N91-20680

KSC'S WORK FLOW ASSISTANT

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ABSTRACT

The Work Flow Assistant (WFA) is an advanced technology project under the Shuttle Processing Data Management System (SPDMS) at Kennedy Space Center (KSC). It will be utilized for short range scheduling, controlling work flow on the floor, and providing near real-time status for all major Space Transportation Systems (STS) work centers at KSC. It will increase personnel and STS safety and improve productivity through deeper active scheduling that includes tracking and correlation of STS and Ground Support Equipment (GSE) configuration and work. It will also provide greater accessibility to this data. WFA defines a standards concept for scheduling data which permit both commercial off-the-shelf (COTS) scheduling tools and WFA developed applications to be reused. WFA will utilize industry standard languages and workstations to achieve a scalable, adaptable, and portable architecture which may be used at other sites.

1. INTRODUCTION

The task of preparing the Space Shuttle for flight is complex and involves systematically moving the shuttle through a series of work centers. The preparation activities at each work center involves coordination of a sizeable team of personnel and materials as well as the cumulative execution of some 25,000 operations per shuttle flow. While this coordination effort is scheduled daily in advance based on planned work and durations, the actual work required may vary by as much as 40% due to non-recurring activities revealed by scheduled inspections, e.g. correcting tile damage incurred during the previous mission. The limitation is that re-scheduling is done as a one day delayed reaction reconciling differences between planned and actual schedules.

In response to this need, the Work Flow Assistant (WFA) project of Kennedy Space Center's Shuttle Processing Data Management System (SPDMS) was initiated. This system is envisioned as a knowledge-based scheduling assistant acting primarily at the work center level. WFA will include the capability to: track schedule progress, the STS and ground support equipment (GSE) configuration and critical path on a near-real-time basis; and screen all work for compatibility to configuration. It will also provide the active scheduling and resource balancing of open standard work and for integration of non-recurring work into the schedule.

2. STRUCTURE AND FUNCTION

Functional aspects of the WFA will include:

- Information collection, assimilation, and dissemination.

- Multi-perspective user interface.

- Electronic signature capability.

- Tracking task events (e.g. enable, cancel, start, stop, hold, and resume).

- Dynamic critical path projection.

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- Interactive queries

  - Status (e.g. configuration, activities in progress, etc.).

  - What-if schedule assessments.

  - Meta task event inquires (e.g. area close-out).

- Incorporation of non-recurring or non-standard work into scheduled activities.

- Proposed scheduling data exchange format

Figure 1 presents the top level logical organization of the WFA. Planning and scheduling, ranging from multi-mission 5 year planning to work center work package release for the next 11 days, will be accomplished through an integrated set of SPDMS host based applications . WFA will then construct and maintain a more in depth schedule taking individual resources and work center GSE configuration into consideration. WFA will receive transactions to start, stop, hold, resume, cancel and complete work. WFA uses this data to verify that prerequisite tasks are complete and that the current configuration is compatible before allowing work to begin. WFA also tracks schedule progress and configuration as the tasks are received; and maintains schedule data, critical paths and configuration in near real-time. WFA assists floor supervisors in the work centers to balance work and resources and to gain increased visibility into work center status. It assists flow managers and controllers of multi-work-center resources , e.g. quality or safety personnel, on a flow or multi-flow level to track and manage tasks in their purview. Near real-time status is also made available throughout KSC to keep the NASA and contractor work force informed on the progress of STS testing and the effect on their respective organizations.

3. CENTRAL CONCEPTS

The following presents the hinge-pins upon which WFA is founded. The approach to standards and modularity takes on unusual importance in that it determines whether WFA will be a single-use application or a reusable tool. Also information distribution and user customization concepts will heavily affect how well the many and varied user groups are served.

3.1 Standards

Like all major government installations, KSC has workstations, computer equipment and software from many vendors. Data paths required by the WFA span multiple vendor platforms and software packages. Standards utilization will lessen the implementation cost and have a positive effect on the extent of reusability. Using standards as the platform, rather than a single vendor model or line, permits maximum use of existing equipment and allows new acquisitions to be based on benchmark and cost considerations uniquely for each requirement.

Where no formal standard exists, ad hoc standards supported by multiple vendors are preferred.

Candidate multi-vendor standards or emerging standards are available which cover most areas of concern. One notable exception, for WFA's purpose, is the absence of standards governing the exchange of scheduling data between COTS scheduling applications. The existence of such a "standard", albeit ad hoc and limited in agency scope, will reduce the need for further custom developed software tools for WFA, and permit WFA technology to be more easily reused.

Analogous to the definition of an Application Portability Profile for Posix by the NIST, WFA development will include a set of APP tests and benchmarks to validate vendor independence and vendor supportability of a WFA release.

