Project Planning and Scheduling Workshops: An Overview

by W. M. Lawbaugh

A highly acclaimed and well-received new training effort on the part of NASA's Program/Project Management Initiative (PPMI) has been taking shape over the past couple of years.

So far, about a dozen Project Planning and Scheduling (PPS) workshops have been completed. Each has been designed to provide project teams with an understanding of the principles of planning and scheduling, along with an opportunity to apply those principles to their own current project.

NASA staff and their contractors are brought together for four or five days (and late nights) to work on a project in the early planning or replanning stages. Project teams execute the fundamentals of planning, create and use a methodical work breakdown structure (WBS), and develop some kind of project logic network. From there, they generate a project schedule, and usually the definition and management of the critical path. Throughout the workshop the project team is expected to apply the principles of effective planning and scheduling in a hands-on effort for their current project.

Project Planning and Scheduling workshops are conducted on an as-needed basis at various sites for intact project teams, including NASA staff, customers and contractors. In order to develop a high-level integrated network with a calculated critical path, participants are asked to prepare for the planning process on two levels.

The first, essential level of preparation calls for a team leader, usually the NASA project manager, to work with a PPS facilitator and knowledgeable people who are responsible for the project. Upon arrival at the training site, the project team should have a detailed description of project objectives and control, along with a list of project milestones and deliverables, both internal and external.

First-level preparation also calls for computer hardware and software such as Microsoft Project to capture the project team's critical path at the end of the PPS workshop. An expert operator, furnished by the project team, is expected to handle up to 400 tasks, process all the data generated by the team, meet the online needs of the group, and then print out the project network.

A second level of preparation is advised to assure success of the workshop process. It is a good idea, for example, to create a pictorial illustration of all the essential components and interfaces of the project. A flow chart should show how those components are related to other systems. A hierarchical diagram should show the decomposition and integration structure, while an organizational diagram could illustrate the reporting structure of the project team. A list of constraints on the project would be helpful, along with a description of any strategy for project delivery.

To make sure the project managers, engineers and technicians are all speaking the same language, both a project glossary and list of acronyms are suggested. Often these lists are supplemented during the Project Planning and Scheduling workshop as it progresses.

Space Station Support Equipment (SE) Planning, Scheduling and Integration

One of the first PPMI Project Planning and Scheduling workshops involved the Space Station Support Equipment Integrated Product Team (IPT) from the Kennedy Space Center. Larry Manfredi served as project manager and leader of the PPS workshop. The KSC support equipment is developed for the processing of International Space Station flight hardware resupply and return missions. The KSC support equipment IPT faces daunting challenges in terms of planning, scheduling and integration. The team will design, procure, and conduct verification of more than 75 end items of support equipment. Their task also includes the continuous coordination of interface control documents, design/document reviews, schedules and deliverables pertaining to more than 49 end items of non-KSC-developed support equipment to be turned over to the IPT for sustaining engineering.

The purpose of the PPS workshop was to ensure that members of the Communication & Avionics Sub-IPT, Simulators Sub-IPT, Electrical & Instrumentation Sub-IPT, the Test, Control and Monitor System (TCMS) IPT, and Logistics and Maintenance IPT would integrate their planning and scheduling for the U.S. International Standard Payload Rack (ISPR) Checkout Unit development. The ICU provides a sufficient fidelity test station, which will be used to verify that the ISPRs and EXPRESS (Expedite the Processing of Experiments to Space Station) racks are electrically and mechanically compatible with the space station module prior to prelaunch installation. The Integrated Product Team approach is used to ensure that empowered teams, staffed and supported by functional organizations, are accountable for designs that fully meet customer requirements and expectations. The team is responsible for requirements definition, design development, acquisition, fabrication, verification, training, operations support, maintenance, configuration accounting, and sustaining engineering of standalone end items and systems that must be integrated in order to complete the ICU.

The team members were given instructions on the Support Equipment IPT's technique of using concur-

