Integrated Process Control and Data Management in RASSP Enterprise Systems

John Welsh, Biju Kalathil and Bipin Chadha
Lockheed Martin Advanced Technology Laboratories
Camden, NJ
jwelsh@atl.ge.com, bkalathi@atl.ge.com,
bchadha@atl.ge.com

Mary Catherine Tuck and William Selvidge
Intergraph Corporation
Huntsville, AL
mctuck@ingr.com, wselvid@ingr.com

Elisa Finnie
Aspect Development
Mountain View, CA
elisa@aspectdv.com

Arne Bard
Army Research Laboratory
Ft. Monmouth, NJ
abard@ftmon.arl.mil

Abstract

The RASSP Enterprise System provides key automation support for teams of signal processing/electrical design engineers in the execution of complex development projects. As a result, the system facilitates greatly improved productivity, as well as efficient program control and orderly management of design configurations. Core concepts of the RASSP Enterprise System include integration of tools and tool frameworks into an enterprise environment; program execution control through workflows; integrated data management functions; concurrent engineering team support; and integration of design engineering and manufacturing. This paper presents a strategy for the use of the RASSP environment, methodology/workflows, and information models to improve efficiency in task execution and information management on signal processor development projects.

Enterprise System Overview

The RASSP Enterprise System architecture is hierarchical, integrating individual design tools, as well as collections of tools, which are themselves integrated into specialized frameworks. This architecture includes provisions for purchasing systems and product data management systems [1]. The architecture also provides a distributed reuse system with an object-oriented repository at the enterprise level and coordinated local framework/tool libraries.

The concept of operation for the enterprise framework includes the ability to execute project plans, expressed as workflows, by teams of engineers. Execution of a workflow by a member of a design team, as indicated in Figure 1, initiates control commands to a CAD/CAE tool as relevant for the particular workflow step. This execution also initiates data transactions with the enterprise product data management system; local data management systems; and library systems, as relevant for the particular workflow step. In addition, project management tools are coupled with the enterprise environment, which receives regular status updates as workflow steps are executed. This process facilitates effective, non-interfering project management.

Execution of the workflows is performed using enterprise methodology management tools, which provide links to tools, data access mechanisms, and other services. This process removes these functions as required responsibilities for the design engineer, allowing increased focus on the real design tasks and significantly improving productivity. Using this process, project engineers or supervisors would no longer be responsible for design and implementation of project plans based on workflows using the system.

In addition, the enterprise framework provides multiple workspace views for the design environment to support for workflow usage. These views include:

- Tool and application workspace,
- A data workspace for product and reuse information
- Project/workflow workspaces.

The resources, data objects, and applications available to a particular engineer are defined by his or her identity and role in an authorization hierarchy implemented in the Enterprise System.

