Process Engineering and Development using Customer Focused Object Oriented Design

Craig E. Peterson
Jet Propulsion Laboratory
Mail Stop T-1143
4800 Oak Grove Drive
Pasadena, CA 91109

Abstract. The need for application of system engineering expertise to review and re-engineer institutional processes has become increasingly apparent. In order to provide a unified approach which can be used on any process, a synthesis of current system engineering approaches has been developed. When combined with Total Quality Management principles, this approach is called Process Engineering and Development using Customer Focused Object Oriented Design (PED-CFOOD).

Over the last few years, Software System Engineering (S/WSE) principles have evolved towards an Exoteric Perspective (EP) described by (McMenamin 1987). That is, examining systems from the point of view of the external world in which the system is embedded, and determining what flows into and out of the system. EP has two problems with it, though.

First, there are usually multiple external perspectives that can be adopted. The current solution is to try to examine the system from as many as time will allow, and then settle on the one that seems the most appropriate. TQM, on the other hand, provides us with a suggestion as to which might be most appropriate, namely, the viewpoint (focus) of the Customer.

Second, it does not provide a conceptual framework for process or product design. Object oriented development concepts provide that framework.

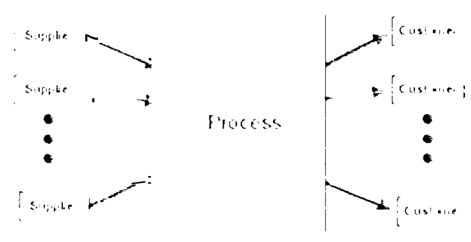
This paper provides a general description of this approach, and illustrates how the approach might be used in practice.

1. INTRODUCTION

The recent emphasis on re-engineering of processes has suffered from the lack of a well-defined methodology (Hammer et al. 1993).

2. DEFINITI

Before defining CFOOD, several underlying concepts must be defined, leading up to "Process". (See Figure 1 for a top-level view of a generic "process".)



igure 1. Gene i 'rocess Top-leve View

Procedures. A procedure consists of a set of one or more *steps*, a *time sequence* of the steps, if needed, a definition of *materials* used in each step, and *suppliers* of materials, which produces one or more *products* for one or more *customers*. For example, a procedure may cover transport of material from place to place, purchase of material, an employee performance evaluation, generation of a management report, etc.

Steps. A step is an atomic action (which may be automated or manual). Mathematically, it is a transform which takes in material in one form and produces material in the same or another form.

Ordering. A time sequence is an ordering to establish which steps (predecessors) have outputs which are products, this is trivial.) If there is no overlap between products and customers (i.e., no occurrences of multiple customers receiving the same product) each customer should be considered separately, unless the product materials derived in steps 2 and 3 have substantial (>50%) overlap. Then, the customers should be weighted in terms of their importance (to the extent possible.) An easy partition is that customers who provide funding should be weighted in the order of their contributions, with non-funders bringing up the bottom. Then, a virtual customer should be defined as the sum of the products for customers above some breakpoint (e.g., if 3 customers provide 80% of the funding, the rest can be eliminated from immediate consideration). If no such weighting and cutoff can be defined, a virtual customer can be defined as the receiver of all unique products.

2. Decompose products into materials (physical and information). This decomposition can be multi-level, although, if more than three levels of decomposition is required, the top-level product can and should be broken down into multiple products along any handy logical division. This should not be a concern, as the products will be re-integrated through the following analysis, if it makes sense to do so. Otherwise, the product should have been broken apart anyway.

3. Determine overlap. Determine overlap of products based on the material decomposition. Some products may have a great deal of overlap, which makes them a candidate for consolidation of their processing. This is particularly true of information materials, but can apply to physical materials as well. If no overlap exists, either decompose materials further, or consider development of separate processes for each disjoint product.

4. Examine potential Suppliers. Examine potential Suppliers for directly received (pass through) or derivable materials. Remember, deriving can include persistent materials that, once received, can be used repetitively to derive other materials. (E.g., a database that is used to generate reports, a set of models that can be applied, etc.)

5. Collect common and related materials. Collect common and related materials to establish product material taxonomy. (Beware of the tendency to collect everything together, due to small or superficial overlaps in products' materials. Rank materials in order of their importance to the product, i.e., which are the materials, that, if removed, would make the product of little or no value to the customer, and use only the highest ranking materials to determine the overlap and corresponding collections.)

6. De-scope products. Eliminate materials that cannot be supplied. (De-scope products.) Otherwise, internal suppliers (other processes) must be created to provide the materials.