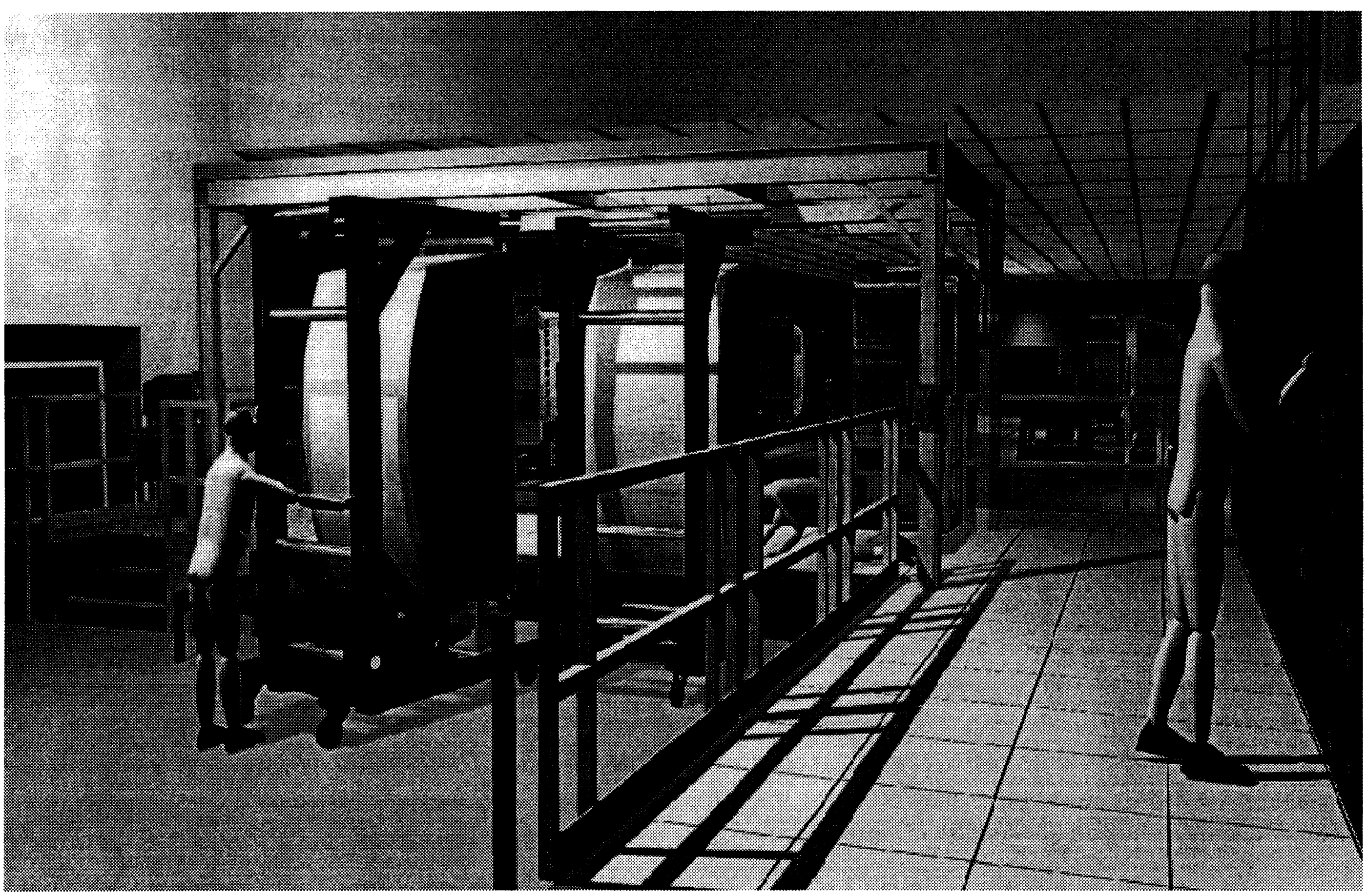

Figure 1. Space Station Support Equipment checkout unit.

rent engineering and integrated process-based management flows to facilitate planning and implementation. The End Item teams were briefed on the structure of the development process, which facilitates continuous improvement by incorporating all required products, activities and associated constraints into an automated project management/scheduling tool. Each product being developed by the team was identified at the task level, along with required duration, input/output requirements, and interdependencies. Required skills were identified and assigned at the task level. Constraints were identified to facilitate Critical Path Method analyses. The planning and actual cycle time of each activity and product development will be traced to facilitate validation of future planning and Root-Cause Analysis.

As the team began to link interdependencies externally and internally, it became evident that there was a need for a more structured activation/validation plan to verify all interfaces in the ICU, including services from the Communication & Tracking Checkout System, Command & Data Handling, Power, Fluids and TCMS. This structured plan evolved as an integrated test scenario known as the Payload Integration Checkout Facility. The PICF is designed to integrate experiments and carriers such as ISPRs and perform a final interface verification test utilizing the TCMS and all other supporting subsystems.

All in all, the multi-disciplined composition of the End Item teams, along with the many international customers that utilize the ICU to accomplish their payload and experiment processing needs, says Michael Jones, makes the KSC Support Equipment Integrated Product Team's implementation task a unique challenge for effective project planning, scheduling and integration.

Stratospheric Aerosol and Gas Experiment III (SAGE III)

SAGE III comes from a long lineage of successful Langley Research Center SAGE-series programs. Three of the four previous instruments operated beyond their design-life and none has failed in-orbit. The fourth, actually the first instrument in the series, was operated for only four orbits during the Apollo-Soyuz mission in 1975 to establish measurement validity of the newly invented solar occultation concept. Two of the four instruments were operated beyond 14 years, with SAGE II still operating today and returning good science measurements. Each successive instrument added new spectral channels, but older instruments were kept operating to preserve the long-term data set. The SAGE series has the longest term data set for aerosols and ozone in the middle atmosphere, and is considered by the World Meteorological Organization to be the standard for global ozone and aerosol profile measurements.

SAGE III, like its predecessors, will be a principal source of data for global changes in aerosols, ozone, water vapor and clouds. State-of-the-art Charge Coupled Device (CCD) detector technology has been employed to boost sensitivity and spectral resolution. Increased sensitivity allows solar occultation measurements to be taken deeper in the troposhere to determine long-term global warming or episodic climate cooling after volcanic eruptions on Earth such as the 1991 Mount Pinatubo disturbance, and additionally, allows for lunar occultation measurements. Using lunar occultation, SAGE III measures nighttime species such as chlorine dioxide.

