A VALUE-CHAIN BASED MODEL FOR SUPPORTING INFORMATION TECHNOLOGY INVESTMENTS

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Abstract

Business organizations are thinking increasingly in terms of *information technology solutions to business problems*, as opposed to data processing for supporting the business. Information technology is now viewed as an important means for achieving competitive advantage. For firms in hardware/software business it is therefore becoming increasingly important to provide clients with the means to do an analysis of business needs and strategies and to think in terms of providing global IT solutions that address these needs.

The value-chain model articulated by Porter (1985) attempts to link IT solutions to business strategy. It is based on a simple economic theory: a firm remains competitive by virtue of being a low cost producer or differentiating its products/services; accordingly its strategies must be based on countering forces (such as new entrants, substitute products, bargaining power of buyers and suppliers) that erode these advantages . Information technology is considered a key factor in being able to deal with these forces Accordingly, how much to spend and where to spend on information technology is determined by how well it enables the firm to deal with its dominant forces (threats).

Porter's model has found widespread appeal among practitioners (notably information systems executives) due to its simplicity and intuitive appeal. Several methodologies have been designed around this model that encourage executives to "think through" this model in order to identify technologies that could provide competitive advantage. However, there are no existing formalizations of the value-chain model either by industry, market structure, or organizational structure. We have been developing such a model for a specific industry (insurance) with the objective of building an executive support tool that can show interactively, how a proposed technology or organizational change can impact specific metrics/values of interest of business processes defined at various levels of abstraction, and thereby the bottom line. By using such a model, an executive can also analyze technology and resource requirements required to transform one set of business processes into another, more desirable state.

1 Where Should Information Systems Plans Come From?

In many industries, competitiveness hinges on how creatively information technology is used. Technological laggards are often forced into playing catchup (as in the airline industry where American Airlines continues to dominate by virtue of SABRE). In these "information intensive" industries, senior managers must decide on which technologies to pursue, based on how these enable the firm to deal with the competitive forces in the industry. Once the strategic technologies have been determined, detailed Information Systems plans can be developed. In these industries, the criteria for assessing technology are not simply labor cost displacement, but how the technology enables the firm to "re-engineer" its business processes for competitive advantage. As pointed out by a chief information officer in the insurance industry:

> Now that we're talking about redesigning the business process, and the technology is so inseperable from the business change, how do we factor it into the benefit determination? It's not strictly labor displacement any longer.

2 The Underlying Economic Theory

The reason for the existence of an organization is that it performs a set of integrated activities more efficiently than the market (see Williamson (1980) for the theory of markets and hierarchies). Porter's notion of the "value chain" derives from this theory: if we divide a firm's activities into technologically and economically distinct activities that are used to "create value", this value can be measured by the amount that buyers are willing to pay for its final product or service. To be competitive, a firm must either perform these activities at a low cost or perform them in a way that leads to product differentiation (and hence premium price or value). Activities have "cost drivers" that determine the potential sources of a cost advantage. Similarly, a company's ability to differentiate itself derives from the contribution of each value activity in the chain toward fulfillment of buyer needs.

In virtually any industry, information technology can be applied to the value chain at every point, transforming activities and the linkages among them (i.e. it can change the way individual or aggregate activities are performed).

For an executive, the essential decisions ultimately boil down to the following: given a set of business goals and strategies, decide on database and communications architectures, hardware strategies, application portfolio priorities, and business processes (changes) required. The hard part is to *measure* and justify the necessary investments in information technology and the changes in processes required.

Our specific objective is to operationalize the value chain concept to the point where it actually becomes meaningful to measure (value) business processes along criteria that are meaningful to the business, and to be able to assess specifically, how a proposed technology or organizational change can impact the values of interest of business processes that are defined at various levels of abstraction. From a pragmatic standpoint, it is neccessary to limit the analysis to an industry so that meaningful processes and measurements can be defined. We have chosen to focus on the insurance industry, and within this industry, on **claims**, which is an important core business process in the industry.

