GODDARD'S NEW APPROACH TO INFORMATION TECHNOLOGY

The Information Systems Center
An Overview

The 23rd Annual Software Engineering Workshop

December 2-3, 1994

By Howard E. Kea

PREFACE
By Martha Szczur

Welcome and Al Diaz Introduction
23rd GSFC Software Engineering Workshop
December 2, 1998

Hi, I'm Marti Szczur, the Chief of the Information Systems Center, which is one of the organizations within the Applied Engineering & Technology Directorate (AETD).

Since last year's workshop, Goddard has undergone a significant reorganization. AETD is one of two new directorates, made up of over 1300 Goddard engineers, including computer science professionals. The engineers are matrixed or assigned to flight projects, science directorate activities and/or advanced technology tasks. ISC is one of the engineering groups within AETD, and as the name implies, the Information System Center is heavily vested in all aspects of software (from design, development, testing, validation, integration, maintenance, and including assessment of existing software products.)

The software is applied to a broad spectrum of mission and science systems … from command & control of the spacecraft (both on-board and on the ground) to planning/scheduling, guidance & navigation systems, communication support, to the processing, archival, & distribution and analysis of science data … Software is one of the key business products within the ISC.

And thus, my interest in software engineering is extremely high. In fact, the Software Engineering Lab, the group hosting this workshop, resides within the ISC, and I am a strong supporter of the research they conduct. I'm also interested in their expanding their software engineering knowledge and influence across Goddard, as well as NASA. Because of my vested interest in SE as a computer science discipline, it is quite a privilege for me to be opening this 23rd Software Engineering workshop.

I'd like to mention a recent exercise at Goddard, which involved looking ahead to the year 2003 and defining the type of work and missions in which we would be involved. And, the future missions identified have increasing software complexity, such as

- operation of multiple spacecraft and constellations
- distributed sensing systems
- increased on-board science processing and autonomous operations
- higher volume/higher rate of science data to process, manage, archive and distribute
- collaborative, distributed engineering and science computing environments to improve formulation and implementation of missions, as well as to foster collaborative scientific discovery.

To meet these software challenges, It is critical that advancements in software engineering be made. Today, the software industry has not been overly successful in consistently developing software systems that are within budget or on time or which meet all the requirements.

For example, in a Standish Group's 1994 study*, based on an evaluation of 8330 industry software projects, only 16% were actually successful in being on-time, in budget and meeting all originally-specified requirements,

A staggering 53% were "challenged". On an average, they were (1) 189% over budget, (2) had time overruns of 222% and (3) only 61% of originally specified requirements were met.

The other 31% of the software projects were canceled somewhere during development.

Thus, with the increase of NASA mission's dependency on software and the increase in its' complexity, a focus on producing quality software, and thus software engineering, I feel, becomes a critical necessity.

And, it is many of you in this room who will move us in a direction to enable a time when we can develop software systems which are bug-free, reusable, delivered on schedule and within cost while meeting all requirements…on a consistent basis.

Many of the presentations over the next two days pertain to advances and lessons learned which are directly related to the software engineering challenges we face. I look forward to listening and learning from the diverse collection of international experts represented here today.

I have the privilege this morning to be introducing, Al Diaz, who is the Director of Goddard Space Flight Center.

We are very lucky at GSFC because Al, I believe more than any other Center Director to date, has an appreciation of the critical role software … and in particular QUALITY software … plays in the success of Goddard's missions, and he recognizes its increasing role in the future.

So, with pleasure, I welcome Al and thank him for agreeing to take time from his incredibly busy schedule to open the 23rd Software Engineering Workshop.

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* NOTE: The Standish Group International, Inc. is a market research and advisory firm specializing in mission-critical software and electronic commerce. Information about this study can be found on their web site: http://www.standishgroup.com Go to the option titled "Chaos Report."

