New Directions in Project Management

Second Caribbean and Latin American Conference on Project Management

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Quoted in "Project Failures Spur Management Back to Basics," by Susan McNeice Filler, *Billing World and OSS Today Magazine*, November 2001.

Ph.D. Students

COURSES and COMMITTEES

Office Hours, Location, and Other Student Resources

Course Sequences for Master's in Project Management

- Senior Fellow, Christina River Institute
- Member of The Project Management Institute and the American Association for the Advancement of Science
- My Favorite Risk Analysis: The Torino Scale
- Keynote speaker, First Caribbean & Latin American Conference On Project Management, 26--27 January 2001
  - also speaking at the second one, May 2002: New Directions in Project Management

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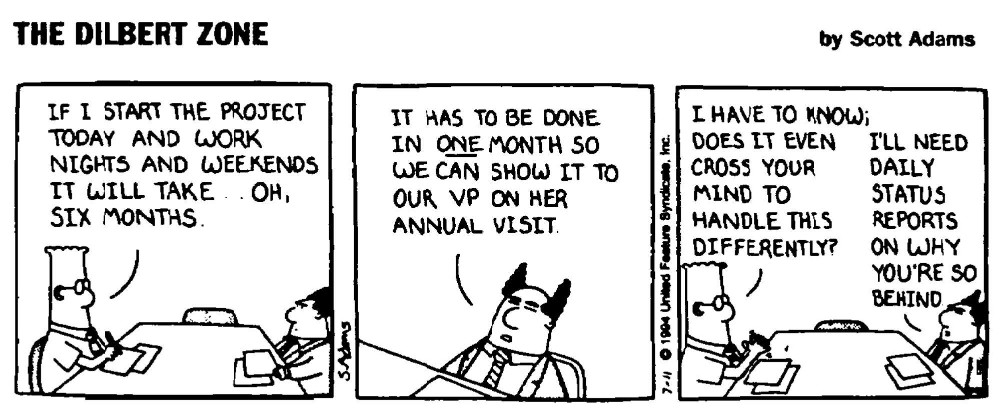
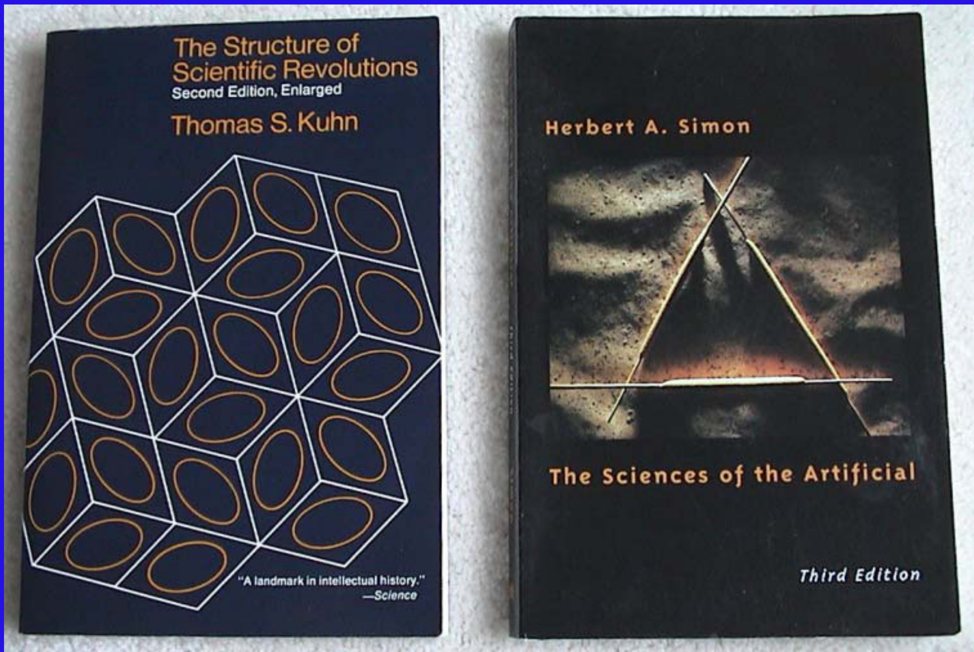
EMPLOYMENT HISTORY

The George Washington University	Director, MSPM Program	Summer 2001 -- present
Washington, D.C.	*Assistant Professor*	1999 -- present
	Adjunct Associate Professor	1998 -- 1999
	The Management Science Department	
National Research Council	Senior Program Officer	1998 -- 1999
Washington, D.C.	Commission on Physical Sciences	
George Mason University	Research Fellow	1996 -- 1998
Arlington, Virginia	Center for Science, Trade, and Technology Policy	
Executive Office of the President	Senior Policy Analyst	1996
Washington, D.C.	Office of Science and Technology Policy	
American Institute of Physics	Editor	1994--96
College Park, Maryland	Physics Today	
NASA Headquarters	Visiting Senior Scientist	1991--93
Washington, D.C.	Astrophysics Division	
National Science Foundation	Associate Program Director	1991
Washington, D.C.	Division of Astronomical Sciences	
North Carolina State University	Visiting Assistant Professor	1989--90
Raleigh, North Carolina	Physics Department	
NASA Goddard Space Flight Center	NAS/NRC Postdoctoral Fellow	1987--89
Greenbelt, Maryland	High Energy Astrophysics	
University of California	Postdoctoral Fellow	1985--87
Berkeley, California	Astronomy Department	
Massachusetts Institute of Technology	Research Assistant	1981
Cambridge, Massachusetts	Center for Space Research	
University of Colorado	JILA	1978--84
Boulder, Colorado		



Rocky Mountain News, 11 July 1999

Fugitive From The Cubicle Police © 1996 United Feature Syndicate Inc.