Workflow Management

Workflow management in the RASSP system is comprised

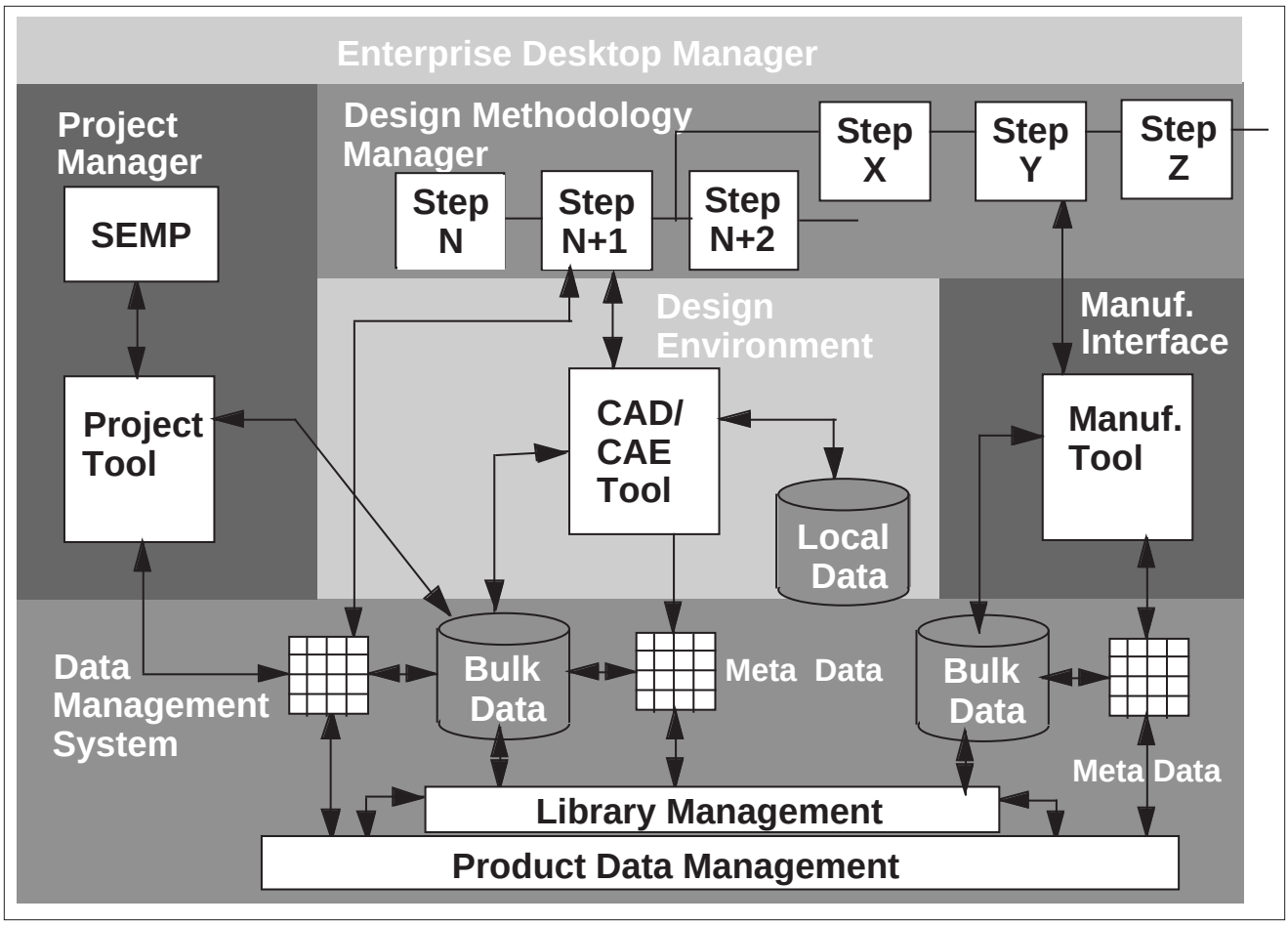

Figure 1. Enterprise system organization.

of methods and tools to provide the project team with an environment that facilitates day-to-day work. We have adopted a process-model-driven philosophy for workflow management. The RASSP methodology leverages process models for electronic design that were developed by Lockheed Martin's Engineering Process Improvement program. These models are being augmented with new RASSP process models that specifically address signal processing issues and provide many enhancements to electronics engineering processes. The RASSP methodology also provides approaches for concurrent engineering; evaluation of multiple alternative solutions; failback paths; and iterations.

The detailed representation of the RASSP methodology and related methodologies are modeled using extensions to IDEF3 [2]. The workflow model captures:

- Process steps
- Their precedence relationships;
- The personnel roles authorized/required to perform work
- The information objects involved (created, used, modified, destroyed, etc.) in the process step
- The tools to be launched or controlled at each step.

The information objects represent place holders for instances of objects that will flow through the workflow. A neutral, process information exchange language (PML) has been developed to facilitate exchange of process data among process-modeling and process-enactment tools. A parser to convert process model data from TopDown Flowcharter to PML format has been developed. The parsed information is stored in a PML repository, which Rockwell is developing. Some implementation details can be found in Lockheed Martin Advanced Technology Laboratories' paper, entitled "Workflow Modeling for Implementing Complex, CAD-Based Design Methodologies" [3].