3 The State of the Art

The Porter framework has led to several methodologies aimed at enabling information systems executives interested in prioritizing information technology investments (Buss, 1983; McFarlan, 1984; McKenney and McFarlan, 1982; Millar, 1984; Parsons, 1983; Cash and Konsynski, 1985; Davey, 1988). The state of the art is perhaps best encapsulated in the ISIS system developed by IBM which is aimed at executives interested in knowing how much and where to invest in information technology. The system combines several of the ideas proposed by Porter, McFarlan, Buss, Rockart, the Boston Consulting Group and others into an easy to use framework that permits executives to analyze the impacts of IT investments on financial statements.

The ISIS method involves going through five steps. The first involves an analysis of the market direction, based in large part on secondary data from Value Line, Standard and Poor's, the U.S. Industrial Outlook and A.M. Best., and an analysis of competitive forces in the industry (the bargaining power of suppliers, the bargaining power of buyers, threat of substitute products or services, and potential new entrants). The second step provides a picture on how much the firm is investing in IT relative to the industry and its competitors. This step uses methods aimed at appraising the condition of the firm's current applications, highlighting those that are critical to the business. The third step identifies those strategic business units where the highest returns are likely. This is based on the importance of the business unit and that of IS in supporting it.

The fourth step in ISIS is aimed at prioritizing competing information technologies. This is based on the analysis performed in step 1 on market direction etc, critical success factors (Rockart), and estimates of benefits and doability of the applications.

Finally, a detailed business case is built for the identified applications based on impacts on the bottom line. This is based on historical data and the cost and benefit projections of the chosen applications under consideration..

The major strengths of the ISIS model are twofold. First, it extracts data systematically from the executive through a series of questionnaires, and uses this and secondary data to generate graphs that position the firm relative to the industry and its competitors in terms of investment and various performance parameters. Broadly speaking, this addresses the question "how much should we be spending on information technology"? Secondly, the process of going through the ISIS exercise forces the executive to try and identify those applications that are likely to yield the best returns. In other words, it addresses to some extent, the question of "how do we get to where we want to be, given how much we can afford to spend"?

ISIS does a better job addressing the first question than it does the second. Specifically, with respect to the second question, the burden of identifying all the applications and quantifying their costs and benefits is primarily on the user. If a particular industry is specified, the system tries to elicit inputs relevant to that industry (such as how a proposed image processing system might impact administrative expenses or the loss ratio). However, there is no explicit representation of industry processes that might enable the executive to assess more fully the impacts of technologies on specific processes, or to be able to check/propse whether the estimates on benefits and costs provided by the executive actually make sense. In the absence of this support, the credibility of the numbers is questionable.

4 Our Contribution

According to ISIS experts, the hard part in the evaluation is quantifying the benefits of potential applications (apparently, costs are easier to assess). Specifically, there is no explicit mapping between the "ways of doing business" and technologies that enable this work to be done that might illustrate the specific impacts of the technology (i.e. whether decision making might move up or down as a consequence of the technology, what the impacts will be on cost displacement or product/service differentiation and so on). Currently, this is done by the user (aided by systems engineers and applications experts) using a numerical scale. For example, each potential application is ranked on a 5 or ten point scale on issues such as

- how closely the project supports the business's goals, strategies, and critical success factors
- the technical importance of the application, i.e. whether it is a prerequisite to implementing other/future key applications
- dooability based on the project's length, level of technology, organizational impact, whether its a brand new or replacement system, etc.
- estimate of the man hours required to design, develop, and implement the project
- estimated costs and benefits of the project; the former includes hardware, software, development, personnel whereas the latter includes increased revenue, reduced costs and improved asset management.

Clearly, coming up with good responses to the above questions requires a fair amount of knowledge about the firm and the industry, specifically, on those aspects of the business impacted by the technology. This knowledge must be used in an analysis in order to come up with credible numbers. What is required is an industry model that represents the basic business processes in that industry. These business processes should be specifiable and analyzable at various levels of abstraction. In the following section, we describe a formalization of the value chain model for the claims function in the insurance industry.