Paradigm Shifts

- Occur in "real" science
  - (Kuhn, *The Structure of Scientific Revolutions*)
- A paradigm is a model
- The model changes in response to new data or new understanding
- The reality has not changed, only the model that we use to interpret the reality.

The Sciences of the Artificial

- By Herbert A. Simon
- Third edition (1996), third printing.

Analyzing vs. Doing

We speak of engineering as concerned with "synthesis," while science is concerned with "analysis." (p. 4)

The Contingent

Engineering, medicine, business, architecture, and painting are concerned not with the necessary but with the contingent — not with how things are but with how they might be — in short, with design. (p. 12)

A General Definition of Design

Everyone designs who devises courses of actions aimed at changing existing situations into preferred ones. … Design, so construed, is the core of all professional training; it is the principal mark that distinguishes the professions from the sciences. (p. 111)

The Problem

In the past much, if not most, of what we knew about design and about the artificial sciences was intellectually soft, intuitive, informal, and cookbooky. (p. 112)

"Dean's Equation"

MBAs, at their core, can only understand two things: money, money and their career (and they can't count well either). If management is a continuum with Art on one end and Scientific Process on the other, how can you remove some of the art? PM helps move you closer to the scientific.

Knowing how to cope with shifting requirements, tight deadlines, and personnel issues will make MBAs much more effective. For the simpletons in the group show this slide:

$$PM = \$\$\$.$$

That should get the message across.

First New Direction

The professional schools can reassume their professional responsibilities just to the degree that they discover and teach a science of design, a body of intellectually tough, analytic, partly formalizable, partly empirical, teachable doctrine about the design process. (p. 113)

In Artificial Sciences

"From a pragmatic standpoint we are concerned with the future because securing a satisfactory future may require actions in the present. Any interest in the future that goes beyond this call for present action has to be charged to pure curiosity." (Herbert Simon, *The Sciences of the Artificial*)

My Request

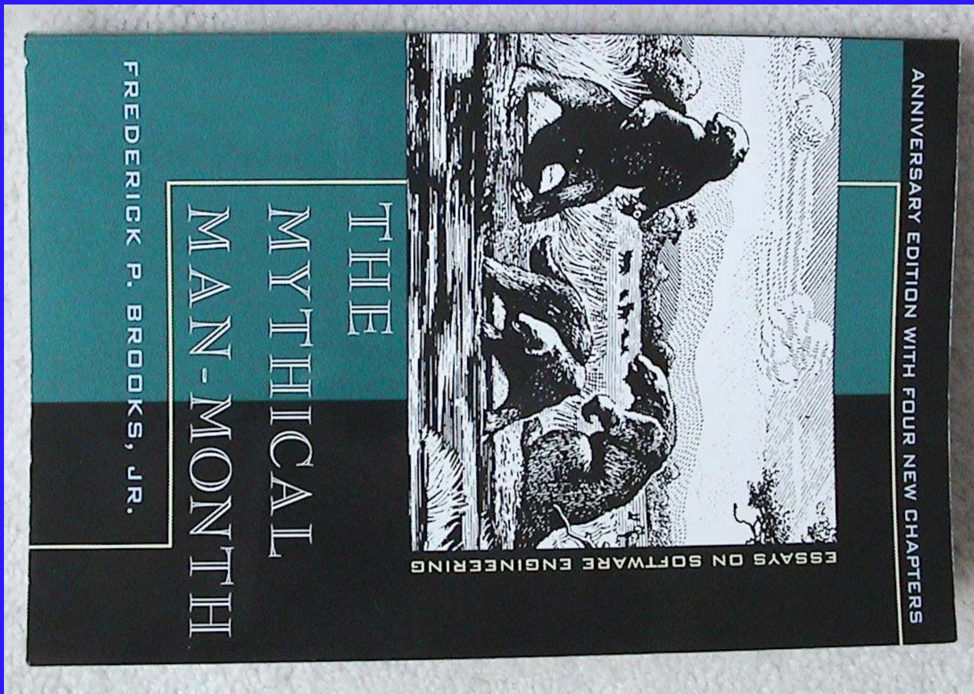
- I'm not asking for a paradigm shift. I am asking for a change in the culture of project management.