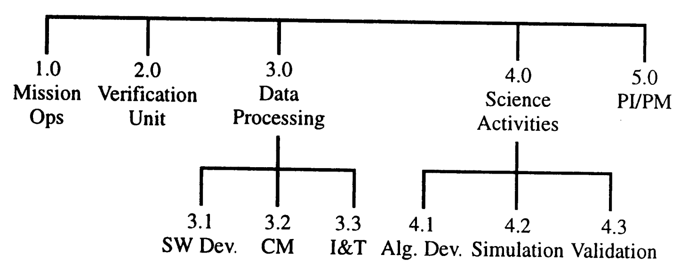

Figure 2. SAGE III WBS.

SAGE III is currently planned for multiple launches as part of the Earth Observing System. The first instrument will fly on a Russian spacecraft—METEOR 3M—in 1998. NASA Headquarters is currently negotiating with space agencies of other countries to find a home for the second instrument. An International Space Station mission beginning in 2001 is planned for the third instrument. International aspects of this program place special challenges on the SAGE III Team. Each team member must be open not only to different cultures and new technical concepts, but to new ways of doing business that are very different from the American norm. Virtually every aspect of the Russian interface (personal, technical and programmatic) is vastly different from past experience. These challenges have the greatest effect on team efficiency. Thus, project work planning must include huge inefficiency factors to account for cultural differences, such as the language barrier where all discussions with the Russians must go through interpreters.

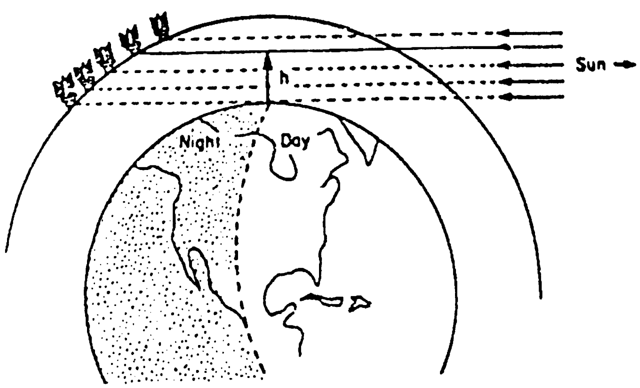

Figure 3. SAGE III measurements.

SAGE III was very fortunate in being able to schedule a PPMI Project Planning and Scheduling Workshop in Hagerstown, Maryland to coincide with the first week of the hardware development (Phase C/D) program. Twenty-seven team members representing Langley, Goddard, Wallops, and Headquarters civil service, on-site Langley contractors, and the prime contractor, Ball Aerospace, met during the second week of January 1995. Not just engineering team personnel, but everyone associated with the Project was invited to attend. During the first evening, sub-teams were organized to divide planning of overall team activities into smaller groups categorized by instrument subsystems, interfaces, operations, etc. Each sub-team planned its piece of the program for two days, and then reconvened as a team to integrate activities on the last two days. One of the most popular of the team building exercises was a meeting that lasted several hours early in the week, in which each statement, and each requirement in the government contract with Ball Aerospace was challenged. Each requirement and each deliverable to the government, including documents, had to meet a strict test: if it didn't contribute to measurement of ozone and aerosols in the atmosphere, it was thrown out. Needless to say, many statements and requirements were eliminated.

CSM facilitator John Chiorini helped the team organize the work into a detailed work breakdown structure (WBS), and indicated the time-phased, interrelated activities using yarn and the Cards-on-the-Wall approach. As each captain described the sub-team's plan, critiques from members of the other sub-teams served to brainstorm activities and interrelationships until yarn stretched completely around the large room and into smaller rooms at the back to describe relationships among the approximately 400 activities. The first critical path to be calculated indicated that delivery of the flight instrument was 14 months after the 34-month requirement. Subsequently, the team brainstormed more efficient logic to establish a plan to deliver flight hardware on time.

It was not surprising that the newly formed team began the week as an amorphous group of strangers with only a vague understanding of what SAGE was all about, but ended the week functioning as a high-performance team with a good work plan. According to Ed Mauldin, SAGE III Project Manager and Hagerstown team leader, the most important benefit from the week was quick development of new interpersonal relationships among team counterparts and establishment of a high-performance team very early in the program. Being off-site in an informal environment made it easy to forget who was government and who was contractor, thus eliminating useless communication barriers. A united team dedicated to building the best possible scientific instrument within budget and schedule constraints was formed and a common sense of purpose was instilled. Now, about halfway through the program, this team remains within budget and on schedule, a remarkable success story. This team is very proud of its record of establishing new standards for others to follow and highly recommends this PPMI Project Planning and Scheduling workshop process to other newly formed project teams.

Transport Research Flight Facilities

The third PPS workshop involved a diverse team of engineers, designers, computer hardware and software experts, QA, fabrication and resource analysts, schedulers and project management people headed by Allen C. Royal of Langley Research Center.

Their task was to plan and schedule the modification of a B-757 aircraft from an airline configuration to a research facility. In addition, the project team was expected to develop an instrumentation integration laboratory and create a simulator facility to replicate the aircraft research flight deck.