Our model addresses a fundamental weakness of the ISIS model, that of linking business goals to applications **via business processes**, that is, by making explicit to the user specific metrics of the processes that are affected. This steps the user explicitly through a level of detail that he would be unable to do otherwise, and in the process, makes it possible to generate cost/benefit numbers that are based on an explicit model of the enterprize as opposed to being pure estimates.

5 What Value Metrics Should be Used?

How the technology is evaluated depends on the valuation metrics. Porter's model provides the answer to this question by forcing the executive to articulate the sources of sustainable competitive advantage in the industry. For example, if one analyzes the competitive forces within the insurance industry, a dominant one is the bargaining power of buyers. What is it that buyers want, and what metrics can be used to measure how well the need is being fulfilled? Let us address this question by considering a core business function of any insurance company, namely, *claims processing*. Assuming that two firms provide identical coverages and premiums, what makes one more competitive than the other? In other words, what are the metrics that differentiate one from the other?

In the claims arena, a firm differentiates itself to the buyer in terms of the following:

- time taken to process a claim
- the quality of information provided to the patient/client concerning the extent of coverage provided, deductibles, exclusions and so on.

The metrics of interest to the insurance company are the following:

- the time taken to process various types of claims
- the cost of processing the various claims
- the number of errors
- the extent of fraud/creep (i.e. type I and type II errors)

Likewise, the metrics of interest to the service provider (doctor, garage, etc) are similar to those of the insured.

In summary, from the standpoint of the insurance company, the challenge is to differentiate its service, making sure that the premium charged for the service exceeds the cost of producing it. This is the criterion used in evaluating the technology. In the next section, we describe how the criterion is operationalized.

6 A Representation for Business Processes

In designing large business systems, it is common practice to use notations that communicate effectively among members of the design team the processes of interest, and the data that they require, manipulate, and generate. In addition to serving the purpose of communication, they also enable a design team to proceed top-down, until detailed processes are identified for which modules of code can be written.

There are several process-oriented notations that are commonly used in the early stages of the systems development life cycle. Common used ones are Business Systems Planning (BSP, popularized by IBM in the early 80s; see BSP-1984) and Structured Analysis. Both these require identifying the following:

- **processes**, which are groups of logically related decisions and activities required to manage or run the business. These can be thought of as similar to Porter's "technologically or economically distinct activities" that create value. At the highest level, these might be marketing, production, sales, etc. In an insurance company, these could be claims analysis, marketing support, billing, outpatient monitoring, and so on. A special type of process, often called an **external entity** either generates or receives data (i.e. does no transformation).

- **data classes**, which are data elements used by or generated by processes. Data can also reside in **data stores**.

- **input/output relationships**; in BSP, these form an "Information architecture" which shows what data items are created by or required by which processes. In structured analysis, they are shown graphically.

Sample diagrams showing the above components are shown in Figures 1 and 2 (Managed-Care Manual 1990). Figire 1 is the highest level depiction of a process called **claims workflow management**. Figure 2 "blows up" figure 1, showing the processes that make up the high level process. It also includes additional data flows that were "hidden" in Figure 1. These are commonly refered to as dataflow diagrams, for obvious reasons. External entities or external systems are shown as rectangles. Processes are shown as circles, and data stores or knowledge bases are shown in enclosed parallel lines (in Figure 1, sets of databases are shown using the DASD symbol).

7 Properties of the Process Notation

It is clear from Figure 1 that the **claims workflow management** function has four objectives specified inside the circle. These are really processes at the next lower level, which can in turn be broken down into more detailed processes. In other words, objectives or functions can simply be aggregated as we move up levels.

As we proceed to the lower levels, the ambiguity between the input/output relationships vanishes (i.e. it becomes clearer which process is using which inputs, producing specific outputs, etc). If we work down to the level of detail where each process has only one output, such processes can be considered "atomic" in that the transformation they represent is unambiguous.

It is possible to associate attributes with processes. Specifically, in object-oriented terms, each processes can be viewed as having the following attributes:

- objective
- **resources used**: this is a list of resources such as labor, machinery (such as processors) and space. Each of these resources themselves could be further categorized as shown in figure 6. Each resource has attributes.
- **total cost**: this is a function defined over the resources used
- **processing rate**: indicating the rate at which the input is processed or the output produced.

