



Highly-Effective Statistical Collaboration

The Art and the Science

Peter A. Parker, Ph.D., P.E.

National Aeronautics and Space Administration

Langley Research Center

Hampton, Virginia, USA

March 21, 2018

DATAWorks: Defense and Aerospace Test and Analysis Workshop

Springfield, Virginia

Acknowledgements



- **Michael Litano, Ph.D.**
 - Organizational Scientist, Old Dominion University, now Capital One
- **Willis Jensen, Ph.D.**
 - Global Statistical Team Lead, W. L. Gore & Associates
- **Jennifer Van Mullekom, Ph.D.**
 - Associate Professor of Practice, Virginia Tech, formerly DuPont
- **Christine Anderson-Cook, PhD.**
 - Statistician - Research Scientist, Los Alamos National Labs
- **Lu Lu, Ph.D.**
 - Assistant Professor, University of South Florida
- **And many, many others who have shaped my thinking on this topic, too numerous to list**

Motivation for Statistical Engineering



- Influence the most challenging, complex systems in the world
- Strive for greater impact
- Can do better -- Must do better
- Intent of this Workshop, to equip and motivate better practice
 - Modeling
 - Data Acquisition
 - Analysis
 - Visualization and Communication
 - Inference and Decision Making

It takes more than statistical expertise and tools.... It takes

Highly Effective Statistical Collaboration

Key Elements



- **Distinguish Collaboration**
- **Motivation and Benefits**
- **Challenges in Statistical Practice**

Illustrate through Experience (Art)

Referenced to Methodological Research (Science)

Spectrum of Teamwork



Consultation

Helping others understand a pre-defined problem in a larger system

Cooperation

Dividing a task among team members, where each person is responsible for a portion of the problem solving

Collaboration

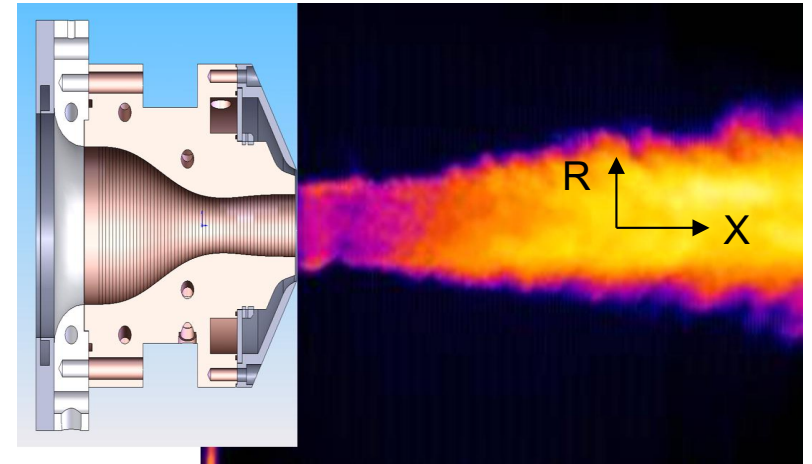
Mutual engagement to identify and solve a problem together with a common goal

Hypersonic Research



Background

Refine our understanding of fundamental physics involved in hypersonic propulsion



Lessons Learned

- **Team lead exemplified mutual respect and trust**
- **Common focus enabled productive collaboration**

Consulting toward Collaboration



Consultant	Collaborator
Focus on Specific Problem	Build Relationships
Advisory: Interprets, Analyzes	Interactive: Catalyst, Advocate, Directs
Monologue	Dialogue
Speaks in Statistical Terms	Speaks in Application Terms
Focus on Statistical Solutions	Focus on Impact
Support, Peripheral	Embedded, “Totally Involved”

