Tony Giunta

Part I: Summary

I. Interview Data

Interviewee: Dr. Anthony A. Giunta
Interviewee's Organization/ Job/Position: Sandia/ Senior Member of Tech Staff
Date: Friday, June 14, 2002
Place: Tony's home
Interviewers: Padula/ Green
Length of Interview: 90 minutes
Method (face to face, phone, written): phone
Phone Number: 505-286-2860

II. Key Insights

A. Burning Questions

i. Does MDOB need new blood?
ii. Does NASA support enough graduate students in MDR?

B. Important Insights

i. Vision

1. **Government should develop methods and release SW (Dakota is a good example)**
2. **Government should work the hard problems that industry can not afford to study**

ii. Environment

1. **Choosing the lowest fidelity simulation which gives the proper results is critical**
2. **Develop methods for computer architectures owned and used by our customers**
3. How well does distributed collaboration work? On the horizon for other groups- so MDOB should consider
4. Giunta's personal choice - likes face to face contact with experts.

iii. Customer Needs

1. Approximation methods are very important
2. Uncertainty must be included (e.g. uncertainty in modeling or boundary conditions)
3. MDOB is not alone in working on hi fidelity codes – Sandia needs prelim design where our strength is - but we are pushed towards more conceptual design

iv. **MDOB Products**

1. Should be doing R&D methods developments, not applications - should be consultants to others who are doing applications; claim other's results as our success
2. Usefulness of Dakota; users exercise many options; used Dakota for tech transfer into and out of Sandia; not clear

what the inputs were to Dakota from others - physics or optimization improvements?

v. **Key Enablers**
   1. More students & university support - not done recently by MDOB; Infuses MDO knowledge into outside orgs
   2. Look outside of aero engineering community; Seek robust design, design under uncertainty

vi. **Management and Organization**
   1. **MDO research is not as visible to NASA management as it is to Sandia**

III. SWOT Analysis

A. **Strengths (internal to MDOB)**
   i. new approximation methods - quad poly kriging, splines, neural net, AMMO!!!
   ii. **Sensitivity analysis**

B. **Weaknesses (internal to MDOB)**
   i. **Is optimization always needed? Better to run 100 - 1000's of process & compute statistic on results?**
   ii. **Need influx of people and ideas and skills**
   iii. **Could get a feel from website that this is happening -hiring!!!**

C. **Opportunities (external to MDOB)**
   i. Sandia can't test weapons systems [look for other similar situations/simulation only]
   ii. Coupled sensitivities for MDA problem [needed]

   iii. Opt is important but need statistical analyses with hifi simulations must quantify uncertainty

D. **Threats (external to MDOB)**
   i. Legal steps impede SW transfer
   ii. ASCI Mindset – use biggest, most hifi model available or fear it is "gibberish"
   iii. **Is MDOB well known? Try advertising on web or society publications**

IV. Summary of Key Points

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V. Ideas for Interview Process Improvement

· Thought given to kind of interviewee - should we have dug deeper into areas Tony's learned about since days at LaRC? How to change MDOB? What did he learn here that's useful?

· Add What threats to our research to questoinnaire? Symptoms - univ $$$ not visible now. New way of getting money from NASA Programs has

changed our funding patterns. Having as trouble as we are getting MDO to [external] customers. Good preparation from our material.

VI. Follow-up Action/Questions

- Didn't mention Los Alamos (Are there differences in what each lab is doing with regard to MDO?)
- What would you do to make MDOB better? What are our strengths?
- What threats to our research? (add this to questionnaire)
- Selling MDO…insights?

Reply from Tony re Follow-up Questions:

- LANL Connection?
The DAKOTA team at Sandia has contact with several research and applications groups at Los Alamos. Primarily, this contact has been fostered through two areas: (1) training of LANL staff on how to use/apply DAKOTA, (2) joint Sandia-LANL working group on uncertainty quantification. LANL staff are using DAKOTA for optimization and uncertainty estimation studies, but we don't know if they are using formal MDO techniques (my guess is single-discipline opt only). FYI, the DAKOTA team has a similar relationship with various group at Lawrence Livermore National Lab, and LLNL staff are doing opt and UQ work (probably no MDO work).

