



Effective Communication Platforms

Howard T. Moncarz

U.S. DEPARTMENT OF COMMERCE
Technology Administration
National Institute of Standards
and Technology
Manufacturing Engineering Laboratory
Gaithersburg, MD 20899-0001

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U.S. DEPARTMENT OF COMMERCE
William M. Daley, Secretary
TECHNOLOGY ADMINISTRATION
Mary L. Good, Under Secretary for Technology
NATIONAL INSTITUTE OF STANDARDS
AND TECHNOLOGY
Arati Prabhakar, Director

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Howard T. Moncarz
Manufacturing Engineering Laboratory
National Institute of Standards and Technology
Gaithersburg, Maryland

ABSTRACT

New information technology (IT) concepts created in today's research and development programs are difficult to explain. A major reason is the abstract nature of the concepts themselves. Furthermore, the concepts are often buried within an IT infrastructure, whose value is not evident from the applications enabled by it. However, it is increasingly important to communicate the value of those research contributions effectively so that important, programmatic decisions can be made. Those decisions depend on information presented at program and project briefings. Today those briefings are usually accomplished with viewgraphs and a linear tour through them. But, new IT-based communication tools are available and, if properly and effectively put to use, can greatly improve the communication of today's research programs.

A case in point is the Framework Project in the National Advanced Manufacturing Testbed Program at the Manufacturing Engineering Laboratory of the National Institute of Standards and Technology (NIST). The Framework Project is contributing towards the development of IT infrastructure that will enable manufacturing applications to interoperate with one another. In this project, not only are the concepts themselves difficult to explain—the particular contribution that NIST is making is difficult to explain. But, it is essential to make those ideas clear to an array of audiences. The solution initiated for this project was the design and implementation of a visualization that a presenter could use to communicate the main ideas of the project effectively.

The Framework visualization was a specific task, required by the Framework Project, but, in addition, it was an experiment to test the value of using high-tech communication tools to communicate a project effectively. This paper describes what is termed an "Effective Communication Platform" for a project and the results of an initial attempt to implement one for the Framework Project.

KEYWORDS

communication, framework, information technology, visualization

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Manufacturing Engineering Laboratory
National Institute of Standards and Technology
Gaithersburg, Maryland

1 INTRODUCTION

A great deal of money can be invested in a research project; the larger the project, the larger the investment. If the size of the project and the importance to communicate the results are sufficient, a separate task to communicate the project throughout its life cycle is useful.

This paper recommends an approach to create an **Effective Communication Platform** for a project. The activity to create the platform would begin at the project's start, or even earlier at the proposal phase. The activity would continue beyond the completion of the initial platform, so that the platform's capability would continue to evolve throughout the life cycle of the project.

2 PROBLEM STATEMENT AND SOLUTION

2.1 Needed—Effective Communication of Technology Concepts

New concepts that are developed in research and development projects are often difficult to explain. The difficulties are associated with explaining:

- **what** the concepts are,
- **why** they are useful, and
- **how** they can benefit the customer.

One reason for the difficulty is that the concepts are often abstract. For example, new concepts in information technology that can be implemented to enhance an information infrastructure may be very valuable. But, it is difficult to show that value or even what was done, except indirectly by demonstrating applications that are possible because of the advances made. A second reason for the difficulty is the mismatch in perspectives from the technical developer to the required audience, which is often non-technical.¹ A technical developer needs to step out of his or her normal mode of thinking to determine what information is important and how to present it to, for example, a program reviewer. Practically speaking, the transition is not easy and often is not done at an acceptable level, much less at the demanding level that might be called for in a programmatic review.

There are consequences to suffer as a result of ineffectively communicating the main ideas of a project. If the project is poorly presented to a reviewer, the project's funding level or even survival could be threatened. From another perspective, if the project's intent is technology transfer, ineffective presentation can block that goal. Finally, from the internal project perspective, a failure to communicate the large-scale context of the project in simple, understandable terms could mean a disorganized project. The project team members are best

¹An electronics engineer would call it an impedance mismatch.

served by understanding the larger context of their work and how their work is related to each other's. If that context cannot be conveyed, it may indicate that the project is in disarray or headed in that direction.

2.2 Solution—Effective Communication Platforms

Clearly, effective communication of research projects is a goal worthy of investment. What is needed is a systematic approach to capture the main project ideas, represented at the proper perspective for a particular audience, and to encapsulate those in a form that is persistent, but can also evolve with the project. The proper approach, however, without the proper level of capability to execute it, will not succeed.