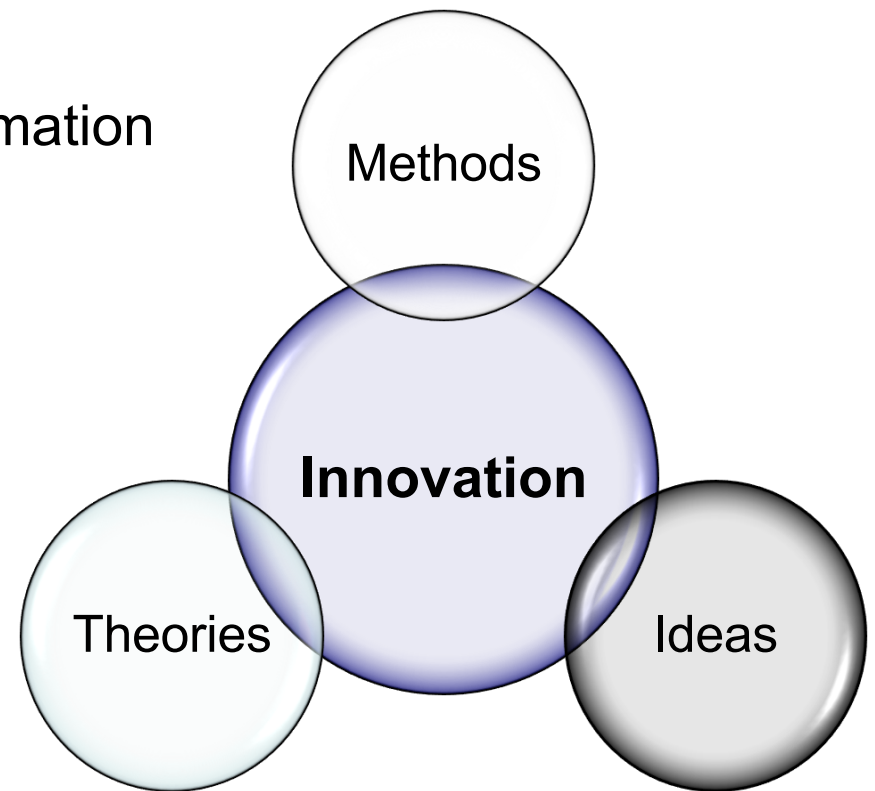
Motivation to Collaborate



Innovation occurs at the intersection of disciplinary fields

Interdisciplinary Collaborators:

- Search more broadly for relevant information
- Consider more alternative solutions
- Engage in more vigorous debate



Statistical Practice Challenges



Pfeifer, Marquardt, Snee (1988) CHANCE "A Time for Change"

- "Our profession is **plagued by lack of public understanding** of just what we do and the contributions we can make"
- "**We must think of ourselves as scientists who can make a difference.**"

Bross (1974) TAS "The Role of the Statistician: Scientist or Shoe Clerk"

- **Scientist or Shoe Clerk?:** "One view of the shoe clerk's job is to please the customer well enough to earn his commission. He must find some item in the store's stock which will fit the customer or which will be so fashionable that the customer will buy a misfit. The aim is **to please the customer in the short term.** What happens in the **long run is somebody else's worry.**"
- "...Anyone who **acts like a shoe clerk will end up being treated like a shoe clerk.**"

Levels of Statistical Practice



Boroto & Zahn (1989) TAS "Promoting Statistics: On Becoming Valued and Utilized"

Consultant: "Journeyman statistician **takes the problem the consumer presents, fits it into a convenient statistical conceptualization**, and then presents it to the consumer – journeyman prefers **monologue**."

Collaborator: "Master statistician **hears the problem from the consumer's viewpoint, discusses statistical solutions using the consumer's language ...**, and arrives at statistically based recommendations or conclusions ... new conceptualizations collaboratively - master statistician relies on **dialogue**."

"Effective statistician is essentially **a skillful translator**, the consumer should never have the experience of being lost in a foreign land. The statistician must be fluent in the language of the consumer or ... be willing to learn."

