by an international community (led by US).
    - NASA has greatly benefited from these interactions as evident by current state of tools (e.g. LASTRAC).
    - Now only a very few groups remain in US sustained principally by Air Force.
    - Corporate knowledge and critical facilities continue to dwindle.



Saric 1986

Nature of University Research

AirStar, NASA AirSTAR UAV test vehicle

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  - Example: University of Illinois at Urbana-Champaign Professor Naira Hovakimyan's L1 Adaptive Control work has been very well received at NASA Langley in particular.
    - Successfully flight tested many times, started a company.
    - Bridges gap between "fundamental Aero" and "other“.
    - Represents very successful effort from Aviation Safety that is no longer really part of a NASA program.
    - Over the years not one but a series of aviation safety projects supported sufficient development to mature the research from concept through development and flight testing.

Nature of University Research

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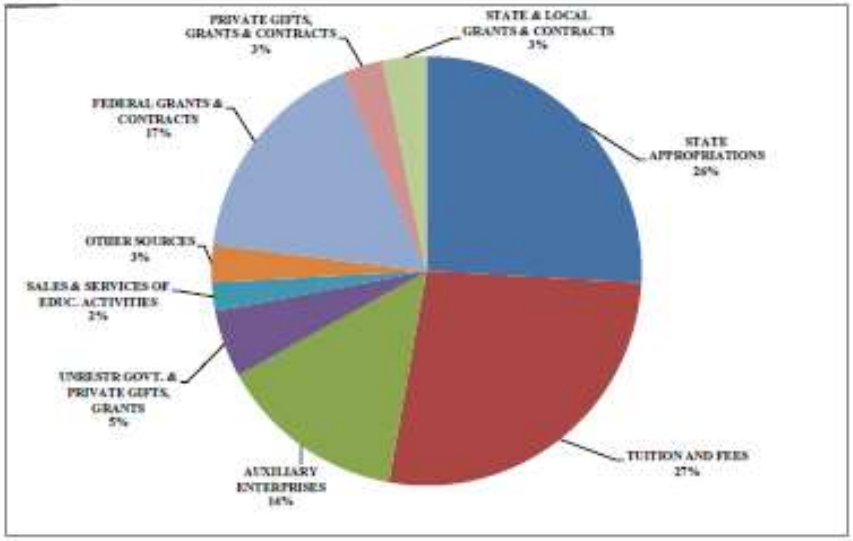
  - Example: Adaptive Compliant Trailing Edge (ACTE)
    - FlexSys, Inc., US small business, was founded in 2000 by University of Michigan Professor Sridhar Kota.
    - Developing shape morphing technology for application to leading and trailing edge aircraft airfoils for the past 22 years.
    - 14 year SBIR phase 1, 2, and 3 development program between FlexSys, Inc. and AFRL has come to fruition, resulting in flight testing of the FlexSys designed and created shape morphing high lift flaps on a NASA Gulfstream III aircraft.

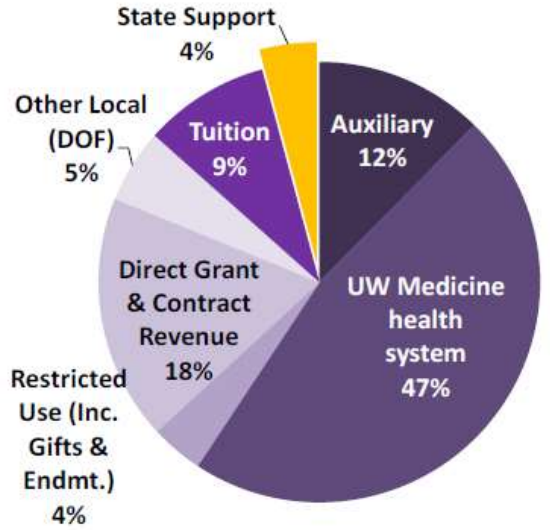
University Operations

- Budgets for most research schools
  - ***Depend on external grants/contracts for research***
    - Direct: Faculty time, student salaries/tuition, facilities, …
    - Indirect: Supporting infrastructure
  - Only a fraction of state support
    - "Science Board Concerned About Declines in Public Research University Funding" (2012), http://www.nsf.gov/news/news_summ.jsp?cntn_id=125542; http://www.nsf.gov/nsb/sei/companion2/
    - Public research universities rely on state funding for a share of their operating revenues, most supports their education function.
  - Pressures to keep tuition down
  - Faculty typically not supported for full-year:
    - 9 Months +/-
    - Release time