- How to make MDOB better?
I think MDOB should position itself to serve both LaRC and NASA-wide optimization needs. Note - don't focus solely on MDO methods. Many people/organizations need help understanding and using single-disciplinary optimization approaches. MDO can be overwhelming for the uninitiated. Suggestion - MDOB could host a LaRC-wide symposium (or just an open house) on optimization, where MDOB staff would give short talks, or better yet, poster presentations, on optimization and MDO impact on LaRC/NASA mission areas. Then, grow the symposium to include other NASA centers, and hold a multi-day workshop in the Hampton area.

FYI: The DAKOTA team is pursuing a similar approach within the Sandia and with the three DOE weapons laboratories (SNL, LANL, LLNL).

- Threats to MDOB?
Some of my comments related to this question are already contained in other parts of the summary. In
short: MDOB would benefit from an influx of new staff to invigorate research ideas and to explore new opt applications areas. MDOB should fund more university research, and should host post-doc and university staff visitors for multi-week and/or multi-month terms. There are several programs in place at LaRC to facilitate visitors - ASEE summer faculty, NRC post-doc, others?
Don't be afraid to look outside Aerospace/Aeronautical engineering programs for faculty/post-doc/grad student visitors. Folks from other disciplines will bring new/different perspectives to opt/MDO research.

Part II: DETAILED Interview Notes

Technology
4 - Are you familiar with the definition of MDO we provided?

Likes definition, concise; good def.
They do single disc optimization, not MDO, want to do MDO soon - coming years
Stru/elect on circuit design

(S,I) Guinta/Eldrige familiar with methods; look internally & MDOB, univ
GATECH, VATECH Stanford

Org Barriers:
Informal -easy by phone
Formal - share software - (I,W) they eliminate by distribute as gnu… [we don't]
Reciprocal agreement favorable
(T,I) Legal steps impede SW transfer

Other barriers:
He has no problem talking with MDOB
(T,I) He doesn't know how widely MDOB is known - not sure

Customer Needs

Existing needs (application pull)

7 - What are the top technical and non-technical factors that will be driving your organization in 10 years?

Tech:

(W) analysis driven by hifi physics simulations [we insist on hifi codes]
(I,F) Roadblocks: code conversion to C++ [why C++?]
Hi spatial resolution & grids - biggest computers in the world - custom computers
Simulation SW not mature / computer issues dominate
Use DAKOTA w/ analysis for easy opt
Account for uncertainty in the hifi analysis & design process
(O) Can't test weapons systems [look for other similar situations/simulation only]
(O) Must do simulations
(I,O) Opt is important but need statistical analyses with hifi simulations
must quantify uncertainty
[justify existence - computers]

Robust design / reliabity
Robust - nominal performance - manufacturing tolerances

Reliability - extreme events - prob of failure of structure

Uncertinaty in siumaltions- bc's wind speeds, manf tolerances, inside physics code
Turb model a vs model b, or similar switch in stru code
Code validation/verification issue
(O) Unc in how code is used - correct use of code right options, etc.

Most important: 1 code verification / 6 on analysis & optimization
Code verification is critical - must have confidence in the code
(W) Line management must certify reliability - need sims good enough for the president [very high level of certainty] [ISAT could be visible to high level/disconnect on code validation]

Success stories: [might ask this earlier in the interview]
1 - weapons system w/ load bearing plate /impact or crush load
failed under applied load & too heavy - opt applied to rib reinforecement
rib pattersn - 3 by engineers; took best to design team; met stress & accel goal and save 25% of weight; used in field weapon system

