

Virtual Manufacturing White Paper (aka Toward a Process Engineering Repository RFP)

(Notes from the Tuesday-in-the-bar meeting based on the SAVE Model)

The following “business objects” appear in the SAVE overview:

Model Management Data

- Design Study – a Project that incorporates manufacturing planning and simulation
- Design Alternative – a set of design choices jointly constituting one possible solution
- Manufacturing Program – a particular product family, product or subassembly being addressed by the study. This object houses many “constraints” on the manufacturing planning, such as expected lot sizes and due dates, budgets, target facilities and production lifetime of the product.
- Simulation Request – a transaction initiating a particular sequence of analyses, seen also as a package of the information needed to perform those analyses
- Simulation Model – a “native” model for a particular simulation software application that supports or is derived from a Process Plan and its associated information objects.

Core Process Data

- Process Plan – a specification at some level of detail for the performance of a set of manufacturing tasks that result in product. It consists primarily of Operations.
- Operation – a specification for or description of a unit of work for purposes of analysis, typically a single process from the viewpoint of manufacturing planning, bringing together product materials and resources with specific capabilities for a nominal period of time with a nominal cost.
- Reference Process – a characterization of an Operation in terms of standard performance, associated external requirements, and expected behaviors, including yield, failure rates, time, cost, etc.
- Manufacturing Order – a unit of production work given to some manufacturing facility. The actual work to be performed is specified by a Process Plan.

Product Data

- Part - may be a detail (component) part or an assembly
- CAD Model – the geometric and topological model of a Part, together with all associated annotations (i.e. the CAD file, whatever all is in it, although in some cases all that is needed is a viewer form).
- Feature – a characterization of some aspect of a Part that is important to making decisions about processing operations and resources.
- Part Usage – the relationship of a Part to an Operation, but seen usually as the occurrence of the Part in an Assembly (Part) and therefore in the related assembly operation.
- Part Location – position and possibly orientation of the Part (in some coordinate system) relative to a Part Usage. The position is defined as needed for performing the operation itself. This may be the position in the assembly at the final stage of the process plan. It is used by the simulation tools and is defined relative to their needs. (It is not clear whether this is position in the assembly itself, or placement of the raw part instances for access during the assembly operations, or both.)
- Material – the acquired materials from which a Part is fabricated or assembled, possibly after some kind of materials preparation.

Assessment Data

- Schedule – for a Manufacturing Order, the assignments of Materials and Operations to specific Resource instances in specific time periods, sequenced as required by the Process Plan.
- Risk – characterizations of possible perturbations in the nominal time, cost, resource and materials requirements of a Process Plan per product instance — yield, lossage, failure rate, time loss, etc.
- Contributor – specific factors in Risk elements, including qualifications and quantifications of their probable occurrence and effect on the process.

- Cost – estimated cost in time and money for the production of a particular product Feature by a particular Operation using particular Resources, or more generally for the production of a particular Part by a particular Process Plan.
- Inflation Table – (synecdoche) the general concept here is Reference Time and Cost data that may change over time per some predictor function.

Resource Data

- Resource – manufacturing assets that are used in the performance of Operations, primarily Personnel and Machines, and some Tooling.
- Resource Pool – the set of Resource instances that are capable of performing a given Operation and considered available to perform it, for planning purposes. (The same Resource Pool may apply to multiple Operations.)
- Resource Application – the assignment of a Resource instance to an Operation, including all information associated with that assignment, such as setups, operator instructions, equipment programs, special handling and performance notes, etc. This may be the assignment made by a manufacturing engineer, which defines only the requirements for the use of this (type of) Resource in this Operation, or the assignment made by a scheduler, which selects a Resource instance and associates a time slot and a particular Manufacturing Order (Job, Lot). (SAVE allows either or both, depending upon the type of simulation being performed.)
- Tool – a machine or attached tooling object or both, whose use and maintenance is scheduled. The SAVE model does not really distinguish Machines from “Durable tooling”.
- Breakdown – estimates of the mean time to failure and mean time to recovery of a Tool, based on (and possibly containing) historical data. In some cases, this may be organized by Reference Process.
- Personnel – the human resources that are planned and scheduled to perform manufacturing tasks, according to their certified skills and availability
- Work Calendar – a characterization of the availability of Personnel, and more generally, of a manufacturing facility as a whole
- Work Shift – a characterization of the availability of Personnel
- Break – a nominal recurring requirement for Personnel to be unavailable during a Work Shift

Of the above, we decided that the following objects are “in scope” for a Process Engineering Repository RFP:

- Process Plan
- Operation
- Reference Process
- Simulation Model, and other Process Documents
- Part
- CAD Model, and other Part Documents
- Feature
- Material (those properties that relate to process, such as identification, quantity, preparation and handling)
- Part Usage, and Part Location
- Cost, and Cost Reference data (possibly including Inflation Table)
- Risk, and Contributors
- Resource
- Resource Pool
- Resource Application (at least the engineering concept)
- Personnel
- Machine, Tool
- Breakdown
- Manufacturing Program data, such as constraints, expectations and requirements
- Simulation Request, as a data package

And the following are “out of scope”:

- Manufacturing Order – an operations concern, not an engineering concern
- Schedule – an operations concern, not an engineering concern

- Work Calendar, Work Shift, Break – an operations concern, not an engineering concern
- Simulation Request, as an invocation of simulation activities – not a repository interface
- Manufacturing Program – a user business process concern
- Design Study – a user business process concern
- Design Alternative – a user business process concern

The following SAVE objects have some overlap with the existing PDM Enablers:

- Part — PdmProductStructure::PartMaster, PartRevision
- CAD Model — PdmDocumentManagement::Document, PdmProductStructure::PartDocumentRelationship
- Material — PdmProductStructure::PartMaster, PartRevision
- Part Usage — PdmProductStructure::Usage, PdmManufacturingImplementation::ProcessStepConsumesPart
- ProcessPlan — PdmManufacturingImplementation::ProcessMaster, ProcessRevision
- Operation — PdmManufacturingImplementation::ProcessStep
- Resource — PdmManufacturingImplementation (Tool, ProcessStep::Process_resource)

It is expected that a Process Engineering Repository RFP will extend, and ultimately replace, the PdmManufacturingImplementation interfaces, but “upward compatibility” with PdmProductStructure and PdmDocumentManagement is very desirable, since Part and Process engineering repositories may not be easily separated in applications software products.