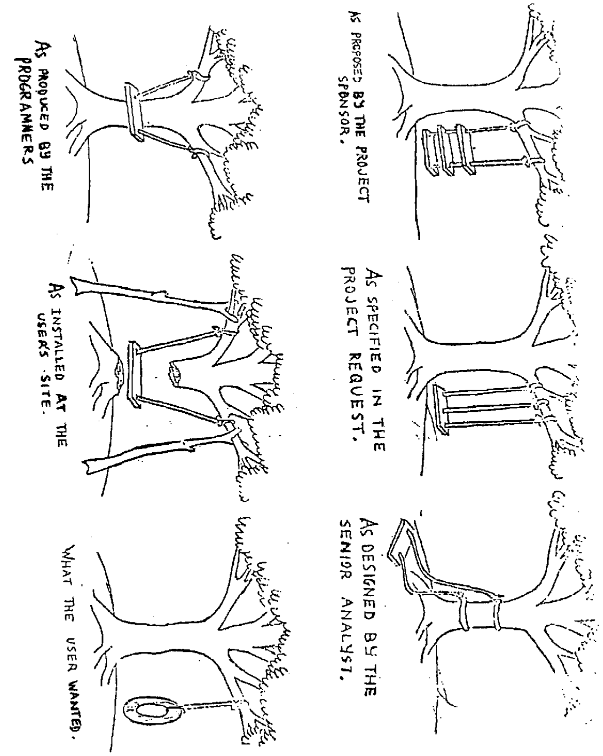
  I want you to change the reality of how projects are managed.

  – (It is not a problem of technology.)

What Is Meant By Integration in PM?

- First, the classic, narrow — but tremendously important! — interpretation: Integrate Cost, Schedule, and Scope.





Project Management is Integration Management

- To integrate means to “make entire or complete” (NSOED)
- integration represents creating the whole “by adding together or combining separate parts.” (NSOED)
- If not integrated, the project is, by definition, only partially managed: To say, therefore, that one is managing a project implies integration management ⇒ unity of effort

Three Possible Paths to Integration

- the discordant path (NASA lawyer story)
- the consilient path: arrive at a common understanding by taking different routes
- *ab initio*: The organizational infrastructure and its processes ease and promote sharing information; the compensation system rewards cooperative activities.

⇒ **The Second New Direction**

A Note About Knowledge

- traditional: data → information → knowledge
  - ◦ *organized* data: information (facts)
  - ◦ *codified* info.: knowledge (intellectual perception)
  - ◦ the ability to *utilize* new knowledge resides in people: **understanding**

    (a way of putting together pieces of knowledge)

Projects Within the Organization

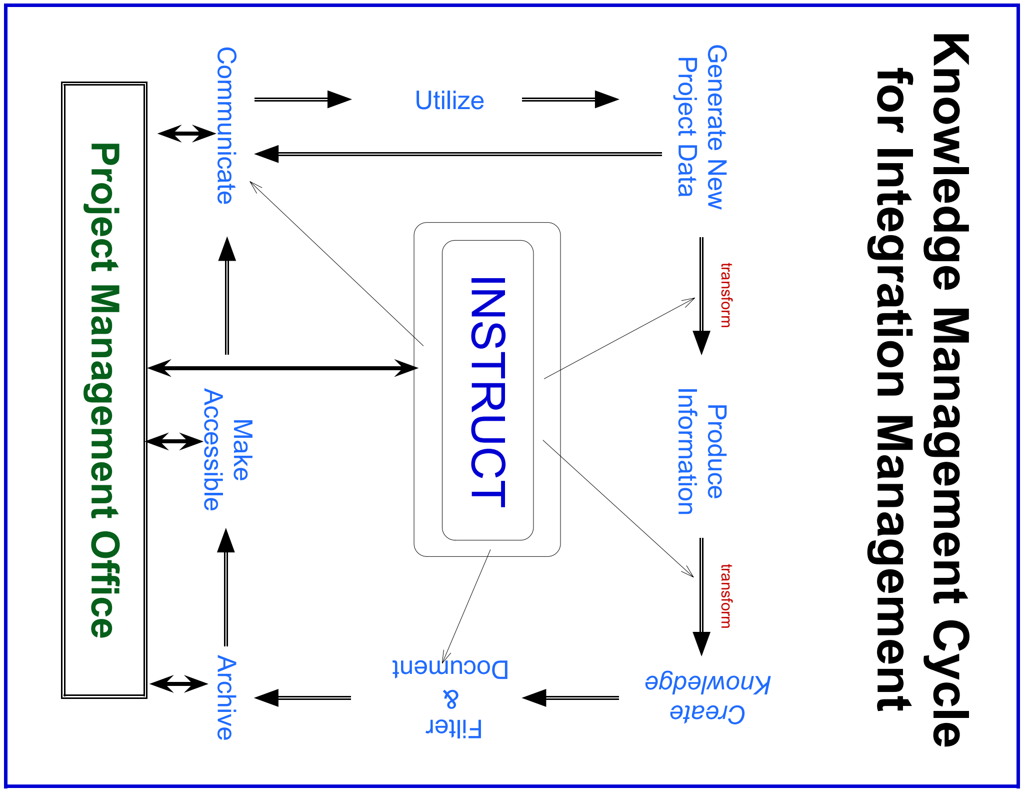
Vision
Mission
Strategy
  Portfolio of Programs
  Portfolios of Projects Within Programs
Tactics
  A Pipeline of Projects
  Integrated Management of Multiple Projects
  Integrated Management of Individual Projects
  Task Management

JAN 2001

TEAM →	1	2	3	4
ave. ind.	48	45	39	45
low ind.	36	20	14	30
Team	34	22	28	38
difference: ave ind. − Team	14	23	11	7

The Third New Direction

Project management as an integral part of enterprise or knowledge management.