BACKGROUND

The Goddard Space Flight Center (GSFC) Strategic Implementation Plan (SIP) was published in January 1997. Since the plan was published several centerwide activities have been initiated. One in particular known as "Project Goddard" is responsible for one of the most significant changes that have occurred in Goddard's history. This was the reorganization of Codes 500 and 700. The reorganization [Reference 1] was the result of much planning that began with an assessment of the external environment and the writing of Goddard's SIP followed by definition of macro level processes from which an organization that could support those processes was derived. In today's environment, performance, cost and schedule are three critical elements to the successful execution of a program. The requirements have become an integral factor throughout the development process making it necessary for close customer involvement. The reorganization was primarily structured to more effectively focus engineering talent into teams drawn from the different disciplines. This would facilitate being able to provide products and services which support mission needs aligned with customer requirements.

INFORMATION SYSTEMS CENTER

The ISC was created as part of the Goddard reorganization and was located within the Applied Engineering and Technology (AET) Directorate. Why create an ISC? The creation of ISC was to (1) focus expertise and leadership in information system development. (2)Promote organizational collaboration, partnerships, and resource sharing. (3)Stimulate design /development of seamless end-to-end flight and ground systems. (4) Enable flexibility to effectively support many simultaneous projects by improved access to critical mass of discipline expertise. (5)Enhance career growth and opportunities including multi-disciplinary opportunities and (6) to improve communications among information system professionals. Figure 1, is an Organizational Chart of Goddard after the reorganization showing AETD and System, Technology, and Advanced Concepts (STAAC) as new organizations.

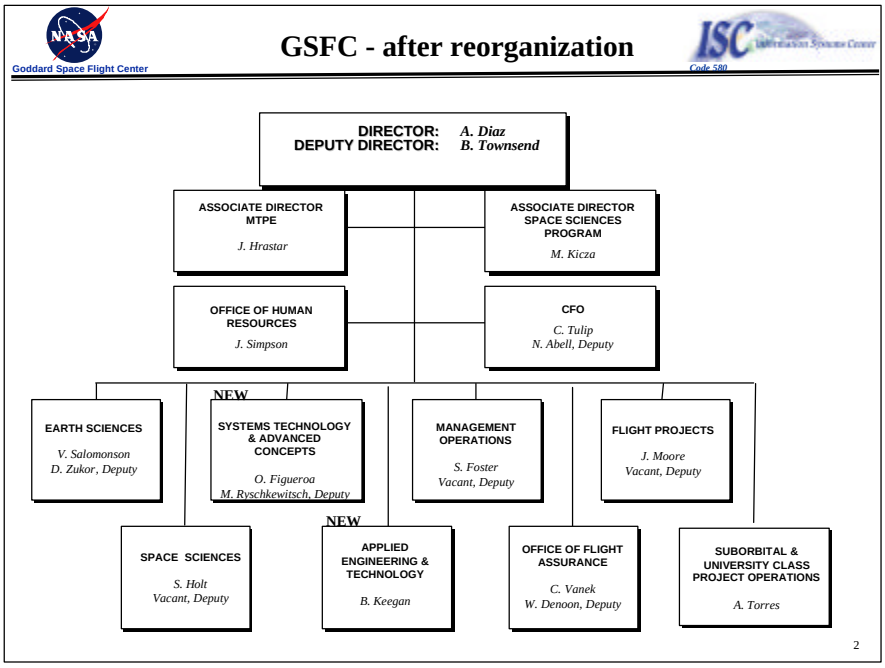

Figure 1.

Figure 2. Shows the AETD Organization, the Director is Brian Keegan.