Given the worthiness of the goal and the effort and capability necessary to achieve it, an approach at the organizational level, rather than at the project level, is recommended. A program established at the organizational level to create Effective Communication Platforms on a project-by-project basis can leverage the organization's resources to achieve the best results at the minimum cost and effort. A key ingredient is the right individual² to lead the program who can create the bridge from the project concepts to the communication of them. The focus of the program will be to create a system for each project that encapsulates the main project ideas and evolves with the project. The systems created will utilize current communication technologies and are referred to in this paper as "Effective Communication Platforms."

The objectives of each platform will be:

- to communicate the project's concepts;
- to show the organization's contribution/impact, particularly if the organization's effort is part of a larger collaboration of other organizations;
- to foster a better understanding by the internal project team, particularly how their efforts fit within the overall project goals; and
- to provide the perspective to help determine the future direction of the project.

3 WHAT IS AN EFFECTIVE COMMUNICATION PLATFORM?

3.1 Description

An Effective Communication Platform is not just a piece of software nor just a tool; it is a methodology and a unified system. An Effective Communication Platform integrates a number of *presentation resources* into a single entity. The synthesis of resources forms a vehicle that can crystallize and amplify the main significance of a possibly vast sum of very complex information, including complex inter-relationships. The presentation resources are comprised of:

- presentation fragments,
- the organization of the fragments,
- the system that encapsulates them, and
- the resulting impression that is presented as a unified message.

²That individual is referred to as the platform production director and is described further in the next section.

The presentation fragments consist of capsules of concise information, for example, the types of information—text, graphics, images—that are normally included on viewgraphs. In addition, presentation fragments include *active diagrams*, that is, schematics or more complex graphics that are interactive through a direct manipulation interface. Also, presentation fragments can include a window into an actual experiment or process, for example, a window into the dynamic data environment at a selected point within a manufacturing process. Each presentation fragment presents units of information from a particular perspective that communicate certain ideas about the overall project.

The presentation fragments are linked together within a computer or a computer network and have a single point of access. A navigation from that point is necessary to reach the particular fragment needed. Furthermore, the fragments are organized so they can be cognitively integrated (by the presenter) to form larger concepts from the unification and successive or concurrent presentation of multiple fragments. In other words, the presenter shares in the responsibility to pull the appropriate fragments together to make particular points during a presentation, but also, the fragments should be arranged and connected within the computer to enable an intuitive navigation among the fragments that a presenter would likely conduct.

Physically, the single point of access is through interface devices to a single computer screen, though the screen could be part of a system that is networked to many other computers. In fact, the information could be presented from multiple computer screens, though all the traffic is coordinated from the single access point. Generally, a single computer system and a single monitor, keyboard, and other interface devices will provide the display for the entire presentation, though as mentioned, the information could and often would come through a network. In general, the access/display of information is based on a particular computer, operating system, window manager, and set of communication tools that are required. On top of the environment just mentioned sits the actual application, consisting of application software (providing the structure), information (the content), and scripts (for "canned" navigations of information if necessary). Finally, the presenter rounds out the entire system that is referred to as the Effective Communication Platform. The presenter is part of the system.

The *whole* created by the synthesis of presentation resources enables the capability to navigate presentation fragments according to need "on-the-fly" or to run through a "canned" script that is targeted for a particular audience to present a particular message. The ease of going back and forth among different presentation fragments and types of fragments, for example from a viewgraph type of presentation fragment to a window showing an appropriate data representation in real time of an actual process and back again can be a powerful method to amplify the message conveyed and consequently the impact of the message.

Note that a collection of pages on the World Wide Web could be an Effective Communication Platform, but not necessarily. The key component is that the information is collected, organized, and presented based on a methodology that emphasizes the intended audience's requirements in accordance with the goals of the project that need to be communicated. More on this point later.

3.2 Program Foundations

An Effective Communication Platform is more than the software application itself. It is a methodology. The methodology depends on three major components of knowledge and capability. First of all, a sufficient understanding of the concepts developed is essential. That understanding does not need to be at the level of the technical developers, but it must be sufficient to drive the design of the platform to present the concepts in the proper perspective and organization. The project itself must drive the design of the platform, not the "whiz-bang" communication technologies, nor the particular viewpoints of the platform designer.