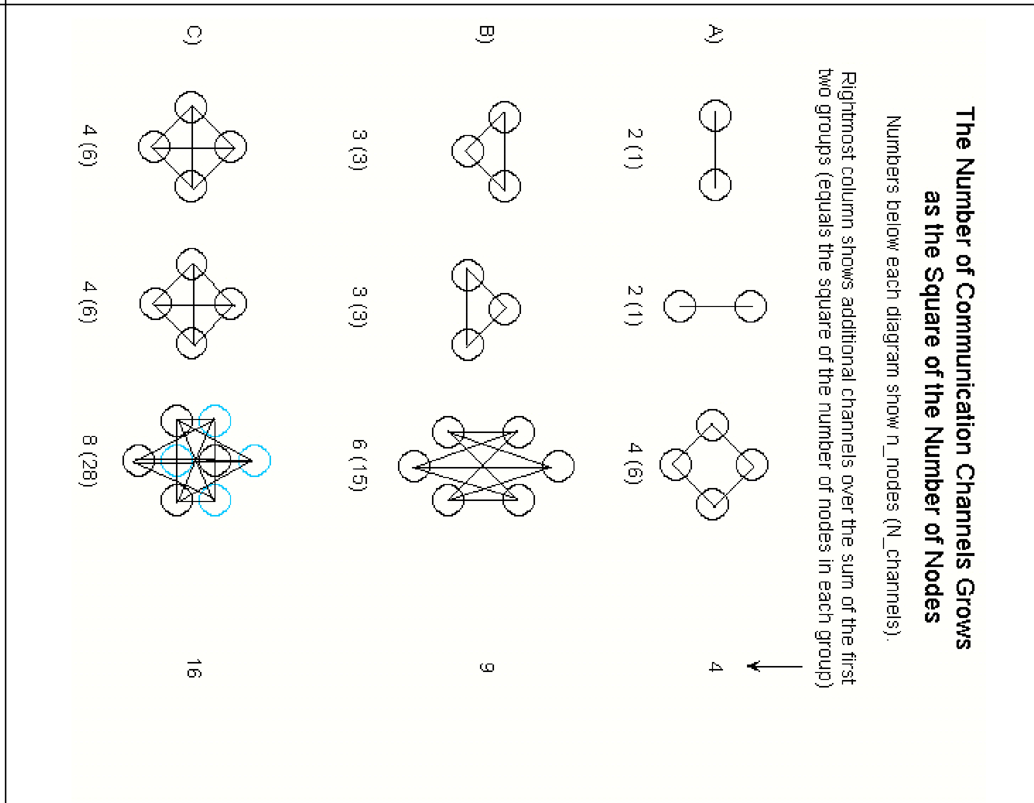


What Makes a Project Large?
And Why Are Large Projects Difficult?

Communication Nodes and Channels

- n_c nodes of communication
- N_{ch} communication channels between the nodes

$$N_{ch} = \frac{n_c(n_c - 1)}{2} \propto n_c^2$$



Channels Carry Messages

- The total number of messages sent, N_m, is the product of the number of nodes and the average number of messages per node, n_m,

$$N_m = n_c n_m.$$

- The number of messages per node is directly proportional to the number of nodes:

$$n_m \propto n_c.$$

Consider All the Messages (With or Without Information)

- As one might have expected initially (by arguing simply that the total number of messages is directly proportional to the total number of channels), the total number of messages is therefore also proportional to the square of the number of nodes:

$$N_m \propto n_c^2.$$

Do More Messages Increase Understanding? Yes, but ...

- In the limit that each individual receives information or data at a rate that can be understood fully and integrated with other relevant project information, an increasing number of messages represents an increase in understanding.

  ◦ the more messages one receives, each containing valid data, the more one understands the integrated progress of the project.

Why Are We Not All Brilliantly Knowledgable? (In this Information Age)

- In addition to having information associated with these messages, the messages come with an associated cost (if nothing else, the time to read them).
- If the number of messages per node increases beyond some limiting number, n_m^*, efficiency decreases and the project's integration suffers.

Limit Local Messages (Increase Bureaucracy)

Bureaucracies grow as intermediaries are installed to keep the average number of messages for decision makers of order n_m^*, such that

$$n_m^{dm} \lesssim n_m^* < n_m,$$

where n_m^{dm} is the average number of messages per decision-making node.

Increase Local Nodes, Increase Global Message Count

- The new intermediate nodes represent a local increase in the number of nodes, in the hope of maintaining a local limit ($\lesssim n_m^*$) on the number of messages at the decision-making nodes (with each message containing better than average information, one hopes).
- The global number of messages, however, continues to grow as the square of the total number of nodes, n_c, which has increased.