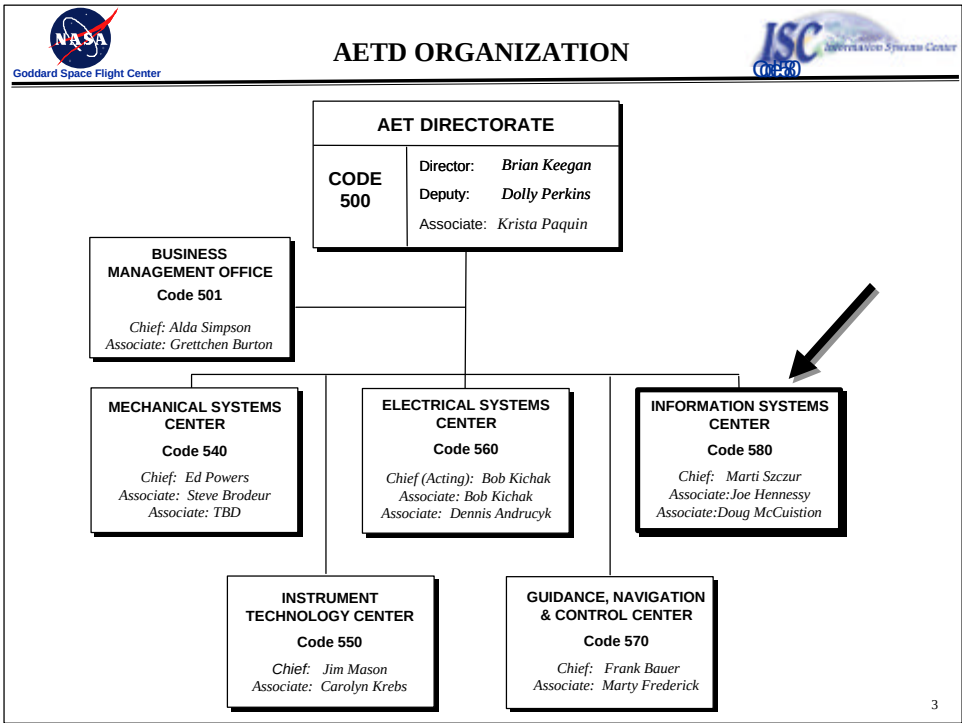

Figure 2.

There are five Engineering Centers within the AETD which are equivalent to Division level organizations. Each of these engineering centers is focused on a particular engineering discipline. The ISC (Code 580) is the engineering center focused on software engineering and computer science. The ISC mission is [Reference 2] "to provide high value information systems products and services and to advance information technologies, which are aligned with customer needs." The ISC organization is shown in Figure 3 below.

ISC has 8 Branches in which each Branch is focused on critical software engineering domains that cover the full lifecycle phase of a mission. Table 1, represents each of the Branches in the ISC and highlights their major functional areas, products and services, customers and projects supported. More detailed information can be found at the ISC Website, http://www.isc.nasa.gov. ISC is predominantly a matrix organization in that many of the Branch personnel 581, 584, 586 are co-located with the project offices. The process in which personnel are assigned is accomplished annually when the projects submit Statements of Work (SOW) to the ISC for services. Personnel with the necessary skills and experience are then assigned to the project from 1 to several years dependent on the duration of the project.

580 / Information Systems Center Branch Structure

Branch	Functional Area/Products	Services	Customer Projects/Org
581 / Systems Integration and Engineering *Leslye Boyce, Howard Kea, Margaret Caulfield*	End-to-end data systems engineering of ISC mission systems development activities.	Mission directors, ground sys/flight ops management, sys. eng., flight prep support, SW eng, Sys I&T, AO prep	EOSDIS, HST, STAAC, NGST, MAP, IMAGE, TRACE, POES, AGS, on-orbit missions
582 / Flight Software *Elaine Shell, Ray Whitley, Lisa Shears*	Embedded spacecraft, instrument and hardware component softwares; FSW testbeds	End-to-end FSW development; simulation s/w; spacecraft sustaining engineering	HST, MAP, TRMM, EO-1, SMEX, SMEX-lite, SPARTAN, EOS AM/PM/Chem, GLAS, XRS XDS, POES, NGST, XTE, EUVE, GRO
583 / Mission Applications *Henry Murray, Scott Green*	Off-line mission data systems (e.g., Command man., s/c mission and science P&S, GN&C, NCC	Sys. eng.& implementation, COTs application, testbeds for concept proof/prototyping in ops environment	NCC SPSR, LS7, EO-1, EOS AM1, HST, TRACE, C930, IMAGE SOC
584 / Realtime Software Engineering *Barb Pfarr, Jay Pittman, John Donohue*	Real-time ground mission data systems for I&T and on-orbit ops (e.g., s/c command & control, launch and tracking services)	Sys. eng.& implementation, COTs application, simulators, testbeds for concept proof/prototyping in ops env.	HST, WFF, ISTP, IMAGE, MAP, SMEX, TRACE,WIRE, EO-1, LS7, HITCHHIKER, SPARTAN, EOS, NGST
585 / Computing Environments and Technology *Howard Eiserike, Steve Naus*	Tools and services in support of information management	Hands-on sys admin., network manage., business/support tool develop, WWW application	EOSDIS, IFMP, C630, C930, HST, WSC, C250, C450, HST
586 / Science Data Systems *Mary Ann Esfandiari, Mary Reph*	Science data systems including data processing, archival, distribution, analysis & info man.	Sys. eng.& implementation, COTs application & integration, testbeds, prototyping	EOSDIS, LS7, TRACE, TRMM, HST
587 / Advanced Data Management and Analysis *M. Esfandiari (Acting), Jim Byrnes*	Advanced concept development for archival, retrieval, display, dissemination of science data	Next-gen req. development, testbed for sys evaluation, prototype products	FAST, NEAR, WIND, ULYSSES, C632, C686, C694, C930, C922
588,/Advanced Architectures & Autonomy *Doug McCuistion (Acting), Julie Breed*	Technology R&D focused on space-ground automation sys. and advanced architectures	Sys. eng & implementation, human-computer eng., technology evaluations, concept prototypes, sw eng. methods	NCC, STAAC, SOMO, Code SM, EOSDIS, MIDEX, NGST