Second, sufficient knowledge of the communication tools available is necessary to be able to select the proper one or more tools that are appropriate for the particular project's needs. Again, a great proficiency in the tools is not necessary for the platform designer, as long as the organization can provide the availability of that expertise on an as-needed and available basis in a matrix-managed arrangement. Of course, the more self sufficient that the platform production staff is in using various communication tools, the better.

The final component is the most critical for success. That component is the capability to mastermind the translation of the messages to be conveyed through the separate project concepts using the proper selection of communication tools. That capability assumes sufficient knowledge of the concepts and the communication tools as described above; it requires advanced abilities in intuition and creativity; and in addition, it requires advanced skills in personal communication. The *platform production director* provides that capability—to synthesize a message created from different cultures, ranging from technical developers to technical managers, and to put that in a form that can be understood by a customer, for example, a program manager who may not have the same technical knowledge.

3.3 What/Why/How

What needs to be understood? **Why** is it important? **How** can it be demonstrated to the customer? The Effective Communication Platform brings these ideas together.

What are the concepts? They arise in the context of particular application domains. The applications exist within particular industry domains. So, to present concepts in an understandable form, it is often necessary to set the context. That may mean that the application domain must be described, and further, it may mean that the context of the application within the particular industry may need to be described.

Why a concept is important to a particular customer depends on the customer's perspective. The communication must be cast in the proper perspective to satisfy the customer's needs. It also must be properly cast within the goal of the message. In other words, is the goal to propose the project for funding? Or, is the goal to describe the status of the project for a project review? Is the goal to create a "consensus platform" to describe multiple views in a workshop and help the participants come to conclusions? Or, is the goal to effect technology transfer from the project to encourage technology supplier companies to embrace it? The general communication intent is an important factor in determining how to cast the project's message.

Finally, how should the concepts be presented? A variety of communication tools are available (for example, scientific visualization tools, user interface design tools, programming languages that support visualization). Some require that the content be appropriately entered into a turnkey system that communicates in a particular way. Others will allow varying degrees of programming the actual structure of the communication. Finally, other tools, in fact, are programming-type languages that give the designer the most flexibility, but require the most effort and consequently the greatest cost. Commercial tools that can be the most easily adapted should be chosen whenever possible.

3.4 Caveats

Even if the methodology is followed step-by-step, that is not a guarantee that the platform created will be successful. A number of caveats must be considered.

- **The project (its concepts, goals, and customer requirements) should drive the design of an Effective Communication Platform;** the enthrallment with particular communication

technologies should not be the driving force. The presentation should not be forced to fit into a preconceived notion of a method of communication. That is often the way presentations are done; but it is backwards to the ultimate goal of effectively communicating the project.

- **An Effective Communication Platform will have a lifetime and a life cycle that is dependent on the project needs.** In a research environment, the platform may only be needed in the proposal phase of the project to secure funding, and thereafter, possibly needed for project reviews. In that case, the effort expended and the corresponding cost should be minimized in the realization that the platform will be a throwaway component. On the other hand, the situation is very different if the platform is expected to have a long lifetime, perhaps as a communication vehicle over the World Wide Web to a vast audience. Then the cost to create a robust, reliable platform will be significantly higher, but the anticipated value will be much higher as well.

- **Value added must be greater than the cost of development.** Whether the cost is high or low, the added value to the project must be greater than the cost. Often that value is intangible and cannot be easily estimated. Often the expected value is underestimated. If a project passes a review with the help of an Effective Communication Platform, the value added by the platform cannot be easily estimated. However, it could be argued that the platform was very valuable if it prevented termination of a worthy project. As another example, if technology transfer is key to the success of a project, and the technology transfer depends on effectively communicating the project results on a programmatic perspective, a sound methodology and communication system is very valuable. Conversely, if a great effort and cost is taken to create a platform which gives little value added to the project, then the decision to create it was a mistake.

- **An Effective Communication Platform is considered a system that includes the presenter.** Unless the goal is to create a platform that is reasonably fail safe, so that a high development cost is justified, then an essential means to minimize cost is to realize that the presenter is part of the system, and will use the platform in a manner to allow for its quirks, failures, and inconsistencies. With that understanding, the platform can be created as the prototype application it is intended to be, without the application maturity expected of other types of applications.