"The team needed the time away from the everyday working environment," said Royal, "to concentrate exclusively on the job at hand, which was to develop logic diagrams, work breakdown structures, GANTT charts, resource assignments, etc."

He added: "In addition, the time spent 'locked up' in a room 12 to 14 hours a day actually resulted in a closer knit group of people (very important, considering the job at hand)."

The four-and-a-half day experience brought the Langley team closer together with specialists from Lockheed, PSI, Unisys and CSC, Computer Sciences Corporation. "One of the many positive results of this experience was that as the individual teams worked," noted Royal, "people began to realize just what was expected of them and what they were to expect from another team, and the enormity of the overall project—this was a big plus."

Another big plus was the momentum that was built up during the PPS workshop that propelled the project past its first major internal milestone. This project team, too, asked for another PPS workshop but the principal players could not be scheduled at the same time.

Guidance, Navigation and Control Integration and Test Facility

The next PPS workshop was designed for the guidance, navigation, and control (GN&C) group developing a test facility for the International Space Station (ISS) of Johnson Space Center. The ISS GN&C function is distributed not only among different segments of the ISS, but between U.S. and Russian hardware and software. The GN&C Integration and Test Facility (GITF) was proposed by JSC Engineering as a facility where a majority of these pieces could be integrated and tested during development to increase the likelihood of the success of the on-orbit configuration.

GITF is bringing together all of the U.S. GN&C components to perform real-time closed loop testing. Flight-equivalent processors for both the GN&C and the Command & Control software will be integrated with the Global Positioning System (GPS) receiver processor, being fed inputs from the GPS radio frequency signal generator, the engineering unit rate gyro assembly, mounted on a three-axis rate table; and an emulator, which is being developed and built at JSC, of the Control Moment Gyro.

The Russian portion of the GN&C system will hopefully be represented by development units of the flight processors, being provided to the Russians by the European Space Agency, loaded with both development and final versions of the Russian flight software, and high fidelity models of the Russian sensors and effectors.

Project manager and group leader Karen Frank of JSC faces the challenges of relying on international cooperation for significant deliverables to her project, as well as the integration of institutionally owned resources with program-contracted hardware. Since the original workshop was conducted, numerous deliveries to the project have slipped schedule and the team has conducted its own mini-workshop, based on the PPS experience, to re-network and replan the project.

The next two Project Planning and Scheduling workshops occurred simultaneously but by different facilitators in September 1995. Blackhawk Management Corporation led the High-Speed Research planning and integration workshop in Hampton, Virginia, and CSM, the Center for Systems Management of Cupertino, California, facilitated the AGATE workshop in Hagerstown, Maryland. The two different approaches are detailed here.

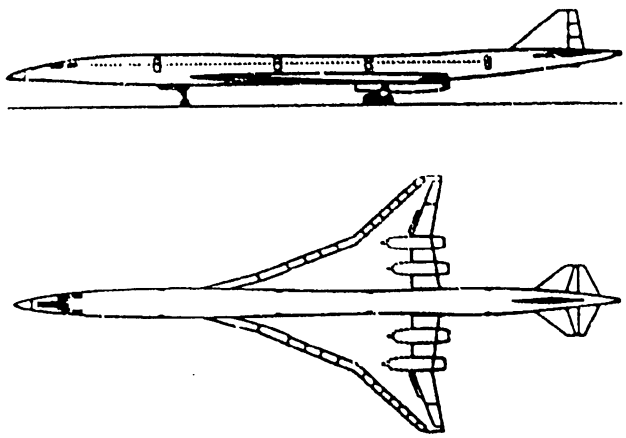

Figure 4. HSCT prototype.

High-Speed Research Program

For more than a quarter of a century, NASA has sponsored research for a supersonic transport aircraft. Environment concerns in the early 1970s led to a halt in funding while the British-French Concorde program moved forward.

A decade ago NASA received funding for Boeing and McDonnell Douglas to conduct studies of a second generation SST to carry about 300 passengers and flying 6,000 nm.

Phase 2 of the NASA/industry effort to develop the technology for the nation's first high-speed civil transport (HSCT) shifted into high gear with the High-Speed Research (HSR) planning and integration workshop held at the Chamberlain Hotel on Fort Monroe in Hampton, Virginia, in September 1995. More than 168 participants were present at the workshop, including officials and engineers from three NASA Centers (Langley, Ames and Lewis) and Boeing, Douglas, Lockheed and Northrop. The workshop, supported by NASA Headquarters under the Program/Project Management Initiative, used NASA expertise and the Blackhawk Management Corporation to teach the HSR Integrated Technology Development teams the latest advances in project management and planning skills. Rob Calloway of Langley was the NASA group leader. Specific tools presented to the attendees included the "One-Pager" tracking methods, logic networks and team building approaches.

In early 1995, Joe Shaw, Project Manager for the Propulsion segment of HSR at LeRC, and Dan Walker, Business Manager, sponsored a different approach to the application of the One-Pager concept to the HSR project. Rather than utilizing the workshop format, Joe Shaw formed a small team comprising, among others, James Wilcox of Blackhawk Management Corporation and Lisa Vietch of LeRC, to analyze the available data and develop the One-Pager products. This was successfully accomplished, and early returns suggest that the concept has proved to be very useful. (The One-Pager illustrations in this article are from the Propulsion segment of the HSR project at LeRC.)