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Table 1.

The ISC has 4 simple but very critical Strategic Goals to achieve in the next 5 years:

1. Advance leading-edge information systems technology.
2. Clearly define the scope of ISC business, and deliver high value products and services that satisfy customer needs.
3. Build a diverse, talented, innovative, energized, internationally recognized, workforce of employees and managers.
4. Establish open, flexible, collaborative relationships with customers and partners.

These strategic goals are aligned with the Goddard Strategic Goals.

Role of the Software Engineering Laboratory in ISC

Given the external drivers such as “Agenda for Change “ which promulgated the creation of the ISC, the SEL has an opportunity to leverage its capabilities to help the ISC meet its strategic goals and objectives. There are several areas where the SEL can be an enabler for software process improvement:[Reference 3]:

- Build an improvement organization within the ISC that will increase the competency of its software engineering professionals, thereby increasing the quality of Goddard software systems.
- Model and characterize software systems in use on the ground and onboard spacecraft.
- Transfer and help tailor proven development and maintenance technologies to new domains, internal and external to GSFC.

As a result of Goddard’s organizational changes, a new vision and mission statement and new goals and objectives have been established for the SEL. Over the past several months a series of workshops had been

conducted with the SEL Director's to outline and define the new direction for the SEL and still maintain its heritage over the past 20 plus years. The SEL's new Vision and Mission statement shown in Figure 3, emphasizes continuous software process improvement.

Software Engineering Laboratory Vision:

To be internationally recognized as a leader for applied research in Evolutionary Software Engineering Process Improvement.

Software Engineering Laboratory Mission:

"Serve as a World Class Laboratory dedicated to evolutionary software engineering process improvement and serve as a clearinghouse within GSFC for software engineering best practices. And to foster the development of highly skilled software engineers in the ISC and in GSFC and contractor community through continued education and training of software development practices and methodologies."

Mission Objectives:

1) To study, research and roll out products from our best practices and methodologies.
2) To provide useable and applicable products aligned with customer needs.
3) To increase visibility, size and scope.
4) To partner with other software engineering organizations.
5) To serve as clearinghouse within ISC/GSFC for Software Engineering process improvement information.
6) To educate the software engineering community on software engineering best practices.
7) To identify resources for funds.
8) To develop quickie products e.g. "reusable abstractions" and modularize SEL documents into a handbook format.
9) To develop strategies for rolling out practices to customers and immersing customers in the process.

Figure 3

The current base of SEL activities include: management of databases and producing monthly reports, development of WEB based forms to eliminate file transfer, maintenance of SEL Library and development of Software Engineering Courses. Current research topics include Meta-process, Baseline Process and Core Metrics development. Short term and long term goals for the SEL have been established. They are:

SEL Short-term Goals:

1) Software Engineering Workshop
2) Complete ISC baseline study
3) Update SEL webpage
4) Develop customer focus teams
5) Increase GSFC visibility and interaction

SEL Long-term Goals:
1) Develop a full Software engineering training development program
2) Assist the ISC in obtaining CMM level 2 & 3
3) Establish partnerships with other software Engineering process improvement organizations

Figure 4 shows the relationship of the SEL with ISC. Under the new SEL structure, the ISC Branches and Teams would work more closely with the SEL in defining current processes and developing improved processes. The SEL analysts' role would expand to encompass end-to-end systems development processes, from requirements definition through maintenance and operations. In addition, new metrics will be developed that include the complete lifecycle of the end-to-end systems development process. An example of software technology products supporting the end-to-end mission system is shown in Figure 5.