3.1.1 Industry and Adhoc Standards

When the multi-vendor support requirement is added to standards selection, the standards picture changes significantly. But without multi-vendor support, there is in effect no standard. While project approval of selected standards has not yet been secured, adequate candidate "standards" appear available for the following project roles: platform equivalent configurations, operating system, network connectivity, database, languages and graphical user interface.

3.1.2 Schedule Information Interchange Format

A unifying concept of the WFA is our proposed Scheduling Information Interchange Format (SIIF), which provides a logical common communications medium for transmitting and receiving scheduling information (Figure 1). The
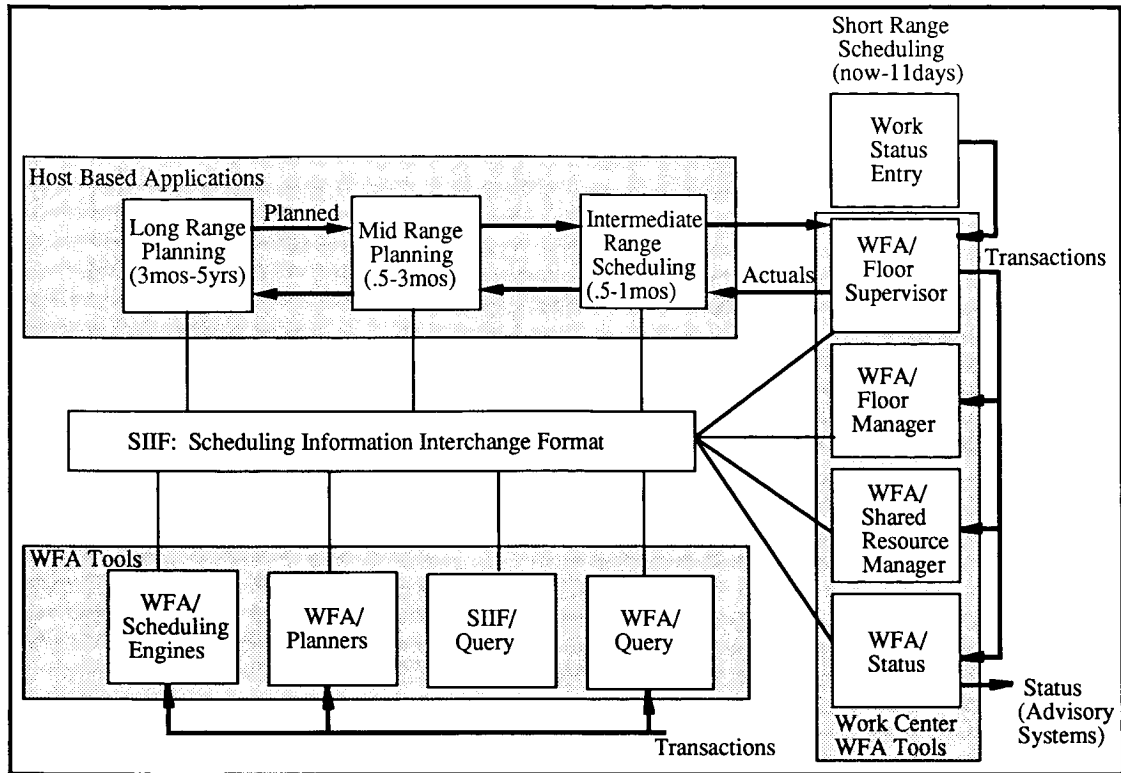
Figure 1: Work Flow Assistant Logical Organization

SIIF defines a standard method for storing scheduling information in an SQL database form, as well as interface protocols for requesting services for each class of scheduling tool. Custom applications requiring SIIF scheduling services follow the SIIF protocol for requesting services from any SIIF scheduling tool.

The primary benefit is to make scheduling data readily accessible and scheduling tools interchangeable. Standardization of data is the next logical step for standards. After all, it is the data itself upon which decisions are made.

In order to make the SIIF practical, all participating data must be stored in SIIF rather than in the internal format of a particular tool. Also, each participating tool must be interfaced to the SIIF and participating applications must utilize the SIIF protocol. Naturally, this is not an all or nothing affair. Benefits will accrue proportional to usage. SIIF definition and compliance represents a significant decision, not yet made, that will require careful deliberation and active commitment.

3.2 Mix N'Match Components

The SIIF will be used analogously to a computer backplane for disseminating scheduling information into which scheduling tools and scheduling application can be installed (Figure 1). Each tool or application is installed via an interface program that maps the protocol and format of that product to the protocol and format of the SIIF. Tools are envisioned to be installed by functional category and to appear to the SIIF as having the same functional interface. as other tools in the same category. New COTS scheduling tools can then be installed by developing or modifying an existing interface program. Scheduling applications can use the installed tools as building blocks. Users can utilize any tool of a tool category to access any of the data maintained in SIIF format.