- **The Platform can only be as good as the information used to design it.** Direct access to project participants, management, and customers is essential to achieve success. An assumption in the methodology proposed is that a typical project manager might not have the skills to create the best platform, nor even to articulate the proper perspective of the project ideas and crystallize them into a solid, clear message. It is not an uncommon experience to have someone describe an event that you attended in a way that makes it sound like it was a completely different event. The person with the responsibility to create an Effective Communication Platform must be authorized direct access to the necessary individuals. After all, as mentioned above, that person was carefully selected, in part, for excellent ability in personal communication.

- **To maximize the leverage of an Effective Communication Platform function, a permanent platform production director coordinates organizational resources to pull the pieces together for each platform.** A goal of the methodology proposed is to separate the function of creating the platform out from normal project responsibilities. Therefore the function can be concentrated in a separate organizational activity that will serve to strengthen that function through focusing the organization's resources and capabilities to provide it. Consequently the capability can be distributed to projects that need it throughout the organization. The platform production director does not necessarily need a permanent staff, if the organizational resources can be made available on an as-needed and as-available basis. For example, a staff member with proficiency in a communication tool needed to create a particular platform might be utilized for a relatively brief period of time for that capability.

3.5 Technical Approach

The capability to create an Effective Communication Platform requires a combination of systematic methodology and intuitive creativity. The methodology outlined here is a guideline; it is not intended as a step-by-step recipe that must be followed exactly as specified here. There are many variables that will come into play; organizational politics cannot be ignored. However, the design and development of the platform should proceed generally along the steps described below in the order they are listed. For example, there might be quite a bit of iteration to get the customer requirements right, and other steps will proceed possibly before the requirements are finalized. But, the requirements should be finalized before any other step is finalized.

- **Customer Requirements.** Why a concept is important to a particular customer depends on the customer's perspective. Any planned communication to a set of customers must begin by first identifying the customer or set of customers. The next step is to understand what the customer requirements are for the presentation. This step is essential to create a presentation that is consistent with the project goals and that will satisfy the customer's expectations.
- **Concepts and Context.** The project concepts that need to be pulled together to create the message must be identified and specified in the appropriate context.
- **Platform Objectives.** The platform is the access to:
 - the project information to be presented,
 - the data off-line or in real-time if that is required, and
 - the interaction with the experiments or processes that underlie the project.

The main objectives for the platform should be described in terms of the customer requirements, the project concepts, and the interaction requirements.

- **Data Access and Representation.** What data and information are available to the platform? If there is real-time data, then the platform needs access to that data at the level of the communication tools that will be used. Furthermore, how should the raw data be transformed to utilize in the communication expressed by the platform to the audience? In other words, what data representations will be used? For example, rather than show raw, numerical data that indicates the vectors of a fluid flow, the representation used could be flow lines.
- **Design and Implementation.** When all of the information specified in the above steps has been determined, the design of the platform can proceed with the confidence that it can meet its expectations.

4 EXAMPLE—THE NAMT FRAMEWORK PROJECT

"The goal of the Framework for Distributed and Virtual Discrete Part Manufacturing project, or Framework project in short, is to analyze, test, validate, and ultimately standardize object-oriented frameworks developed by industry for distributed/virtual manufacturing enterprises." [Bloom] That's quite a mouthful. In fact, the "Framework project" is very complex due to the broad range of technologies included, and particularly due to the broad range of interface specifications addressed and to the many collaborative partners involved. It is difficult to articulate exactly what the main goals of the project are and the specific contributions and impact that NIST expects to make. An Effective Communication Platform could crystallize those ideas together to help a presenter communicate the main goals and ideas for the project.

The Framework project is one of four within the newly created National Advanced Manufacturing Testbed (NAMT) program³ in the Manufacturing Engineering Laboratory (MEL) of the National Institute of Standards and Technology (NIST). The implementation of the Framework is a testbed that consists of manufacturing system components (for example, a shop controller, a product data management system, etc.) including the interfaces between them. Of primary importance to the project are the interfaces, not the system components that are part of the testbed used to study the interfaces. The Framework project is a relatively large project within MEL and therefore the cost of a standalone task to communicate the project effectively was warranted.⁴

4.1 Customer Requirements

Originally, the intended audience was to include program management, technical management, technical people, non-technical people, basically everyone—a bit of a tall order. Ultimately, the audience was identified by practical considerations—the program would be reviewed by top-level management. Hence the general description and the business case for the project were of primary importance. The presentation would be brief—about ten minutes—and would incorporate a demonstration of the current status of the project along with a description of it. The Framework Visualization (as this Effective Communication Platform was called) would be the window into the project's demonstration (of hidden infrastructure technology) and tied to other presentation fragments to help explain the project and make its business case.⁵

4.2 Concepts and Context

The key project ideas, translated to the context necessary for the intended audience are described below (with key words in **bold-face**).