The workflows are hierarchical in nature — representing the various disciplines associated with electronic design. The workflows consist of reusable workflow segments, which can be combined in various configurations to address specific project needs. Figure 2 represents a module final design segment. These segments consist of multiple process steps, each of which are also reusable. Thus, options available to a user organization are either to make use of the RASSP workflows in current form or to develop process

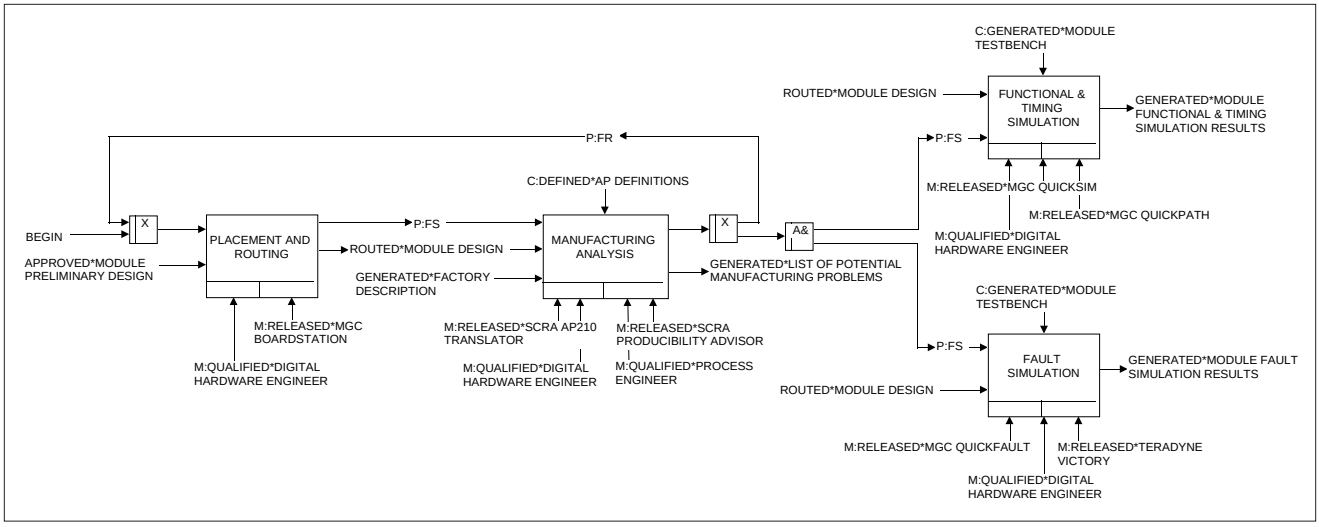

Figure 2. A module final design segment.

plans based on a combination of reuse of RASSP workflow segments, individual process steps, and possible custom user steps.

The RASSP team is producing workflows that will represent the design disciplines and support activities represented in Table 1. To date, the team has implemented detailed hardware design and multiple architecture design processes. Development of systems and software design processes, as well as enhanced supporting processes, are currently underway.

To support implementation, the detailed workflow information captured in IDEF3X is represented using a workflow-tool-independent language form, the Process Modeling Language (PML). This information can then be transferred to an enterprise workflow tool. Utilization of processes in the enterprise workflow tool involves conversion to an executable form that is compatible with the specific workflow tools being used in the enterprise environment. The Design Methodology Manager (DMM), developed by Intergraph, is the workflow management tool that the Lockheed Martin RASSP system is using for this purpose [4]. In addition to the PML workflow, tool-encapsulation files provide specific tool control information necessary for control of the tool-using workflows in the enterprise environment. This information includes path and name of executables; argument variables; files and data required; pre- and post-processing required; and so on.

Information Management

Enterprise information is a key corporate asset and will require a well planned management strategy. The RASSP team developed an enterprise data model, which specifies the metadata that the design engineers and project/system administrators need to track the product and reuse information in the system. In development of the RASSP Enter-

Table 1. RASSP workflows.

System	Architecture	Detailed Design	Support Workflows
System Requirements Analysis and Refinement	Functional Design	Chassis Design	Reusable Design Element Generation
Functional Analysis	Architecture Selection	Backplane Design	Process Plan Generation
System Partitioning	Architecture Verification	Module Design ASIC Design FPGA Design	Conduct Design Review Reuse Workflow Generation Mentor Part Generation Release to Manufacturing

prise Data Model, several standard models were analyzed relative to RASSP-specific requirements. Models analyzed include the Product Data Control Model (which Rockwell developed on the USAF Integrated Data Strategy program), the STEP parts and protocols AP203 [5], and Part 44 [6]. The Enterprise Data Model was therefore developed based on multiple sources of product data requirements.