Statistician's View of their Role



Required for Effective
Statistical Engineering
and Collaboration

Other Subject Matter
Expert(s)

Active

Passive

Statistician as Helper	Statistician as Colleague
	Statistician as Director

Passive

Active

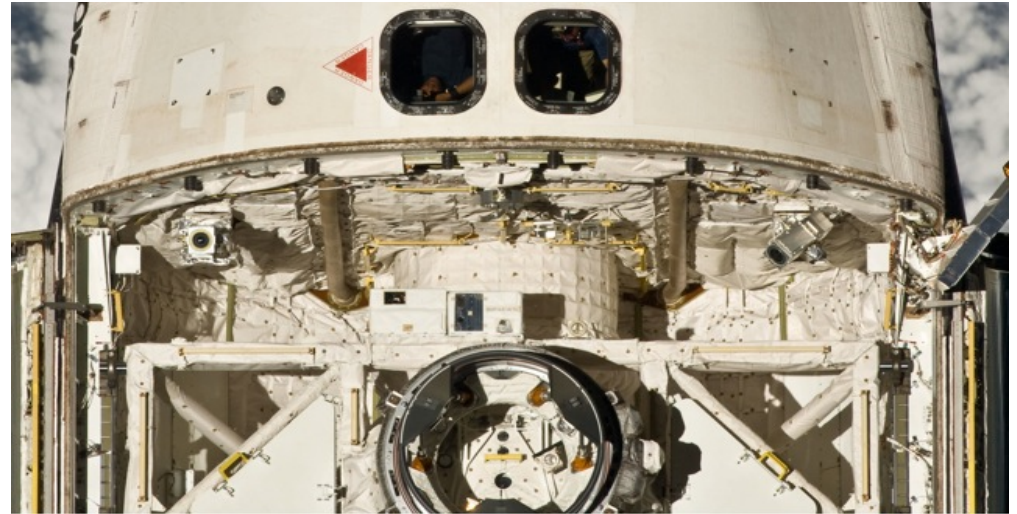
Statistician

On-Orbit Rendezvous and Docking



Background

**Evaluate the performance
of three LIDAR sensors
for On-orbit Rendezvous
and Docking**



Lessons Learned

- **Non-intuitive choice for Team Leadership was vital**
- **Earned respect humbly and demonstrated value**
- **Successful, Positive Technical Disagreement**
- **Benefited the Statistical Discipline's Connotation**

Overcoming Barriers to Collaboration



Barriers

- Defensiveness / threatened
- Mistrust
- Misunderstandings
- Individual goals
- Disrespect
- Unfamiliarity with perspectives

Desired

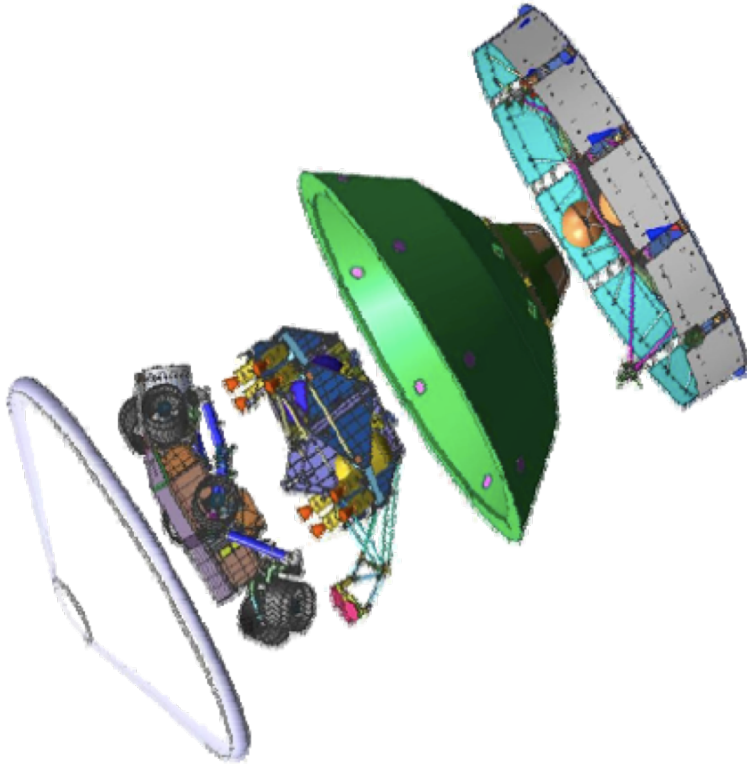
- Shared identity
- Mutual trust
- Common language
- Common shared goals
- Mutual respect
- Shared mental models