But What About Information?

- Since the total information content (which must initially contain redundancies) of the project management system is roughly proportional to the total number of messages, N_m, the information, I, is also growing as the square of the number of nodes:

$$I \propto n_c^2.$$

- Now the nodes might better be termed information nodes.

Information Makes a Project Large

- The above suppositions may explain that a large amount of information makes a project large.
- The information that must be handled grows as the square of the number of nodes, but budgets usually grow linearly, at best.

  ◦ That is, if to make 1 widget costs \$1 in personnel costs, \$100 is budgeted to make 100.

  ◦ Often imagined economies of scale are used to justify cutting budgets below the linear extrapolation.

It's Worse Than You May Think

- Larger projects may be inherently more difficult because linear resource increases do not keep pace with the geometrically growing information content, and integrating the project becomes more and more difficult. How much more difficult?
- Let us speculate further. Surely the amount of effort needed to integrate information initially grows non-linearly with the amount of information that must be integrated. Because connections must be made between all the information quanta (whatever they are), it seems not unreasonable to argue that the first integration efforts go as, say, the square of the quanta.

The Effort to Integrate

- If, remembering Leibniz, we represent the integration effort with a solitary integral sign, $\int$, that relationship would be written $\int \propto I^2$.
- Because we have no real knowledge about this exponent, other than to argue that it is greater than 1 — but does learning allow it to fall below 1 as the project proceeds? — the relationship can be written more generally:

$$\int \propto I^y$$

where y may change as a function of time.

Integration Effort And Channels of Communication

- Combining this general relationship with the proportionality between information and the number of nodes ($I \propto n_c^2$) yields:

$$\int \propto n_c^{2y}$$

- Even if the integration effort were only linear ($y = 1$), we would still have $\int \propto n_c^2$. If the exponent y is only 5/3 — and above we postulated that it might be closer to 2 — doubling the number of communication nodes increases the integration effort by a factor of 10!

Why Are Large Projects Difficult?

- From the perspective of integrating information communicated over many channels, then, perhaps large projects are difficult to manage precisely because they contain so much information, and resources are rarely scaled accordingly.
- Studies of successful projects may be able to verify this conjecture.

The Fourth New Direction

Greater use of information technology will make large projects larger and, paradoxically, more more difficult to manage well without extraordinary effort.

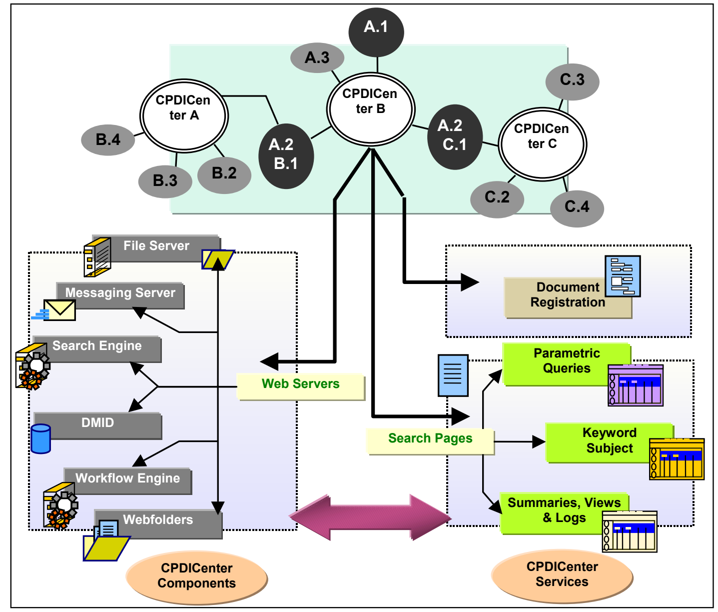


Figure 3. CPDICenter Systems and Components WBS.

CPDICenter Web forms for Document Classification/Registration

Hammad (GWU), 2002

An Example: "Construction Sites Seek Technologically Adept"

"For the professionals who oversee the projects, things are even more complicated. . . . Global-positioning satellites allow them to keep track of heavy equipment. On-site digital cameras transmit images by e-mail to their offices, Web sites give a blow-by-blow display of construction progress and computers plot the logistics of moving workers and materials into and off the site. . . . And that is just a partial list."