At the PPS workshop, the high-speed research agenda for the next three years was set regarding HSCT airframe development. The workshop involved the efforts of 16 NASA/industry teams representing the following areas of study: structures and materials, aerodynamic performance, flight deck technology, environmental impact and overall technology integration. Phase 1 of the HSCT development program, involving technical solutions for environmental concerns, were completed later that year. Phase 2 of the program was fully implemented that year and addresses the cost effectiveness and economic viability of the aircraft systems.

The HSR program was spending approximately $20 million a month on HSCT research. NASA facilities, including advanced computer simulators, wind tunnels and labs, were being utilized to develop an HSCT technological database. As stated by Dr. Alan Wilhite, Deputy Director of the High-Speed Research Project Office at NASA Langley, "Technology is being developed for industry use in the year 2001."

The One-Pager approach involves a concise, integrated, executive level set of cost, logic, schedule and metrics data that encourages communication of plans and of progress against plans. This approach focuses on definitive end products with one or more of these characteristics: high cost, high schedule risk, high technical risk and/or key integration intersection. (Weeding out less important items is extremely difficult, say the facilitators.) It starts with an understanding of intermediate level logic flow: "If you can't represent your area in one readable chart, you have too much detail." The approach relies not on milestone density but rather on defining schedule activities that can be communicated.

Implementation of the One-Pager concept calls for the imposition of certain intermediate level requirements on the technology manager in order to satisfy the requirement of consistency. While it requires a defined interface with detailed cost, logic, schedule and metric plans, it does not impose specific requirements on how a director manages below defined interfaces, such as a formal performance measurement system or low-level logic. Automation is desirable but not mandatory—communication is the key, and no known software can yet meet the conciseness and integration requirements.

Earned value computation with the One-Pager is somewhat subjective. Earned value is estimated at a high level and does not depend upon milestone counts. The plan is rebaselined only once a year unless otherwise directed, and earned value is computed against the baseline, not updated for changes. Thus, there are no "who's at fault" implications in the One-Pager approach.

The One-Pager concept is a proven methodology which should be given serious consideration for use in both very large hardware development projects and technology projects. It was developed by Phil Shanahan and James Wilcox in Texas and refined by NASA.