The RASSP team is implementing the enterprise data management system using the Intergraph DM2.0 distributed product data management product [7]. As a result, the team is mapping the RASSP enterprise data model to the core model of the DM2.0 product (Figure 3) and is implementing extensions that make practical and commercial sense. Some of the new classes being added to DM2.0 are: *security classification*, *anomoly*, *product concept*, and *software configuration item*.

The DM2.0 product manages the enterprise documents and their metadata; product structure and configurations; user roles and authorizations; storage locations and vaults; and related data in a distributed environment. It also interfaces with the reuse libraries to facilitate reuse of the enterprise information. DM2.0 provides these services either directly or under the control of a workflow manager, based on the needs of particular projects. This enables the workflow manager to access and store information (such as design documents, bills of material, and test procedures) by a process step, as needed.

For configuration management [8] and authorization, RASSP-developed models define specific requirements for these capabilities. Support for implementation of these models is provided using the rules subsystem of DM2.0. A combination of DM2.0 and secure internet services will provide distributed product data management capability for a multi-organization, multi-site environment.

Reuse Management

Library management in the RASSP system involves the release, cataloging, and searching of reusable design objects. The RASSP Reuse Data Manager (RRDM) supports this library management. Sources for reusable design objects in the RASSP system include:

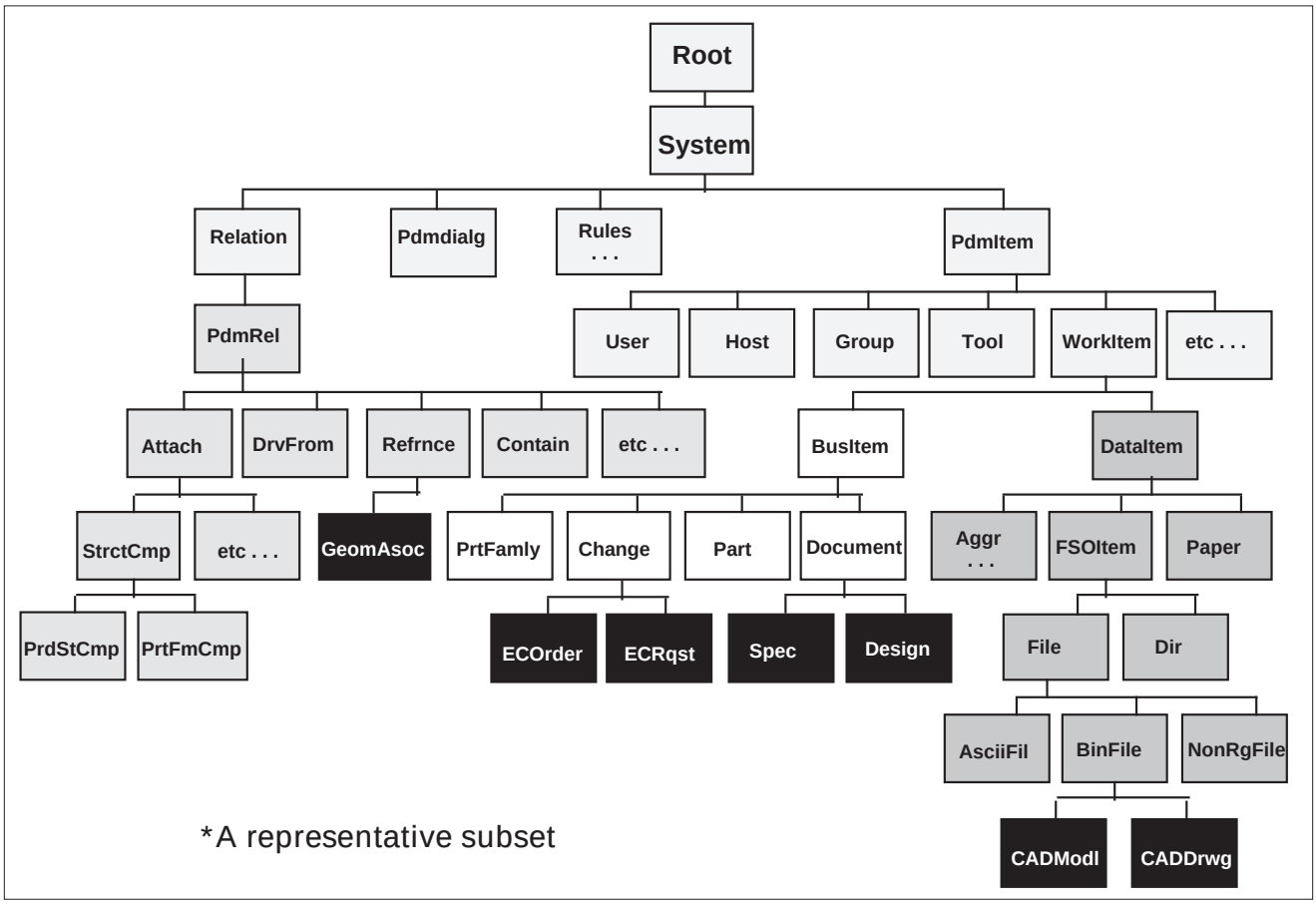

Figure 3. DM2.0 object-oriented data model.

- CAD tool libraries
- CAD-tool-independent libraries
- Component vendor data books
- Design objects created within a design organization.