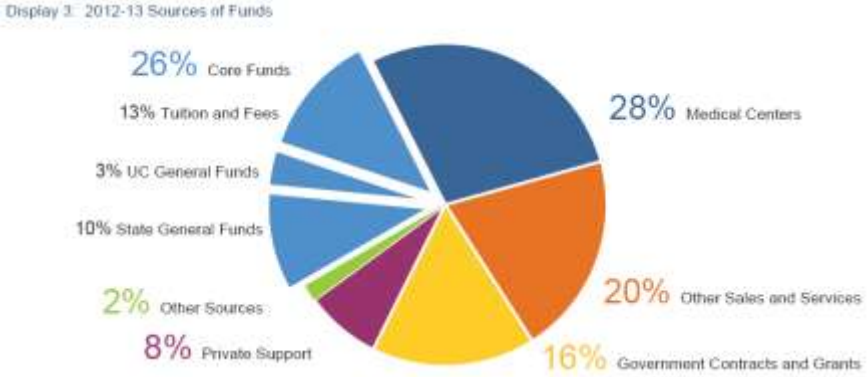
University of Maryland:

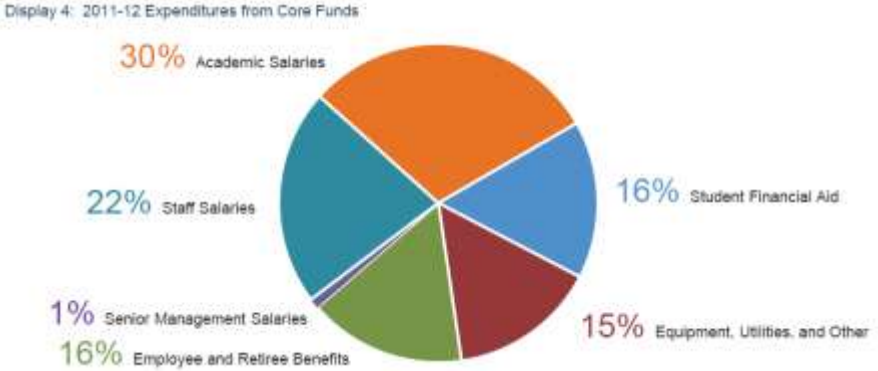
http://otcads.umd.edu/bfa/FY15%20Working%20Budget/web2/FY15%20REVENUE%20TOTAL%20OP%20BUDGET.pdf



University of Washington:

http://opb.washington.edu/sites/default/files/opb/Budget/Final-FY2014_Operating_%26_Capital%20.pdf





University of California:

http://regents.universityofcalifornia.edu/regmeet/nov12/f1attach3.pdf

NASA Support: NRA Model

- Pros
  - Standard mechanism to obtain funding from NASA that is accessible to new faculty and outside groups
- Cons
  - Focused large topics, different each time
  - Nominally 3 years (PhD students 4-5 years), but stated as one year with two one-year options
    - Some recent NRAs have offered only one or 1.5 year periods of performance. Such projects are difficult to staff with PhD students who would provide greater research output than would MS students possible to fund over this short period.

NASA Support: NRA Model

- Cons
  - Does not provide continuity to incubate basic research.
    - NASA Langley Review: “Does not allow long-term interactions”. “May not be opportunities often enough to sustain” research in “barrier technologies” . “NRA’s too big, want to fund little things”. “Losing early TRL work, students, facilities”, faculty. “Essential part of pipeline now broken”.
  - Released randomly with short response periods – student recruiting is a challenge
  - Often requires collaboration across multiple disciplines which is hard to achieve in short time windows available
  - Contracting can take 6+ months to finalize
  - PM role is more administrative than collaborative

NASA Support: Fellowship Model

- Funding “senior design projects” or student fellowships alone are important, but often do not cover all the costs and sustain basic research
- Pros:
  - Allows research that is more exploratory than normal
  - Allows researchers to collaborate more closely with NASA personnel over longer durations
- Cons:
  - Does not really fund faculty sufficiently for their time
  - Does not cover full cost of student tuition
  - Does not allow faculty member to develop research program in this area.