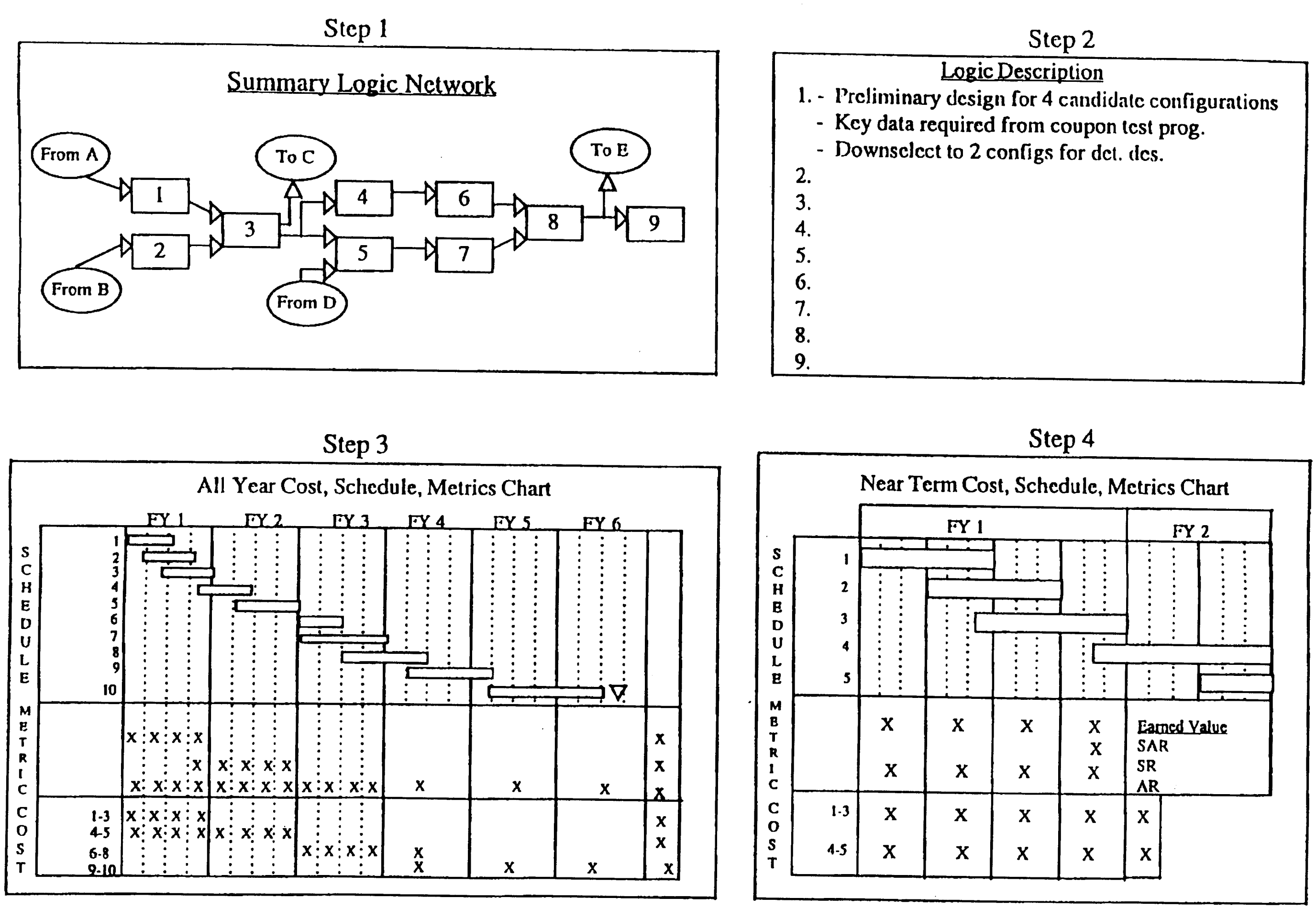

Figure 5. The One-Pager approach.

The AGATE Project Cycle

The Advanced General Aviation Transport Experiments (AGATE) project team in Hagerstown, Maryland, took a different approach with CSM facilitators. A stakeholder team approach to project planning and scheduling involves a Cards-on-the-Wall approach pioneered by Kevin Forsberg and Hal Mooz in California.

The purpose of the CSM workshop is to create a high-level integrated network with a calculated path.

The first effort is to develop a coherent Work Breakdown Structure (WBS) upon the foundation of a Project Products List. The PPL is a complete list of hardware, software, support equipment, support services, tools and documentation required to perform the contract. The WBS is broken down into manageable work packages that can be scheduled, budgeted, organized, statused and controlled.

Networking and scheduling are then introduced for a Project Master Schedule reflecting any requirements fixed by the customer. The Project Master Schedule usually includes project completion dates and customer-imposed reviews such as preliminary and critical design reviews, document delivery dates and the like.

The Critical Path Analysis is at the heart of the "Cards on the Wall" approach. A "Task Planning Form" is filled out and tacked or taped on the wall. Colored strings or yarn run from card to card showing "input" and "output" (expressed in nouns), connected to a "Task Description" expressed in verbs. Thus, "data" might connect to a verb such as "draft" with a noun output such as "report." The strings rep-

Resources	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	Totals
*NASA ($M)	1.945	5.900	8.156	11.113	9.721	9.608	9.653	4.728	60.824
FTE's (CS)	8.7	15.4	21.3	22.3	22.9	22.5	21.0	20.0	154.1
(SSC)	2.5	8.3	14.8	15.6	12.6	11.0	9.5	4.0	78.3

* Does not include Industry 1-to-1 matching on ~70% of NASA funds (see backup figure 51).