7. Establish steps. Breakdown all derivations to a set of steps. Steps are characterized as either:

manual - for physical transformations,

automated - for information transformations (can also be manual, but trades efficiency for ease of implementation. I.e., manual procedures have no software development costs), or

custodial - for persistent materials. May be automated or manual, depending on the material.

Allow one step for pass-through of information or transport of physical material.

8. Order steps. Develop procedures by determining the ordering of the steps. Then collect into sets those sequential steps that are *connected* (does not rely on any other set of steps except for input) and *disjoint* (does not both collect input from and provide output to any other set of steps.)

9. Object Orientation. The process can now be **object oriented** by collecting together all steps, which act on the same class of materials, into an *object*. Each such step (transform) then becomes a *method* for the object. The process procedures can then be used to define the messages sent to each object and the sequence in which they occur. The advantage of this approach is that the objects can be classified similarly to the material, with higher (or lower) level object classes, **inheriting** methods from lower (or higher) level objects, based on relevance. An additional advantage is the number of object oriented design techniques such as Booch Diagrams (Booch 1991), Rumbaugh's Object Modeling Technique (OMT) (Rumbaugh et al 1991) and Coad & Yourdan's Class and Object diagrams (Coad et al 1991).

4. EXAMPLE - REENGINEERING TOOL SERVICE

This example is from a current design effort underway at JPL. The goal is to provide a process for Engineers that will allow them to acquire and use commercial-off-the shelf (COTS) software tools efficiently and economically. JPL has a very efficient process for purchasing individual COTS packages that was developed over the past two years called the Just-in-time System. However, this system does not provide the economies of scale that can be obtained through bulk purchases or floating licenses. It also as a supplier for some materials, and the suppliers to appear as customers for [illegible]. This indicates that this is a relatively complex process. Complete decomposition reveals that a "supplier" of the overall process can be a "customer" of one of its sub processes, and vice versa.

It is important, and relatively obvious, that one not lose sight of the fact that, in this case, the engineers are the true customers. Difficulties frequently occur in real life when an individual or department shifts their focus from the "true" customer to the individuals or processes who may appear to be a customer for their materials.

5. **Collect common and related materials.** The License and Notice of purchase confirmation are related in that assignment of a license number (serial number) is the necessary assurance that the engineer has successfully purchased and will be provided with access to the Tool in question. The license number may be required for servicing of help requests regarding specific COTS Tools.

License upgrades are related to existing licenses.

Help Request Responses are related to Help Requests.

Tool Requests are linked to Account numbers, since nothing demonstrates sincerity as much as an offer of funds.

6. **De-scope products.** Not applicable in this scenario. Some mechanism (existing or new) is required to produce all the products identified for the process to be useful.

7. **Establish steps.** In order to establish the steps necessary to transform the supplied material into products, it is necessary to decompose the overall process into its constituent procedures. This decomposition is illustrated in the following Figures 4 to 6, starting with the top level and ending with one of the processes (Help Process) being divided into three procedures.

Figure 7 illustrates one of the Help Process procedures broken down into steps. Each of the procedures within this process will require a similar treatment, as will the procedures that make up the other processes shown in the previous figures.

Note that at this level of detail, additional aspects of the product produced (e.g., [illegible] to Help Request) have been identified. There are now "responses from FAQ", "responses from experts", and "referral to Vendor". This simply results in an update of the list of product categorizations, and should be expected to occur in any real world process definition effort.