Mars Atmospheric Entry



Background

Develop instrumentation and mathematical models to measure the trajectory during entry into the Martian atmosphere



Lessons Learned

- **Team formation and mutual goals**
- **Mutual Respect and Trust**
- **Collaboration influences Problem Formulation**

Benefits of Collaboration



Individual Benefits

- ↑ Job satisfaction
- ↑ Meaningfulness of work

Team Benefits

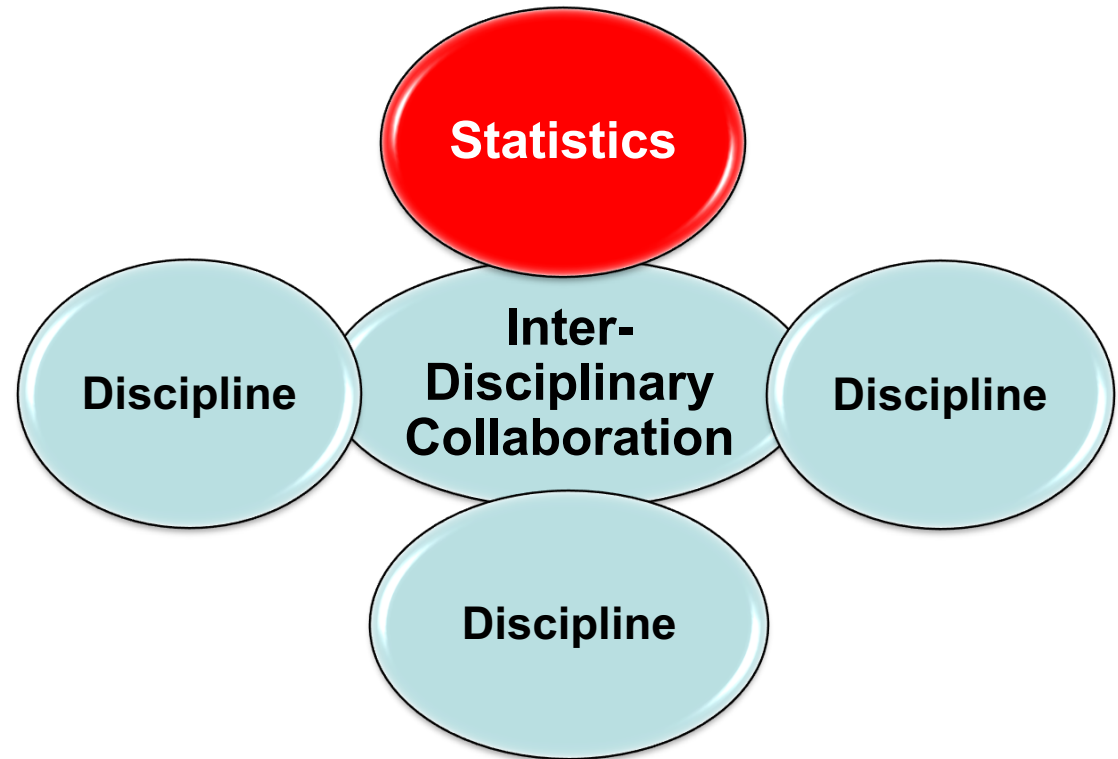
- ↑ Performance, Innovation

Organizational Benefits

- ↑ Time and cost efficiency

Disciplinary Benefits

- ↑ Disciplinary relevance



Concluding Remarks



- **Collaboration is an essential skill** for every discipline expert
- **Embrace the motivation to collaborate**
- Everyone can become a **better collaborator** through
 - Experience, mentoring, and observation (**Art**)
 - Methodological Research (**Science**)



You can possess a mastery of powerful tools, but you may never get to open your toolbox and influence a project without being an effective collaborator



Complete Bibliography is available upon request

peter.a.parker@nasa.gov