— Tanya Mohn, The New York Times (NJ), 28 April 2002

Presenting Information

- "The essence of project management is communication." dfc, 20th and 21st centuries, on many occasions.
- One of the big problems for our students

Required to Accomplish the Objective of Sharing Integrated Information

1) the physical infrastructure needed for collecting, collating, distributing, archiving, and searching for electronic information

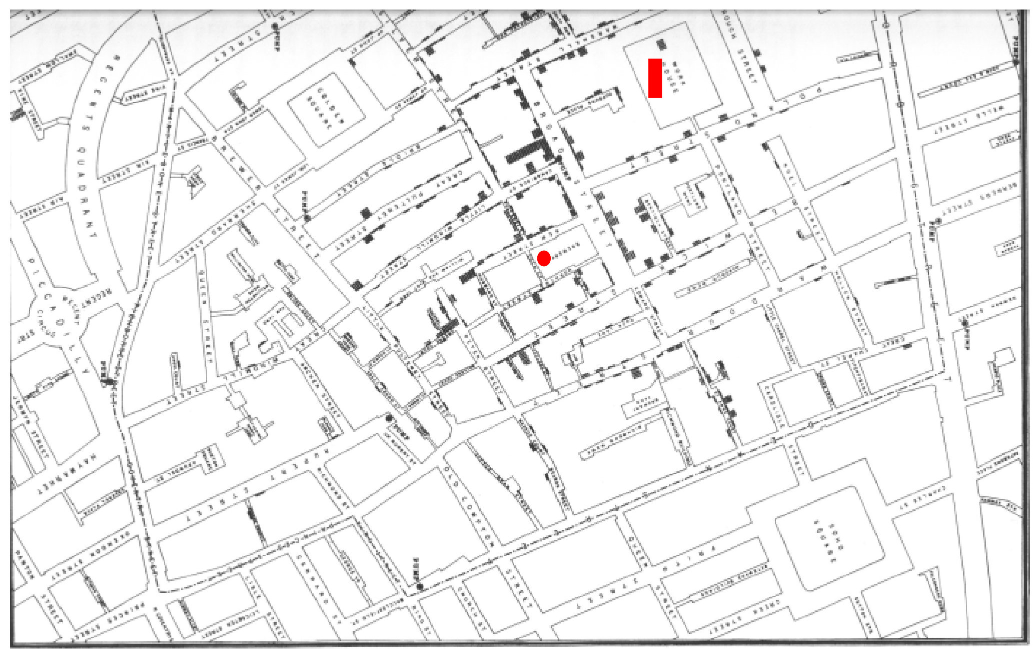
2) the skills needed for effective presentation of information

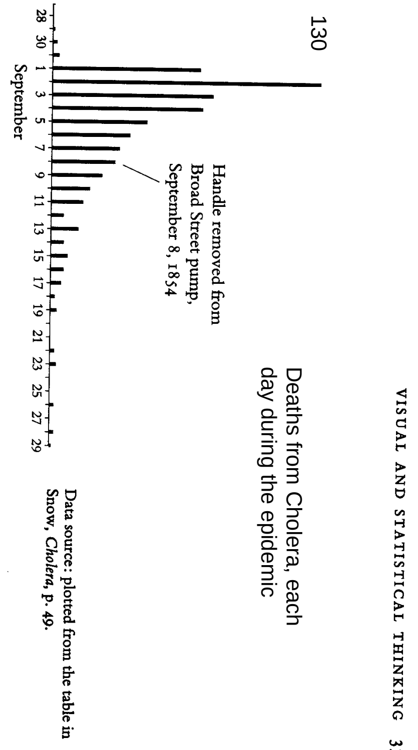
Figure 2. An illustration of the interactive workspace used for the prototype.

Froese, et. al., 2000

What to Present?

"Displays of evidence implicitly but powerfully define the scope of the relevant, as presented data are selected from a larger pool of material. Like magicians, chartmakers reveal what they choose to reveal. That selection of data — whether partisan, hurried, haphazard, uninformed, thoughtful, wise — can make all the difference, determining the scope of the evidence and thereby setting the analytic agenda that leads to a particular decision." (VE, page 43)





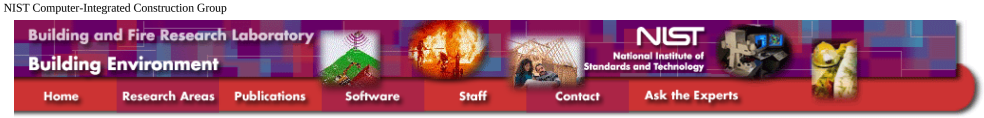
The Presentation Goal

- "Visual representations of evidence should be governed by principles of reasoning about quantitative evidence. For information displays, design reasoning must correspond to scientific reasoning. Clear and precise seeing becomes as one with clear and precise thinking." (VE, page 53)
- "...... *there are right ways and wrong ways to show data; there are displays that reveal the truth and displays that do not.*" (VE, page 45)

The Fifth New Direction

Development of better ways to present project information.

NIST Computer-Integrated Construction Group



Computer-Integrated Construction Group

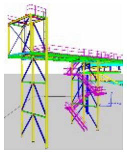
The Computer-Integrated Construction Group is part of the Building Environment Division. For more information, contact Dr. Kent Reed (Group Leader) or Robin Jeffries (secretary).

Overview

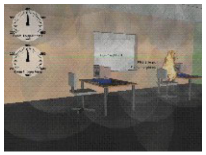
Researchers in the Computer-Integrated Construction Group are working collaboratively with the U.S. construction and building industries to establish an exemplary computer-integrated construction environment, based on open standards for the representation, access, exchange, use, visualization, and archiving of information. With these standards implemented in software systems, industry will be able to achieve its goal of seamlessly circulating information throughout its life-cycle work processes, all taking place in a loosely coupled, distributed, heterogeneous environment.