In today's design environments, the ability of the design engineer to maximize reuse is impaired because there is no efficient way of searching for reusable design objects across multiple sources, and the various sources of reusable data are not coupled with the design environment. In addition, mechanisms and processes for organizing reusable design objects created within a design organization are lacking. Also lacking is the effective sharing the reusable design objects within the organization, as well as with other cooperating organizations.

The RASSP Enterprise System will include tools and methods for integrating the various sources of reusable design objects to provide a single source for searching for reusable design data and will enable enterprise-wide sharing of reuse data. The approach consists of:

1) Developing a design object class hierarchy, which classifies the various types of design objects in the RASSP domain and models the descriptive data associated with the design objects

2) Developing a commercial library management system, which will implement the design object class hierarchy and provide mechanisms for searching for design objects across multiple libraries and across a virtual enterprise.

A support workflow is also provided by the RASSP system for addition of new reuse elements and/or classes in the system. This process includes certification of the new elements, possibly to the classification hierarchy, and generation of documentation updates.

Additionally, the RASSP reuse management system will support loosely-coupled and tightly-coupled federations of cooperating organizations in sharing library data. The core library management search and browse function, which supports the RASSP design object class hierarchy, was implemented by Aspect Development. This function was released as a commercial product in May 1995. Extensions for integration of reuse library systems are currently in development. An initial version of the reuse class hierarchy is shown in Figure 4. The RRDM extensions being developed support: capabilities to manage default and template objects, manage parametric searches, modify existing objects, modify class hierarchy, and so on.