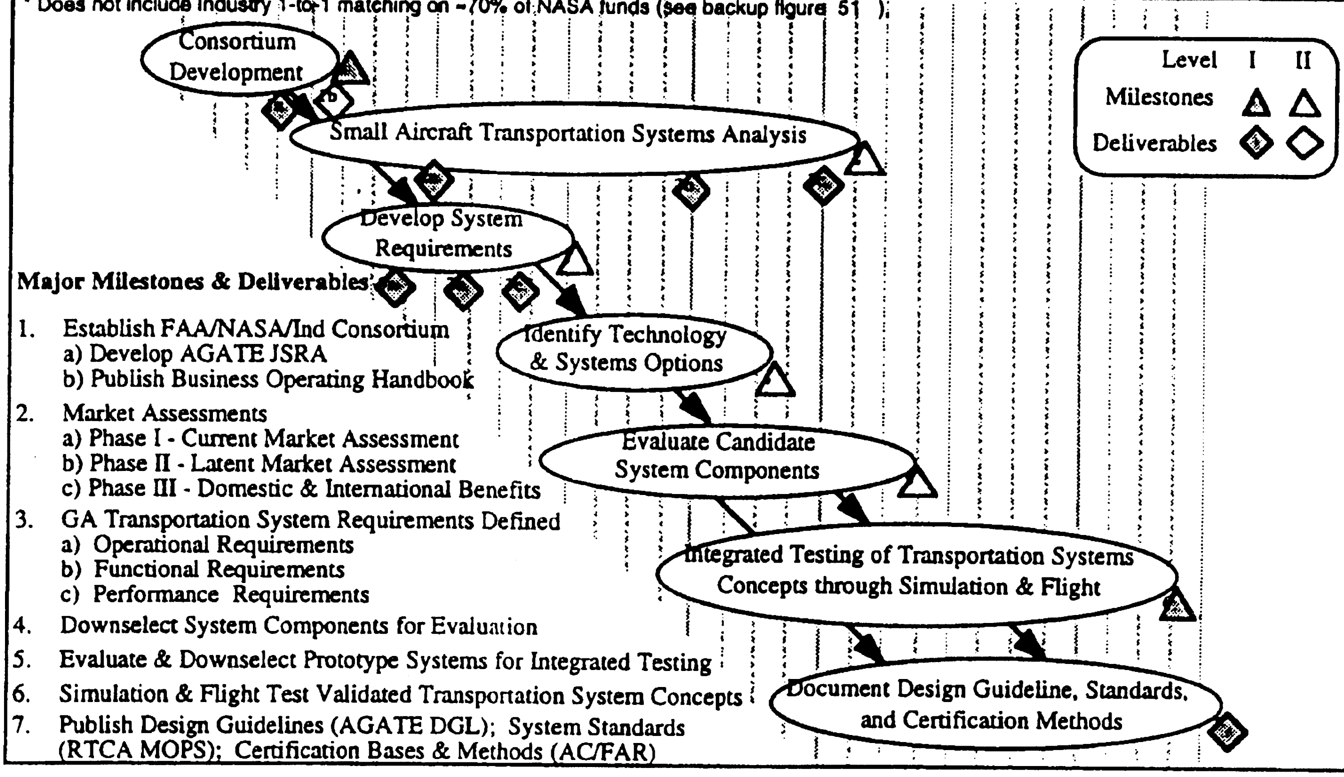

Figure 6. AGATE's baloney chart.

resent various tasks that feed into and flow out of major milestones and deliverables along a timeline.

General Aviation manager Bruce J. Holmes of Langley Research Center led the project team from Langley, Lewis, Avrotec of Oregon, Kestral of Oklahoma, Lockheed Martin, the National Institute for Aviation Research and Raytheon of Kansas, the Research Triangle Institute, Rockwell and Hamilton Standard.

After lectures on WBS development, networking and scheduling, and critical path analysis, the project team of 25 established assumptions and ground rules. Holmes presented the AGATE program roadmap showing the formation of a consortium among NASA, the FAA and the small aircraft industry. Following market analyses and general aviation system requirements, the AGATE group hopes to identify technology options, evaluate options, evaluate candidate system components and publish a library of documents for a revitalized small aircraft transportation system in America by the year 2001.

The AGATE project will require government and industry coordination in five work packages: flight systems, propulsion sensors and controls, integrated design and manufacturing, icing protection systems, and a new one, the AGATE integration platforms. Most of the facilities, such as simulators and laboratories/computers, are furnished by Langley. Lewis is furnishing the icing tunnel, and industry/university facilities are scheduled for flight tests.

SAGE III Science Plan

A year after the SAGE III project team met in Hagerstown for Project Planning and Scheduling, the project's science team met to coordinate the efforts among four contractor groups and two NASA Centers. Science Manager Lelia B. Vann of Langley Research Center led the project team from Langley, Goddard Space Flight Center (and Wallops Flight Facility), CSC, GATS, SAIC and IDEA, Inc.

The SAGE III is scheduled for launch in August 1998 on a Russian Meteor 3M spacecraft as part of NASA's Mission to Planet Earth (MTPE) program.

The SAGE III science team included algorithm development, software development for data processing, simulations, validation and mission operations. The team began with a detailed Work Breakdown Structure and ended up with a critical path. Some questions asked included: "What work needs to be done? Who will do it? How long will it take? What will it interface with?" Each task was assigned an estimate of labor, material and other resources. By focusing on critical path tasks, the project team can identify those sequences that will most likely determine the duration and drive the schedule of the project.

The LaRC SAGE III Principal Investigator (P.I.) is responsible for the science research activities, algorithm development, data processing, validation and mission operations. The MTPE program office is responsible for overall coordination of the mission, including funding, program integration and reporting on investigation. They will support SAGE III's communications, ground receiving station, and data generation and distribution.

To show the critical path for this multi-year project, CSM facilitator John Chiorini generated a chart at least 12-feet long showing the relationships of tasks among different organizations. So, why plan? His response: "To bring the future into the present so you can do something about it."

There is every indication that the SAGE III teams, as well as the other Project Planning and Scheduling workshop teams, will not execute their efforts exactly as conceived. Funding irregularities, management structure changes, personnel shifts and unforeseen events will inevitably alter their One-Pager and critical paths. That is to be expected.

What each of these project teams have, however, is a sense of direction. Team members know up front what the project will cost in terms of payroll, facilities and equipment. Any subsequent trade-off in any of the estimated resource areas will, they know, cost the project in terms of budget, schedule or performance. It may even derail the project if the trade-off is excessive.

Another thing each of these project teams now shares is camaraderie, if not just a better understanding of each other and the needs of each component in the project. For some projects, the PPMI Project Planning and Scheduling workshop was the first time all the major players came together in one room at the same time. That intangible, in and of itself, is invaluable, especially in an era where teamwork is the single most cited component of success in completed missions.