WFA scheduling engines are tools of special importance. They have a high level of functionality permitting them to be used by most scheduling applications and are scalable permitting hardware platform performance to be selected based on performance requirements.

3.3 Active Versus Reactive Scheduling

The traditional scheduling approach is reactive; that is schedule, do the work, periodically review progress versus the schedule, and then reschedule to resolve discrepancies . In contrast, WFA will receive task progress transactions (start, hold, complete, resource assignment, etc.) electronically and immediately update schedules and configuration status for each work center. Critical paths and individual resource utilization will also be tracked in near real-time. WFA will also assist floor supervisors, responsible for controlling work flow through a work center, remain abreast of work status, and in balancing resources and ordering tasks to improve productivity and minimize schedule impacts.

3.4 Configuration Based Scheduling and Safety

Scheduling and tracking at the work center level will utilize knowledge of the physical aspects and current configuration of the work center and the STS elements being processed as related to the tasks being performed. Configuration data includes considerations such as Orbiter power status, position of test stands and STS flight moveable surfaces, payload bay door configuration, etc. With each task, any configuration requirements or prerequisites must also be identified by appropriate organizations. Using this information, WFA schedules the work by taking configuration into consideration. Current configuration state will be gathered through manual entry, completion of a scheduling task for which a configuration effect is identified, or by processing STS and GSE real-time measurement data received from the firing rooms at KSC. WFA also tracks the current configuration and verifies that configuration requirements match configuration computed state and that all predecessor tasks are completed before permitting work to commence. While this method is not fool proof, it should significantly improve safety to the work crew and the STS.

3.5 Information Distribution

Three levels of information distribution service are provided by WFA. These services disseminate near real-time status from work centers supported by WFA. The three distribution levels are: assistants and direct support; interactive query and reports; and advisory systems.

Assistants and direct support serve the personnel actively working in and around a work center to accomplish work. Assistants are planned to act as intelligent aids to flow-strategic personnel including floor supervisors, planners and flow managers.

Interactive query and reports are provided to meet special user group needs for access to schedule and status information.

Advisory systems provide work and configuration data in a broadcast mode to user workstations that are primarily IBM PC compatible and utilize a set of KSC developed tools supporting user tailored display of that information. This distribution service makes flow and configuration information available efficiently throughout KSC in a low overhead computational manner and can be disseminated to other centers as well. A number of other advisory systems are being constructed at KSC that work in a similar manner using the same resources and technology.

3.6 Multi-perspective Malleable User Interface

Each work center and user group have different needs for data content and form for the user interface as well as queries and reports. "One size fits all" is not appropriate in this context.

The WFA strategy is two fold. First, provide a core capability that is independent of specific work center or user group needs and provide technology for user customization. Secondly, turn over the customization responsibility and task to user groups.

Since the SIIF is an SQL database, interactive query and reports are readily generated via the provided vendor SQL COTS tools. WFA does not provide these reports and queries but rather, ensures that all scheduling and status information is accessible through them.

The user interface for the assistants alternately presents information to the users as lists, drawings and various scheduling charts, all user selectable. The user can define as many drawings as needed to tailor the interface to the work area itself. Work center status can then be directly depicted on these drawings. This capability is presently being demonstrated to users and has been well received. Figure 2 illustrates various forms of the user interface for the assistants.