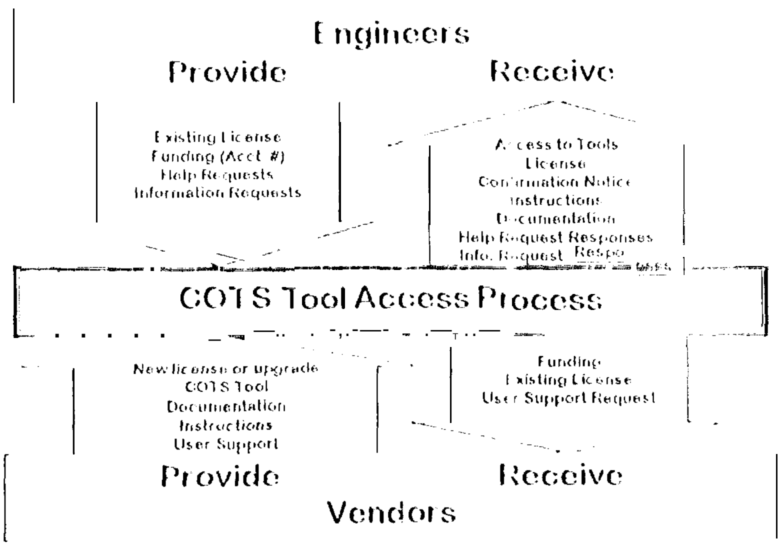


Figure 4. Process Top Level View

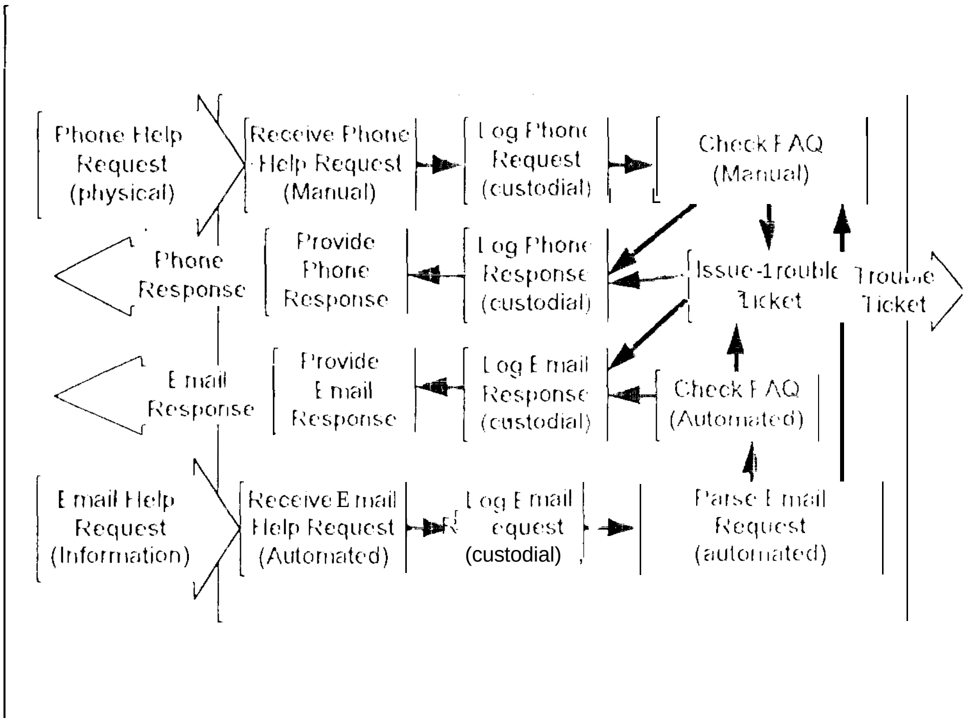


Figure 7. Receive Request Procedure breakdown by steps

8. Order steps. In Figure 7, the steps are illustrated in one possible order. Another possible order would be to not log the request or the response until it is known whether or not a "trouble ticket" will be assigned. In this case, the decision was made to assure that the logs are as current as possible at all times.

If a sequence of steps has different possible orderings (as the example does), it is important to have a complete understanding of why a particular order was selected over another. Hidden assumptions can then be brought to light and examined for other impacts.

In the example above, the decision that the logs must be kept current was motivated by the needs of another process, in this case, a process for measuring the effectiveness of the Help Process. This metric process requires information on the time between receipt of help requests and help responses. Logging the request at the time of the response would eliminate the useful information. While metric oriented processes are not the only outside influences that can effect ordering, they are likely to be dependent on the ordering of steps in procedures that they are measuring, and therefore should be explicitly considered at his time.

9. Object Orientation. It is now clear that there is a great deal of overlap between the steps for handling Email and Phone Help Requests. Classification of the steps as automated or manual can now be revisited to see if any changes are in order. Detailed examination of the materials passed between steps reveals that (apart from receiving the physical phone call and providing a physical phone response) all the material can be categorized as information. Therefore, provided that the information can be converted from the initial phone call and ultimately converted to a phone response, the remainder of the steps can probably be automated.

For example, the manual logging of request might be implemented as a user interaction object that communicates with the automated logging object. One can speculate that eventually it may be possible to have an object with speech recognition and voice synthesis capabilities receive the phone call, although this is not a likely near term implementation.

One likely exception is a manual look-up process necessary when an Email request cannot be automatically parsed. Given the difficulties associated with natural language parsers, this step is probably the most challenging to automate.

Once the classification of the steps has been firmed up, it now remains to determine if multiple steps represent the equivalent of different methods being applied to the same object. In this example, the "logging" of the request and associated response is a