ID	Task Name	Duration	Start	Finish	Resource Names
1	**1.1 Mission Operations**	510d	03/11/96	03/20/98	
2	**1.1.1 DAAC /NOC Interface**	60d	03/11/96	06/03/96	
3	1.1.1.1 Data Transfer for Protocol	2w	03/11/96	03/22/96	PD[0.2],SN[0.2]
4	1.1.1.2 Support ECS Level 0 ICD	2w	05/20/96	06/03/96	MC[0.5],SN[0.5]
5	1.1.1.3 Determine Level 0 Took Kit Specification	2w	03/25/96	04/05/96	SN
6	1.1.1.6 Determine Definitive Orbit Format and Meta Data	1w	05/13/96	05/17/96	SN
7	**1.1.2 MOC/WFF Interface**	100d	03/11/96	07/30/96	
8	1.1.2.1 Define and Determine Comm Link LaRC to WFF	2w	04/01/96	04/12/96	AS
9	1.1.2.2 Define Acquisition Data Requirements	1w	04/22/96	04/26/96	AS,SN[0.2]
10	1.1.2.3 Define SAGE Raw Data and 9C Formats	3w	03/11/96	03/29/96	SN[0.2]
11	1.1.2.4 Data Transfer from WFF to LaRC	4w	04/29/96	05/24/96	SN[0.1],AS
12	1.1.2.6 Develop Interface Documents	4w	06/25/96	07/23/96	AS,MC[0.25]
13	1.1.2.8 Schedule Passes	4w	05/28/96	06/24/96	SN[0.2],AS
14	1.1.2.9 Initial Data Transfer Tests LaRC to WFF	1w	07/24/96	07/30/96	AS,MC[0.2]
15	**1.1.3 MOC / FDF Interface**	155d	03/11/96	10/17/96	
16	**1.1.3.1 I2RU AOS/COS**	20d	03/25/96	04/19/96	
17	1.1.3.1.1 Define Station Predict Format	2w	03/25/96	04/05/96	MB[0.1],MC[0.1]
18	1.1.3.1.2 Define IIRV File Format	2w	04/08/96	04/19/96	SN[0.1],AS[0.1]
19	**1.1.3.2 Definitive Orbit**	65d	03/11/96	06/10/96	
20	1.1.3.2.1 Define QA Parameter and Format	2w	03/11/96	03/22/96	MB[0.1],MC[0.1]
21	1.1.3.2.2 Define GPS /Glonass State Vector file Format	1w	04/22/96	04/26/96	MC[0.1],MB[0.1]
22	1.1.3.2.3 Define State Vector Set file Format	2w	04/29/96	05/10/96	MB,MC[0.1],MR[0.1]
23	1.1.3.2.4 Define Job Control Parameter for Flight Dynamics	2w	05/13/96	05/24/96	MB,MC[0.1]
24	1.1.3.2.5 Define Predicted Ephemeris File Format	2w	05/28/96	06/10/96	MB,EP,MC[0.1]
25	1.1.3.6 Prepare FDD SAGE III Operations Guide	2w	06/11/96	06/24/96	MB,MC[0.1]
26	**1.1.3.7 Flight Dynamics**	80d	06/25/96	10/17/96	
27	1.1.3.7.1 Develop Flight Dynamics	8w	06/25/96	08/20/96	MB
28	1.1.3.7.2 Verify, Validate Flight dynamics	4w	08/21/96	09/18/96	SN[0.1],MB
29	1.1.3.7.3 Port Flight Dynamics	4w	09/19/96	10/17/96	SN[0.5],MB
30	**1.1.4 MOC Data Processing**	365d	03/11/96	08/19/97	
31	**1.1.4.1 MOC Data Processing**	365d	03/11/96	08/19/97	
32	1.1.4.1.1 Develop High Level Design Requirements for MOC Data	6w	03/11/96	04/19/96	SN
33	1.1.4.1.2 Design Level 0 Data Ingest	1w	07/16/97	07/22/97	SN
34	**1.1.4.1.3 Health and Safety**	80d	02/07/97	06/02/97	
35	1.1.4.1.3.1 Design SAGE III Health and Safety Reports	4w	02/07/97	03/07/97	SN
36	1.1.4.1.3.2 Design SAGE III Health and Safety Notification Pro	6w	03/10/97	04/18/97	SN
37	1.1.4.1.3.3. Design SAGEIII Health and Safety Standard Data	4w	04/21/97	05/16/97	SN
38	1.1.4.1.3.4 Design Network Link Monitor	2w	05/19/97	06/02/97	SN
39	**1.1.4.1.4. Level 0 Data Collection**	170d	06/04/96	02/06/97	
40	1.1.4.1.4.1 Design and Develop Level 0 Meta Data (DAAC)	1w	09/19/96	09/25/96	SN
41	1.1.4.1.4.2 Design Modal Files	4w	01/09/97	02/06/97	SN,BC
42	1.1.4.1.4.3 Design Level 0 Data (DAAC)	8w	07/24/96	09/18/96	SN
43	1.1.4.1.4.4 Design Data Archive System	2w	12/24/96	01/08/97	SN
44	1.1.4.1.4.5 Develop Data Delivery Method to DAAC/SCF	2w	12/03/96	12/16/96	SN
45	1.1.4.1.4.6 Design and Develop SAGE III Definitive Orbit Form	8w	09/26/96	11/22/96	SN
46	1.1.4.1.4.7 Design Calculation of I2RV	1w	12/17/96	12/23/96	SN
47	1.1.4.1.4.8 Design SAGE III First Data time Process	2w	06/04/96	06/17/96	SN
48	1.1.4.1.4.9 Develop Definitive Orbit Meta Data Code	1w	11/25/96	12/02/96	SN
49	1.1.4.1.5 Design Data Cataloging System	4w	06/17/97	07/15/97	SN
50	1.1.4.1.6 Procure TK Hardware	2w	04/22/96	05/03/96	SN,MC,EP
51	1.1.4.1.7 Procure TK Software	3w	05/06/96	05/24/96	SN,MC

Figure 7. A planning print-out showing relationships of tasks.