Current research is concentrated in three areas: the integration of project information, the integration and automation of activities on the construction site, and the electronic commerce of technical information between supplier and project. The output of this research is prototype standards and protocols, measurement technologies, and testing procedures. Experiments to evaluate and demonstrate these outputs are conducted in a testbed that is open to industry and academia.

Visualization of Steel Product Models, Construction Project and Site Information, and Building Performance




The group is doing research on the visual representation and simulation of construction and building related models, activities, and processes. The Virtual Reality Modeling Language (VRML) is used for the visual representation of those functions.

BFRL Program

CONSIAT: Construction Integration and Automation Technology

The CONSIAT program will enable industry use and further development of new automation capabilities that will lead to significant cycle time and life-cycle cost reductions in the delivery of construction projects by achieving breakthrough, technology-intensive process changes. Such innovations – with emphasis on "integration," "automation," and the filling of critical information gaps – are vital to business competitiveness of facility owners and owner-operators, and of engineer-procure-construct (EPC) or EPC-operate-maintain (EPCO&M) contractors.

Specifically, this NIST program will contribute to U.S. industry's ability to:

- compress project schedule through concurrent engineering and reduce design changes;
- enable better control of project schedule and cost;
- improve supply chain management, including tracking of materials, equipment, and labor;
- rapidly detect and rectify differences between intended design ("should-be") and actual construction ("as-is");
- avoid rework through just-in-time guidance for field operations;
- automate the construction process, including equipment for automated positioning and high-speed assembly/placement; and
- capture the physical and functional "as-built" status of a project for later use in facility commissioning, operation, maintenance, and renovation.

BFRL Goal

Advanced Construction Technology

The first focus of **Advanced Construction Technology** is the integration and automation of project information and the integration of metrology data from the construction site into project information management systems.

The construction Industry Institute (CII), an organization with more than 100 members representing the Nation's leading owners, contractors, and suppliers of constructed facilities, has made the development of Fully Integrated and Automated Project Processes, FIAPP, a top priority. However, the construction industry faces special challenges in reaping the full benefits of the information technology revolution that has brought and continues to bring rich rewards to many other industries. These challenges include low R&D investment, the fragmentation of the industry, and the strong project-oriented nature of its processes.

BFRL is developing (1) information representation and exchange protocols that describe construction processes and projects, (2) communication protocols that work in the distributed construction environment, (3) technical transaction protocols that support construction practices, and (4) performance metrics and recommended practices for construction measurement systems. BFRL will conduct a full-scale demonstration of a prototype FIAPP system in partnership with construction industry stakeholders by 2004.

The second focus of Advanced Construction Technology is to develop and apply performance prediction tools, standards, and practices for structures that are subjected to extreme loads from earthquakes, winds, fires, and blast.

Losses due to natural and man-made disasters are escalating sharply due to increasing population density and urban growth in regions of high risk. Total property losses from recent disasters, including earthquakes, hurricanes, tornadoes, flooding, and fires, exceed $22 billion per year.

BFRL is (I) developing the modeling and simulation tools necessary for evaluating the structural performance of conventional and innovative systems

AN MIT ENTERPRISE TECHNOLOGY REVIEW
Emerging Technologies and Their Impact

NIST's system generates a 3-D model of a construction site's terrain before excavation. (Image courtesy of the National Institute of Standards and Technology)

TR Related Articles

- Automatic Networks
- Vibrational Parasites
- Power Play

Innovation **By Kevin Hogan** May 2002

Construction sites go wireless.

Keeping accurate tabs on every element of a construction project, from piles of earth to stacks of steel beams, is complicated and expensive. To ease the burden on builders, engineers at the National Institute of Standards and Technology are developing information networks that could automate the process.

In one experiment, a construction site is rigged with a Global Positioning System antenna, a computer equipped with a wireless Ethernet connection and a laser-based measuring device. The laser scanner analyzes the size of an object—say a mound of excavated dirt; measurements are sent via wireless Ethernet to databases and file servers that can be accessed by contractors and engineers both on and off the site. Software puts the data into an intelligible form—say, a 3-D model for monitoring job status—and can provide precise measurements for billing purposes. "Right now, many estimates for jobs like ground removal are taken only by how many trucks were used to haul the stuff away," says Geraldine S. Cheok, a research structural engineer at NIST. "This will make the numbers much more exact."

Ultimately, the NIST system would go beyond measuring dirt piles. Researchers plan to use radio frequency identification tags to track every pipe, beam and hammer that enters or leaves a site. While the researchers expect to have the technology ready for field use by 2006, the building industry is notoriously slow in adopting new techniques, says Ken Eickmann, director of the Austin, TX-based Construction Industry Institute, a research organization that looks for better construction practices. "But if it proves to be a cost saver," he says, "you will see it in practice."

Kevin Hogan is a senior editor at Technology Review.