- A **mechanism** is needed for multiple consortia to **determine the overlaps, conflicts, and gaps** among the specifications created for the interoperability of manufacturing applications.
- The mechanism will help **accelerate the transition from specifications to standards** (necessary to induce software vendors to implement the standard in their products).
- Creating a **testbed at a neutral site** (NIST) to analyze interoperability specifications for manufacturing would be beneficial to that transition and additionally could help serve as the mechanism described.

³The National Advanced Manufacturing Testbed (NAMT) is a new program addressing the research needs for technologies and standards for distributed and virtual manufacturing. The program was developed with guidance from over thirty industrial leaders and launched in October 1995. The goals of the NAMT program are to provide the infrastructure to enable companies to rapidly design and manufacture products and to speed U.S. industry's evolution toward distributed and virtual manufacturing. NAMT researchers are developing the scientific basis and technical underpinnings necessary to achieve manufacturing environments that are shared, accessible, integrated, and information-based. The research focuses on measurements, communication protocols, interfaces, and other standards and infrastructural technologies.

⁴The initial goal for this task was to provide a user interface, referred to as the "guardian interface" (the term inherited from a previous NIST project [SWallace]), to operate a demonstration of the Framework project and to enable a human to intercede if necessary. Because of the importance to communicate the goals for the project, the initial task was expanded to help a presenter communicate the main goals and ideas for the project.

⁵The presentation was very successful. Feedback indicated that the Framework Project was understood as a key NAMT project. Furthermore, the project was considered an opportunity to help industry understand the relationships among the specifications created by the multiple consortia.

- Specifications implemented in the testbed to integrate system components represent **composite specifications** that are **drawn from the input of the multiple consortia**. The composite specifications along with additional feedback, separately and together, represent the analysis of the consortia-developed specifications.
- Observations developed from the **analysis of the specifications will be systematically fed back** to the appropriate consortia members and will be archived by the Framework project at NIST.
- The **landscape of interoperability specifications/services** and consortia efforts considered, where they have come from, and issues related to them when considered in context with one another should be incorporated into the visualization.

4.3 Platform Objectives

There are four main goals for the NAMT Framework Visualization as described below.

- **Run the system.** Provide access to the commands, status, and data utilized in the operation of the Framework in an intuitive user-interface.
- **Debug the system.** Provide access to the internal state of the system components and the capability to modify that state at the discretion of the user, again, in an intuitive user-interface.
- **Describe the project concepts and message.** Describe the concepts of the Framework at the proper level of abstraction for the intended audience. Also, clearly delineate what the contribution of NIST is and the impact of the NIST work. Finally, show the contribution of the collaborators and how all the work fits into a larger context that collectively benefits industry beyond the sum of each contribution.
- **Promote the project.** The platform should make an eye-catching impression so that it will be remembered and will leave an image of the project's main ideas in the beholders' mind. The view given should present the top-level business case for the project, where the project details do not hide the main points. However, the top-level view of the project should be sufficiently integrated with the details in an understandable way to prevent the false impression that the project success is hype and not real.

4.4 Data Access and Representation

Information was available to the *guardian computer* for each interface that consisted of:

- the interface specification and
- the information flow at that interface, using the implementation of the interface as specified.

Determining how the raw data should be represented to present the project's message in the right context included considerable iteration with the design phase for the platform. The data used and how it was represented was determined in concert with planning the platform's design. With that understanding, the raw data that was available to the guardian computer during runtime of the Framework demonstration included the following at each interface:

- **Commands initiated and resulting status information** consisting of lines of text messages. The text lines were continuously dumped into an open text file at each interface which was readable by the Guardian Computer.

- A text file in either **Express** (an information modeling language) or **IDL** (interface definition language) format which was **used to specify the interface**.
- A text file that compiled the **issues** resulting from an analysis of the interface that the Framework project would **feed back to the appropriate consortia**.