2 elec - 500k FEM - detailed for design phase stru/elec
environmental conditions - with weight budget but failed during shake and load
stress & accel too big - redesign mpp sim code & Dakota - positive safety margin
mpp example - 10 concurrent FEM's 256 procs at a time; 2560 procs total
4days - gradient-based, non-gradient
4days = 10 years of serial computing

change capacitance of circuit-smaller computing scale - single disc
use Dakota - a variety of techniques; very flexible
(S) new approximation methods - quad poly kriging, splines, neural net, AMMO!!!
Renaud's Notre Dame - surrogate framework
-surf fit
- low & hifi physics

crystal ball - change in next 10 years:

headed toward MDO capability
Sierra framework - 5-10 physic codes \couple thermal/stur
foam melting, structural heating
currently MDA
(S) will be doing MDO and & sens anal
what are effect of uncertainty on MDA systems?
unc on MDA systems
MDO coming
(S,O) Coupled sensitivities for MDA problem [needed]
(S) Leverage LaRC sensitivity work

NonTech:

ASCI Mindset - big, most hifi model or "gibberish"
Unc mindset - can't do unc/opt with biggest hifi system - (S,O) less expensive sim code is necessary for optimization & uncertainty [show that lo fidelity is usable]. Can do more
Currently: use multi 1000 proc computers to get 1 number back
(O,I) Better to run 100 - 1000's of process & compute statistic on results
(S,O) Need for sensitivity analysis is understood;
(O) Need for stats also understood; results suspect for cheaper codes
Particular to computer engineering group at Sandia
Sold to congress as something to solve problems that others can't do
He wants to sell less exotic use of computers [tech transfer - should use everyday computers; not a specialized machine]
Thinks Boeing uses Euler/NS as appropriate

Tech transfer:

Physics codes can't be transferred - year and $$$$

(I) Can transfer Dakota and like tools - not weapons specific tool; taxpayer paid - put in to public domain; find bugs & fix in Dakota - (I) improves tool for internal use

How to tech transfer - as a code, talk about? What works?
ASCII head to DOE - labs should put tools into public domain
Facilitate collaboration with NASA - Eldridge put effort in legal for export control - change category to non-export controlled; non-weapons - 2 years to get past the rules
(T) [lots of time involved in development and support]

How do you get people interest in Dakota?

JH Univ Eng Dept - existing relationship;
NIST, etc.
(I,O) Gnu public license for Dakota - announcements
(I,O) numerical analysis digest newsline / opnet
(I,O) math & op community for download & manuals - months of work (manuals)
(I,O) press releasae & news relesase
(I,O) send news announcements regularly - Science & Nature mags
snowballs - pop mech mags request for interview
(I) online requests - web address for Dakota (Dev/April - 1000 downloads for trial!!!)
(I,O) don't track usage - but get feedback/bug reports from interested users

(O) role of government in engineering methods development:

R&D that private companies can't do - too expensive, out of scope
Use Dakota to prototype new algorithms - internal R&D
Must communicate through pubs & conf talks
Formalize R&D use in Dakota - to public domain
Funding university R&D heavily
(I) **MDOB/HPCCP - big payoff - 5 universities - infuse MDO in US industry**
Tech transfers of people into other sites

Design environment of future:
Dakota/Sierra - coupled physics (10 to 15 codes - common geom. Format)
Sierra/MDA; couple Dakota w/ Sierra for MDO/MDA 5 to 10 years to mature;
new Sandia staff would pick up tool for coupled hifi aero/stru on parallel computer [kill funding on FIDO before mature]
(O) Longer term vision - use opt tools w/ eng codes - distributed grid system
Access Dakota server from web - execute on parallel computer elsewhere
Not routine today - specialized

(I) What is the value of highly distributed system?
Compute Horsepower - preserve knowledge?
Resource use - run from home; then org may not need resource in house
(I) **Common compute centers used by many orgs; reduces burden on host**
Transparent connection
Not as good a feel for distributed work groups? Not a good enough reason?
Haven't thought about this - need someone down the hall expert on code
Diagram on blackboard - teleconference not as easy as being close