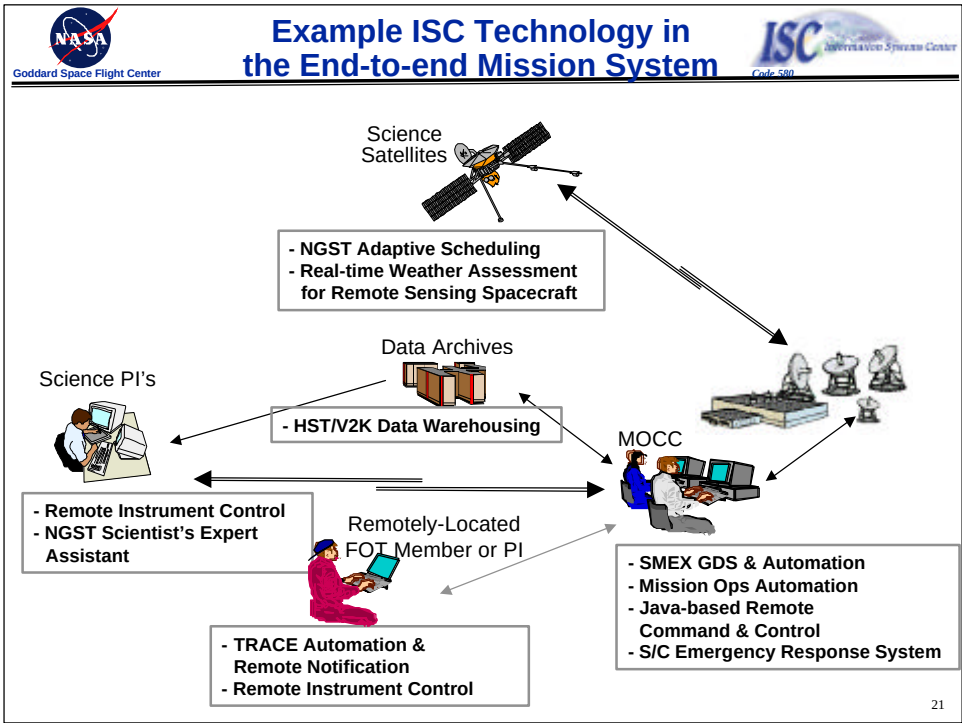

Figure 5.

As a result of the expanded responsibilities, the SEL has already begun to baseline the ISC Branch's products and services and software development processes and team products. This effort will establish a basis for measuring the impact of software process improvement measures that are implemented within the ISC. SEL is also in the process of developing a series of lectures and courses that focus on the Software Engineering Process incorporating the CMM philosophy. The SEL will also play a key role in helping the ISC to achieve CMM levels 2 & 3 and the presence of the SEL in ISC also provides the potential to ultimately achieve CMM levels 4 &5.

In summary, the 23 year history of the SEL has proven that long term focus on continuous improvement can reduce costs and produce a better product. The SEL, as a research organization must continuously adopt to the changing environment in which it exists. Expanding the scope and support activities of the SEL will present a great challenge, however, it will position the ISC to be able to improve Goddard's future systems development efforts.

References:

(1) Keegan, B. “Applied Engineering & Technology Directorate (AETD) 500,” AETD Newsletter, NASA Goddard Space Flight Center, August 1998.
(2) ISC Management Team, “ISC Retreat Report”, St. Michaels, MD, March 1998.
(3) Pajerski, R. and V. Basili, “The SEL Adapts to Meet Changing Times,” Proceedings of the 22nd Annual Software Engineering Workshop, Greenbelt, MD, December 1997.
(4) Szczur, M., “Information Systems Center (ISC) Overview Briefing”, NASA Goddard Space Flight Center, May 1998.
(5) Kea, H., “Software Engineering Laboratory Overview,” NASA Goddard Space Flight Center, September 1998