For each line of the Express, IDL, and issues files, the Framework project team member that was directly responsible for that interface made a judgement call to identify which consortia specification it was derived from. An abbreviation was assigned to each consortia specification and that abbreviation would be the first word written in each line of those files. The same was done for the "live" command and status information generated. In that case the program that generated the command and status information had to be modified to write the designated abbreviation at the beginning of each line of text message generated. Those abbreviations at the beginning of each line could then be recognized by the Framework visualization to be color-coded on the screen.

The next section describes how everything was brought together.

4.5 Design and Implementation

The guardian interface is integrated with the *framework visualization* to allow a presenter to illustrate project concepts using data generated during the actual execution of the Framework. The objectives for the guardian interface are to control the Shop Controller's Job Manager, to create new jobs, to control all of the existing jobs "alive" in the system, and to update status information for each. (Aside from the user interface, the Shop Controller is the highest level of control, hierarchically speaking, in the Framework implementation.)

The objectives for the framework visualization are to crystallize the main ideas that drive the Framework Project and warrant its need. The visualization shows a schematic for the entire Framework testbed, shows the interfaces that are under analysis, shows and reinforces the notion that the analysis of each interface is a suggested interface that represents a composite specification of multiple consortia efforts, and all together, gives a picture of a neutral testbed site that can accelerate the consensus process that leads to interoperability standards.

The visualization task was implemented on a UNIX-based computer with color monitor on top of the X Window system (and the window manager of choice), using the Tcl/Tk language [Ousterhout]. Tcl/Tk is a scripting language, selected for its ease in creating quick prototype user interfaces to other applications. The application developed in Tcl/Tk was integrated with CORBA⁶ to communicate with the Shop Controller. In addition to the display, the interface supports the keyboard and mouse, where buttons, and other user interface objects, can be selected by mouse click.

The guardian interface is comprised of a single window (figure 1), named "List of Jobs" in the window's title bar. The window is composed of a table that lists jobs (along the scrollable vertical axis) that are currently "alive" in the system along with status information for each job. The information includes the name assigned to the job, its lot name, state, priority assigned, location, and its estimated time of completion. (Currently, the latter two items are not available to the Guardian and are not displayed.) The field, "Manager State," at the bottom of the table shows the state of the Job Manager.

⁶Simply stated, the Common Object Request Broker Architecture (CORBA) is the Object Management Group's answer to enable applications to communicate with one another no matter where they are located or who has designed them. [OMG]

The operator has access to the guardian through the menu bar at the top of the "List of Jobs" window. The menu bar has four sets of menus—File, Edit, Manager, and Command. The File menu contains a print command to print a selected window or selected portions of the screen. The Edit menu contains a command to modify the interval that the guardian uses to update its information. The Manager menu has commands to control the Job Manager—Pause Manager, Resume Manager, Abort Manager, and Stop Manager. Finally, the Command menu has commands to control a current job or create a new one. Those commands are—Create/Start New Job, Pause Job, Resume Job, Abort Job, Stop Job, and Remove Job. When Create/Start New Job is selected, a window pops up with entries to set the job name, lot name, and priority. For any of the other commands, the user first selects one of the jobs listed in the table, and then selects the command desired. The interface includes some logic to verify that the combination of job and command selected, as well as job state and job manager state are legitimate. During a framework demonstration the operator will create a number of jobs with the guardian and switch over to the framework visualization to demonstrate the action of the framework in the context of the project's message.