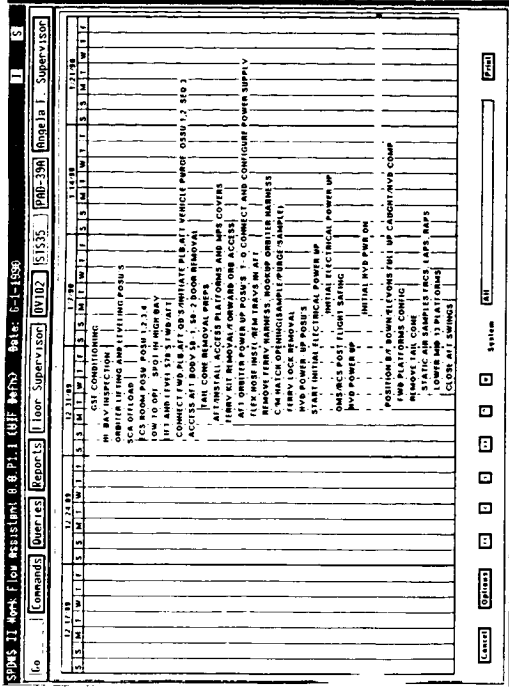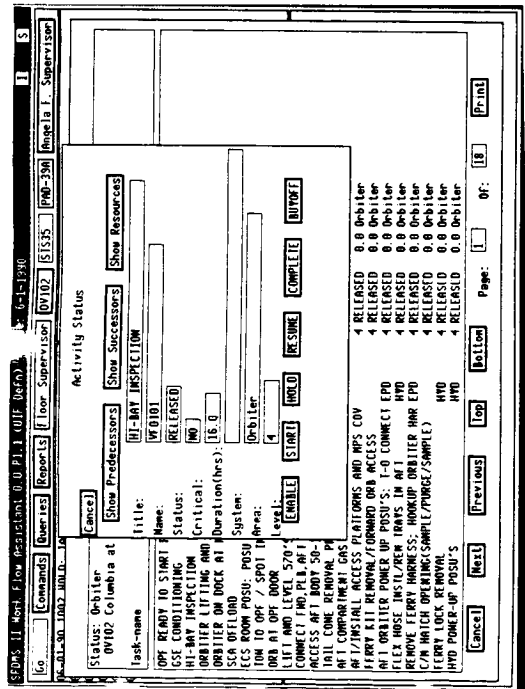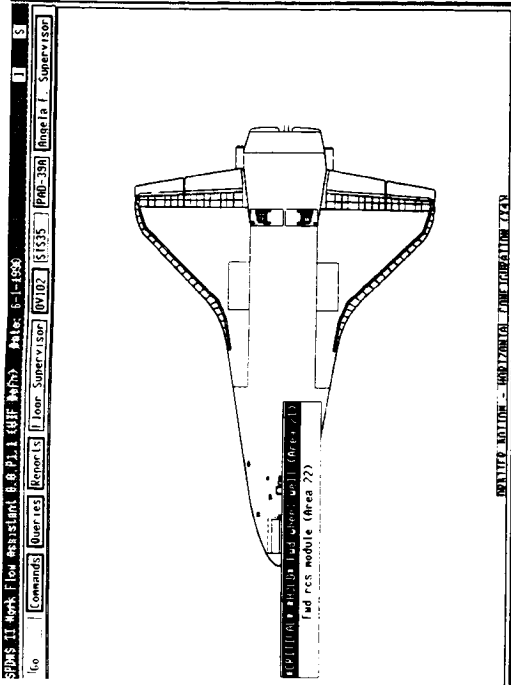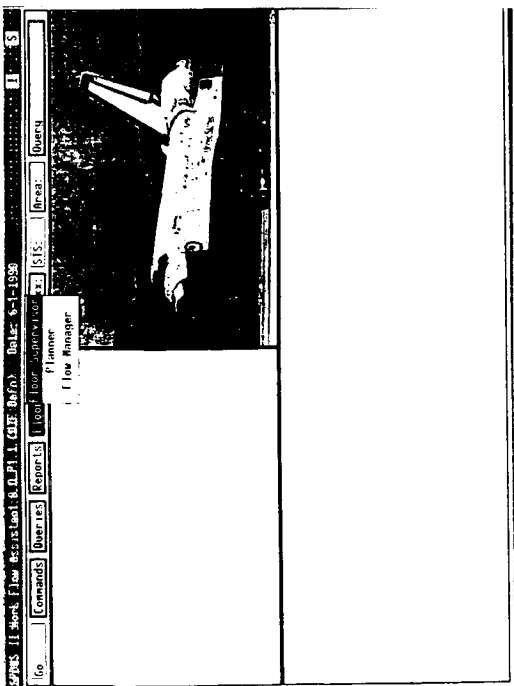Advisory system displays are also fully defined by the users.

Figure 2: Flexible User Interface

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4. PROJECT BENEFITS

Program benefits range from aspects as diverse as technology insertion, and comparative validation/assessment of new products, to system maintenance. And as new products are introduced, they may be evaluated *in situ* rather than in a standalone mode.

The WFA will make information readily available to a large segment of the KSC user community, that has previously been assessable only via personal contact with numerous individuals with area specific knowledge.

Data sharing across tools, systems and organizational groups is a natural outgrowth.

Consumers of scheduling information and application developers as well should receive something new in tool selection...a choice.

Near real-time interactive decision making aids should improve productivity and permit more timely informed decisions

Once the proposed SIIF standard is in place, a synergistic effect may occur, and unforeseen latent benefits may accrue.

If successful, SIIF may encourage others within NASA or contractor organizations to undertake data format standardization efforts in other areas.

5. CONCLUSION

As reflected from user feedback of demonstrations of the first phase prototype, WFA is envisioned by users as a ground breaking project with much promise. However the challenge is also real. WFA is being therefore deployed in separate phases to mitigate that risk. Each major phase also contains a prototyping step to gain early user critique and permit project mid-course corrections. The success of this system and its extent are dependent upon factors which to a large measure require the persistent commitment and willingness of contractors, vendors and NASA to make WFA an actuality

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