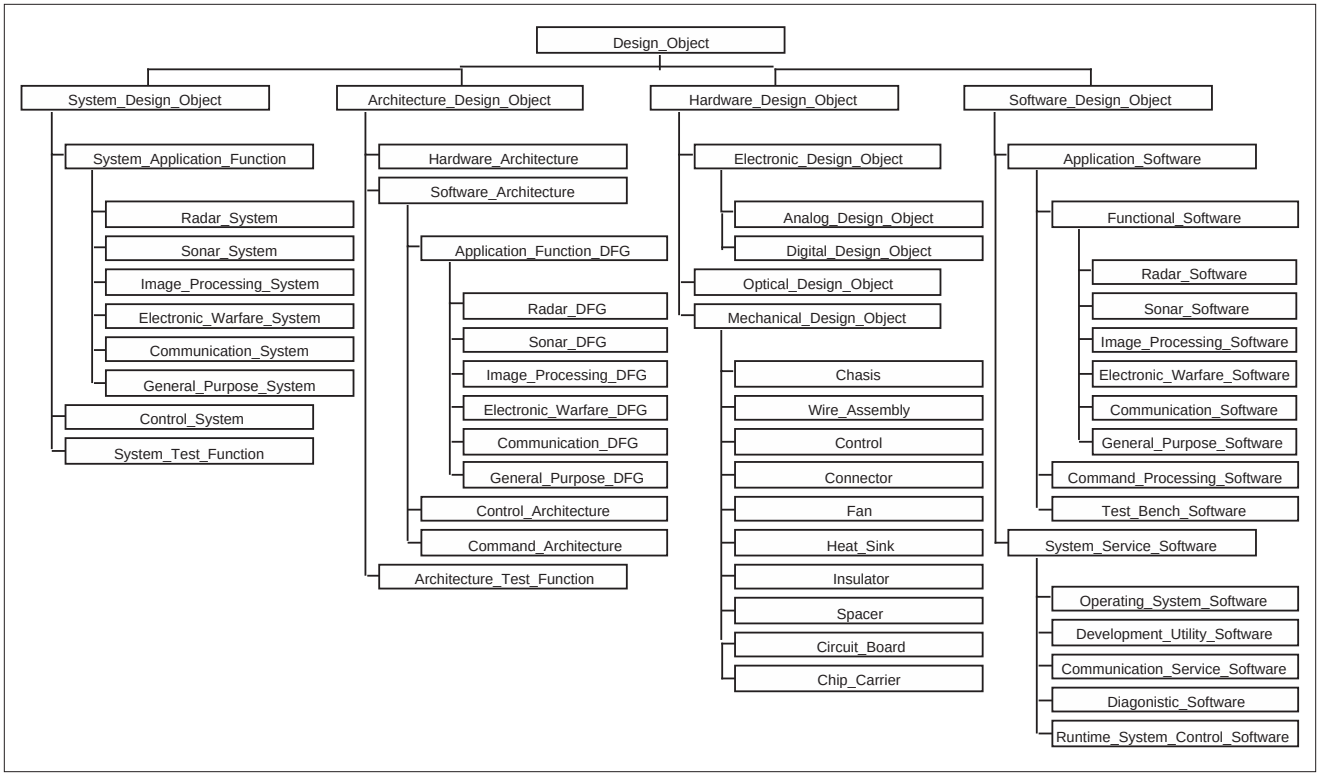

Figure 4. RASSP design object class hierarchy.

Project Planning

A project plan is a specific collection of workflows that have been customized to meet the specific requirements of the project and the performing organization. The RASSP Enterprise System includes tools to enable construction of these project plans using workflow segments or other project plans that are maintained in the workflow reuse system (Figure 5). These tools enable selection of the workflow segments, customization of the workflows, linkage of the segments, and definition of totally new workflows. Because the workflows also include the data object definitions, the process of combining workflows into projects produces data object templates. These data object templates specify the detailed information associated with, or produced on, the projects.

Within the RASSP enterprise environment, a project builder toolset that is being developed as an extension of DMM provides capabilities for construction of project plans using the workflow segments or activities, as well as previously developed program plans. These capabilities will include the ability to:

- Cut and paste workflow models (shallow and deep-copying)
- Browse multiple models
- Interface with reuse repositories
- Capture metadata about models, such as where used, rationale, metrics, author, etc.
- Analyze newly created models for consistency.

The RASSP team anticipates that user organizations will use these tools to create new instances of these workflow models (or even design new workflow models), which are tailored to particular project needs. These models can also be added to the workflow library and made available for use on future projects.

The data object set for a given project represents a set of place holders, or data templates, for management of the project data. These are mapped onto the RASSP information model, which specifies the requirements for management tracking of the data objects. Execution of the workflow steps produces more detailed design information within design objects, such as additional product structure information and/or documentation information.