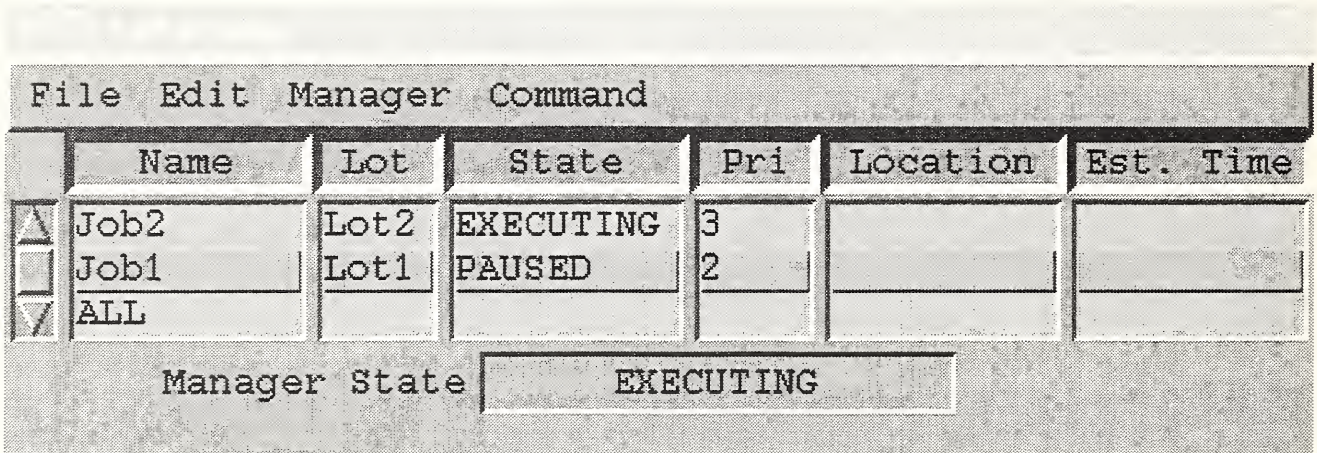


Figure 1. Guardian Interface

The framework visualization is comprised of a window that takes up the entire screen (figure 2), and is named "NAMT Framework Contributors" in the window's title bar.⁷ Portions of the window's content are controlled by buttons at the bottom of the window, so the presenter can display and describe a portion at a time to simplify the presentation of a lot of information. When the window first comes up, a schematic of the NAMT Framework testbed is shown, in which the boxes represent manufacturing system components, and the connecting lines represent the information paths between them. Each connecting path is an interface, the analysis of which is the objective of the Framework Project. The key window contains a list of contributors to the Framework's interface specifications. The asterisk preceding the name indicates that the contributed portion is a modification of the specification listed. Each item in the list is color-coded to show the contributions to each interface specification in the four scrollable data windows shown on top of the interface information paths.

⁷Other screens were implemented as part of the framework visualization, but for the ten-minute presentation to top-level management, the main ideas were incorporated into the single screen shown in figure 2.

The button on the top left corner of each data window pops up a menu that enables the user to display selected information at the interface. The choices are IDL, to show the IDL file; EXP to show the Express file; LOG, to display commands and other information that flow along the path while jobs are being executed; and finally, ISS, to display the issues that have been compiled in the analysis of that particular interface in the context of the Framework. (All data windows can be scrolled horizontally and vertically by dragging the mouse with the middle button pressed.)

The final window, titled "Zoom Data," shows a magnified version of one of the data windows, selected by clicking on the label bar at the top of each data window, just to the right of the button mentioned above. In addition to its magnification, this window can be moved and resized to show more clearly the contents of the selected data window during a demonstration.

5 SUMMARY/CONCLUSIONS

Effectively communicating a technical project is difficult, but important. For the right type of project, an Effective Communication Platform is worth the effort and cost required. However, the platform is not a standalone system; the presenter is part of the system, which has important cost considerations as well as a significant influence on the design. Furthermore, the old axiom, "garbage in, garbage out," definitely applies to the development of the platform; the platform itself cannot address that problem.

An Effective Communication Platform can amplify and crystallize good input to produce an effective message; in fact, the cognitive synthesis of multiple presentation fragments of different types can produce a message greater than the sum of its parts. Furthermore, the message can be captured in a persistent form that can enhance the repeatability of the message, even when the presentation is given by different people at different times.

As an organizational function that can be leveraged over multiple projects, the development cost can be significantly lowered on a per project basis. That type of arrangement may be necessary to cost justify the approach

Finally, the Effective Communication Platform created for the NIST Framework project helped communicate the project's main message at a critical program review and helped lead to a favorable critique.

REFERENCES

- [Bloom] Bloom, H. M., Christopher, N. B., "A Framework for Discrete Parts Manufacturing," *CALS Expo International '96 Conference Proceedings*, Long Beach, CA, October 1996.
- [OMG] Object Management Group (OMG) Website: <http://www.omg.org/>.
- [Ousterhout] Ousterhout, J. K., *Tcl and the Tk Toolkit*, Addison-Wesley Publishing Company, Inc., Reading, MA, 1994.
- [SWallace] Wallace, S., et al., *Manufacturing Systems Integration: Control Entity Interface Specification*, NISTIR 5272, National Institute of Standards and Technology, Gaithersburg, MD, September 1993.