Balance between methods/applications and integration:
(W, F) Shift in focus from 1999 to system level analysis
Taxonomy of MDR - very important for big picture - no org can be an expert in every area, but should know about the areas; pick the boxes where you can have the most impact and collaborate with others; how to identify area of high impact - combination of internal planning & peer review, collaboration with aerospace industry - identify high payoff areas -
(S) MDOB doing a good job of this; good interaction & sharing
(I, O) shouldn't be doing (Sandia as well) - not system analysis prelim design; we should be **consultants** to those doing the job; VAB are experts in systems analysis - MDOB should be opt/MDO consultants to help them do their work and with others at LaRC

Important partnerships:
Industry - Boeing R&D - Paul Frank/Evan Kramer
Lockheed + nonaeronautics industries - RLV - space component of Boeing/Lockheed
For impact of MDO; collaborate with Sandia, Maha at Vanderbuilt
(O) Collab with outside of aero Indus & univs is a real help - aero is cutting edge; not aware of work in stru opt & nonaerospace, comm. Science

What didn't we ask
Scope of MDO too narrow or too broad?

(O) Nonaero problems
(W, T) Need influx of people and ideas
Could get a feel from website that this is happening -hiring!!!
New tech staff into MDOB
(T) Couldn't get a feel for funding post docs , grad students etc.
(I) Fanastic return on investment - Tony's peers - should be going on for infusion [grad students]

(S) What was most valuable in college and MDOB?

approx managament surrogate optimization techniques
Exposure to RS & DOExperiments, statistsics used every day in design studies; helped Dakota; Broad exposure to lots of areaqs 5 to 10 student - aero.srtu/controls/RS&DOExperminents - got very broad education; usually very focused
Where else would we find those broad people? VATech - Turkish CFD & Unc from turb Models & other choices in code CFD & statstitic s; also Mavris/Schrage group at GATech, Notre Dame, Buffalo/Bloebaum - decompositions
(I, O) [he perceived that his education was valuable--broad based training]
[Are we missing something in getting grad students JIAFS, coops etc]

(I) Tech transfers to your group: **use Dakota** to facilitate Ghanem [father of probabilistic finite elements] at J Hopkins
Poly chaos - stochastic FEM in Dakota - download to J Hopkins - allow them to check in code into Dakota; no export control issues on Dakota; filter for Quality Control
On SW coding practices; must be in public domain - assume okay with univs
Regression test, SW quality, poly chaos experts review code; believe not inserting viruses.
[T] [NASA wanted ability to get codes back produced; we are on short end of stick in SW release]

SUMMARY:

- More students & univ support - not done recently by MDOB; Infuses MDO knowledge into outside orgs

- MDOB Not alone in working on hi fidelity codes - need for prelim design where our strength is - but being pushed towards more conceptual design;
- Should be doing R&D methods developments, not applications - should be consultants to others who are doing applications; claim other's results as our success

- Big driver of ASCI for hifi simulations; ASCAC wants lower fidelity;
- go outside of aero engineering; robust design, design under uncertainty;
- code validation is critical;
- unc has to do with the choice of models in codes; verification & validation; many codes uncertainty propagation; uncertain bc's, manufacturing tolerances, param uncertainty; uncertainty of user choosing wrong validated options;
- Usefulness of Dakota; exercise many options; used Dakota for tech transfer into and out of Sandia; not clear what the inputs were to Dakota from others - physics or optimization improvements;
- how to get new blood into the branch and the community?

Burning Question
How well does distributed collaboration work? A visible horizon for other groups. Personal choice - likes face to face contact with experts.

Process Improvement

What did we do well?

Good interviewee
Good follow up questions

Done better?

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Follow up

- Didn't mention Los Alamos (Are their differences in what each lab is doing with regard to MDO?)
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