In execution of the project plan constructed from the workflows, the activities and data object specifications are instantiated for the particular project. As part of this process, users are assigned to the roles in the project plan, and actual object instances are associated with their place holders. The information manager generates the appropriate objects, work locations, and so on to facilitate the workflow. The information models and information manager are therefore closely coupled to the process models and the workflow

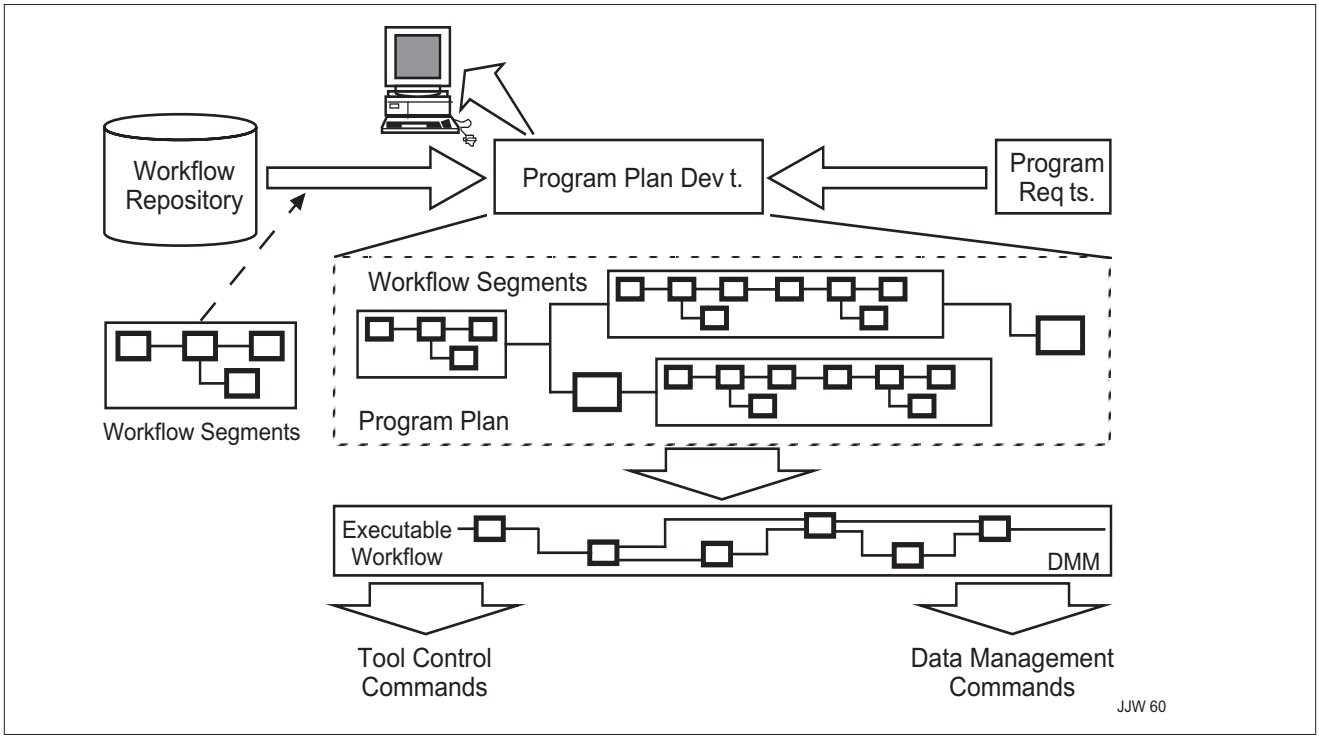

Figure 5. Use of RASSP advanced processes.

manager. The harmony between the two enables the users to perform the right tasks using the right information in a transparent fashion.

Summary/Status

Through integration of workflow/process technology and data management of product and reuse information, the RASSP Enterprise System, provides significant capability for enabling large productivity gains for signal processing/ electronics engineering teams. The development plan for the RASSP Enterprise System includes four prototype build cycles. The team demonstrated the initial prototype system, which focuses on electronic hardware design, in February 1995. The implementation of the functional design and architecture design processes — which are the focus of the Build 2 system — will be demonstrated in February 1996. Prototype demonstrations of these processes are also available at this conference.

Key benefits include a practical approach to apply workflow technology in an engineering environment; capability for planning and management of complex products involving CAD environment; and improvements in reuse implementation through an integrated, distributed strategy.

Accomplishments to date include definitions of four RASSP workflows; an initial definition of PML; prototypes of a PML parser and PML repository; an initial definition of a reuse hierarchy; extensions to DM2.0 classes; and extensions to RRDM functionality.

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