Support: Industry Model

- Industry support is important, but often short term, very focused, and proprietary.
- Industry is focused on project needs rather than workforce development.
- Could NASA Aeronautics work with industry to establish new industry-funded university research project opportunities?
  - These might be competitively bid, extending NASA's portfolio and helping industry solve specific problems with longer-term fundamental research support

“Cross-Cutting”?

- Question 3: Is there adequate focus on research that is "cross-cutting/cross institution" rather than specific to one institution -- and how can NASA encourage and support more collaborative research between and among academic institutions?
  - It is all about balance to support what makes sense
    - Must sustain basic elements of research for present and future
    - Support collaborative work as appropriate
      - Bring together elements of basic research
      - Bring together experimental/computational/theoretical expertise
      - Bring together different disciplines
      - Identify the best individuals to bring to bear on the need
      - Be careful that too many people on a team diminish the resources to each

Working with Research Community

- Question 4: In order for research to be of greater utility from NASA's perspective, how can the agency work with the university community so that the outputs from academic research can reach a point where NASA or industry can take it and develop it further?
  - From prior comments, sustain the research and the interactions.

Working with Research Community

- Question 4
  - When a small business or academic institution has created and developed a technology, it is in NASA's interest to celebrate its working with that entity as part of a successful conclusion, and retain the name/logo of that organization in visuals, news articles, press releases…
    - Related to FlexSyS/AFRL/NASA success and removal of FlexSys logo from aircraft: NASA Assoc Admin for Legislative and Intergovernmental Affairs: "NASA … does not permit ..contractors to brand their contributions on NASA government-owned aircraft."
    - ***Institutions depend on the publicity and recognition to be able to further their innovations and research***

Support Open-Ended Research?

- Question 5: Should NASA continue to appeal to universities to pick their research "thrusts" from among those key areas of research need that NASA has already identified or is there a role for more open ended research calls, given the limited budgets available and the fact that NASA is a "mission" agency?
  - It is a balance
  - LEARN is an alternative that allows open-ended research. However, LEARN calls are only for one-year projects (with maximum of one-year extensions). This short project duration really prevents someone with a new idea from doing more than a broad initial study of the concept.

Support Open-Ended Research?

- Question 5
  - Policy: Executive Order signed December 2006 (updated)
    - Outlines 7 basic principles to follow in order for the US to "maintain its technological leadership across the aeronautics enterprise": mobility, national security, aviation safety, security, workforce, energy & efficiency, environment (ARMD overview 14-16 April 2015, NASA Langley)
  - If not NASA, then ***who*** will sustain Aeronautics basic research in Academe for both the present and the future? ***How can we afford not to support long-term basic research?***

Suggestions

- NASA Aeronautics needs a champion for budget increases for long-term collaboration with universities in addition to more "targeted research programs" like UAS or materials. Whatever is "fundamental" to aeronautics education and research needs to find support over a long term.
- Encourage at least large businesses to collaborate (financially as well as in topics) with universities. Maybe establish a three-way collaboration structure NASA-industry-university where industry and NASA cost share in research support.
- In addition to targeted NRAs, solicit research in more general areas which are responsive to the roadmaps, but less prescriptive.

Suggestions

- Use a two-stage (white paper/full proposal) process providing feedback in the interim
- Release NRAs on a set schedule
  - Be sensitive to student recruiting cycles
- Allow collaborative agreements between research universities (so NASA lets multiple contracts, one to each university)
- Provide funding for NASA researchers to be true collaborative partners with academics
  - Example: new UTM project is currently asking for people to partner with them for free. That may work for companies with investors, and universities can partner in the short-term in good faith, but this type of collaboration won't strengthen the work force.