The Greater Team

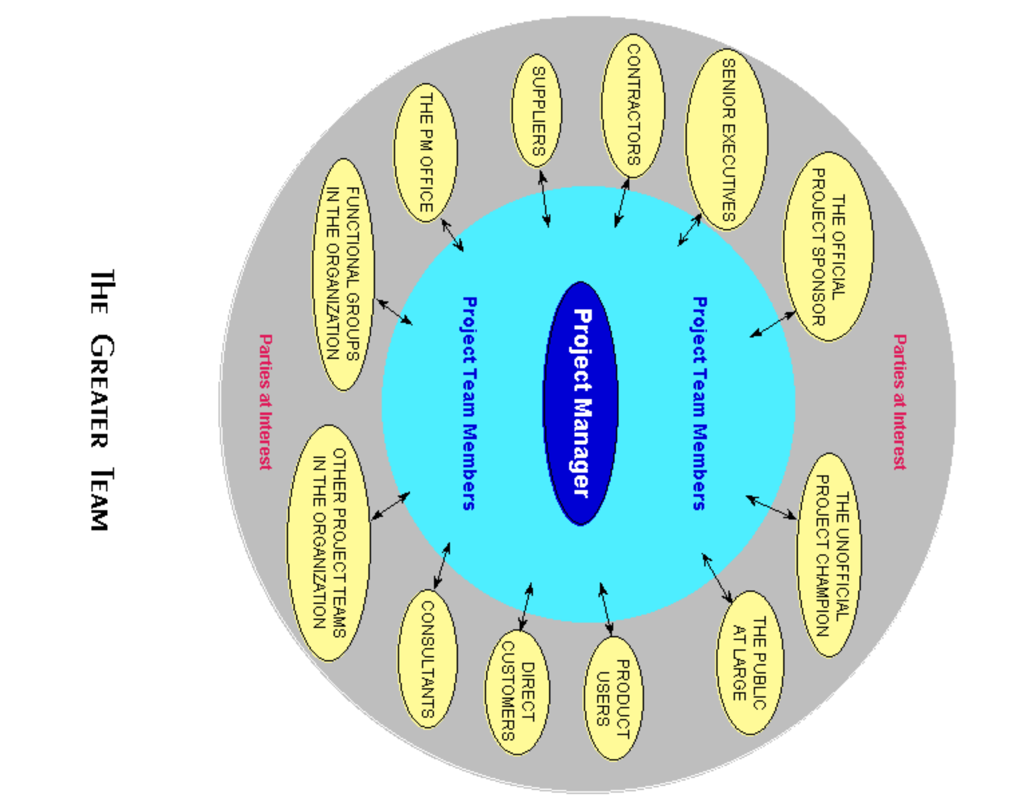
- Any population outside the immediate project team that the project may affect, whether directly or indirectly.
- including the project sponsor or chief advocate within the organization (its champion),
  - other project teams in the organization
  - the project management office,
  - suppliers
  - consultants

The GT, continued

  - contractors
  - functional groups in the organization
  - the public
  - the client and the client's customers too
- Ferreting out the indirect effects of the project requires considering of the project's long-term as well as immediate implications. Paradoxically, because they are not so intimately involved, individuals of the greater team may be the first to understand the more subtle consequences of a project.

Diverse Teams

- The best team will almost always be a diverse team, that is, a team diverse in the skills of its members.
- The collected experience of a diverse team will be far wider than that of a homogenous team.
- If properly managed, a diverse teams will also be more creative.



The Sixth New Direction

A greater appreciation (and use of) the greater team.

washingtonpost.com

Group Tackles Software Quality

Consortium to Focus on Security and Reliability

By Neil Irwin
Washington Post Staff Writer
Friday, May 17, 2002; Page E05

Major software companies, government agencies and academics yesterday launched a consortium that aims to find ways to make software more dependable and secure.

Carnegie Mellon University in Pittsburgh announced the creation of Sustainable Computing Consortium, a group whose founding members include Microsoft Corp., Raytheon Co. and NASA. The group intends, among other tasks, to figure out specifications for software quality so that sellers and buyers of computer programs will have a uniform way to measure quality.

The ultimate result of those standards might be word processors that are less likely to freeze up during use, data-processing centers that operate 99.99 percent of the time instead of the 99.9 percent of the time they work now, and insurance companies that are better able to gauge the risk that a client's customer database will get hacked and can therefore appropriately price insurance coverage.

The effort intends to pull in expertise from a broader group of people than just computer scientists, said William Guttman, a professor of economics and technology at Carnegie Mellon who is director of the consortium. He cited studies that concluded that defective software cost businesses worldwide $175 billion in 2001 and that 45 percent of computer downtime is because of software glitches.

"This should not be just technical work on algorithms and methodologies," he said. "We're involving economists, public policy experts and lawyers as well as software engineers."

Managing Projects with Darth Vader and the Emperor

⇒ Technology is not the solution

Summary: Six New Directions

1. Project management as a science of design.
2. Ab initio integration.
3. Project management as an integral part of enterprise or knowledge management.
4. Greater use of information technology (large gets larger).
5. Development of better ways to present project information (both analytic and real).
6. A greater appreciation (and use of) the greater team.