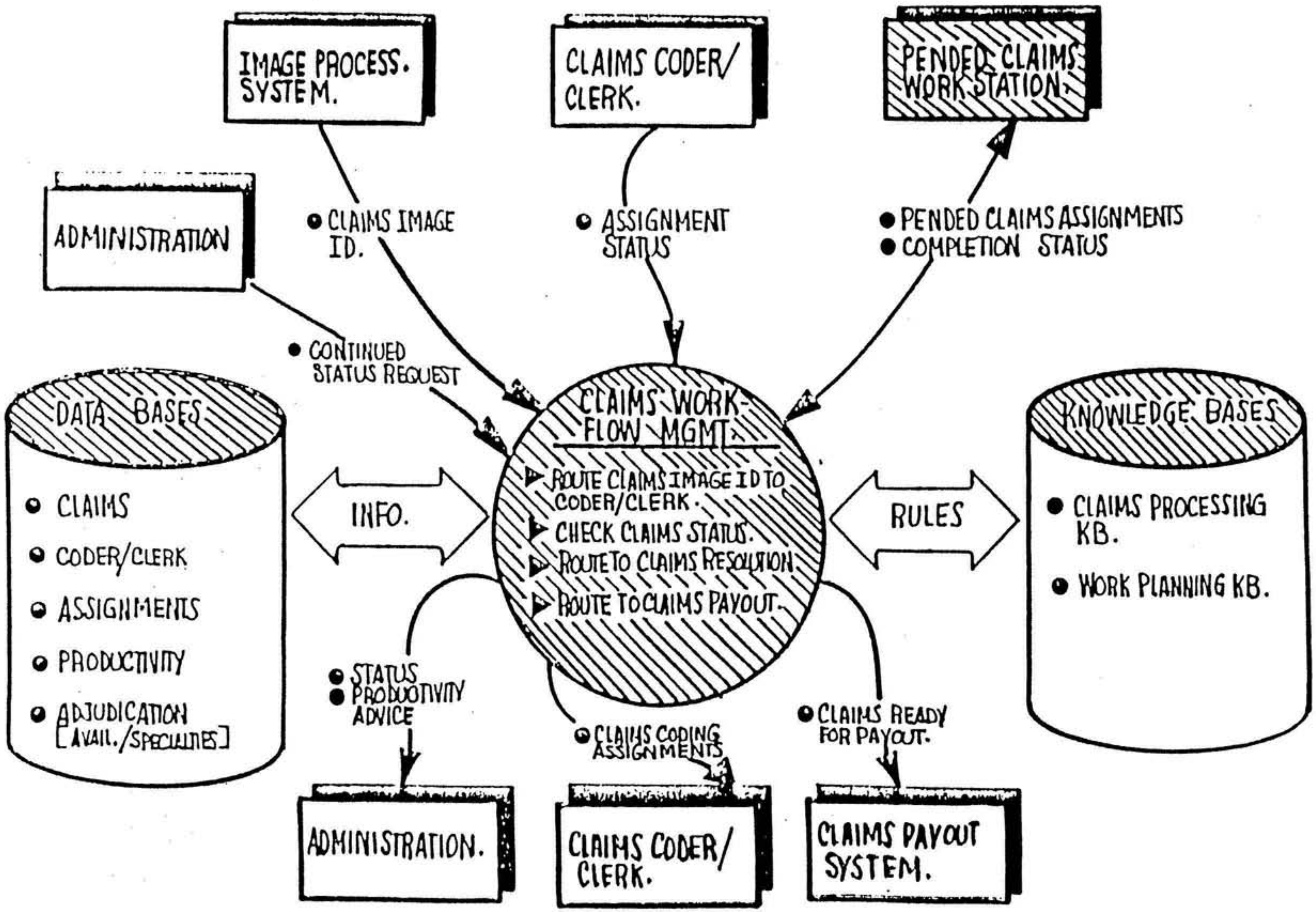


FIGURE 1: LEVEL 1 CONTEXT DIAGRAM — [CLAIMS WORKFLOW MANAGEMENT]

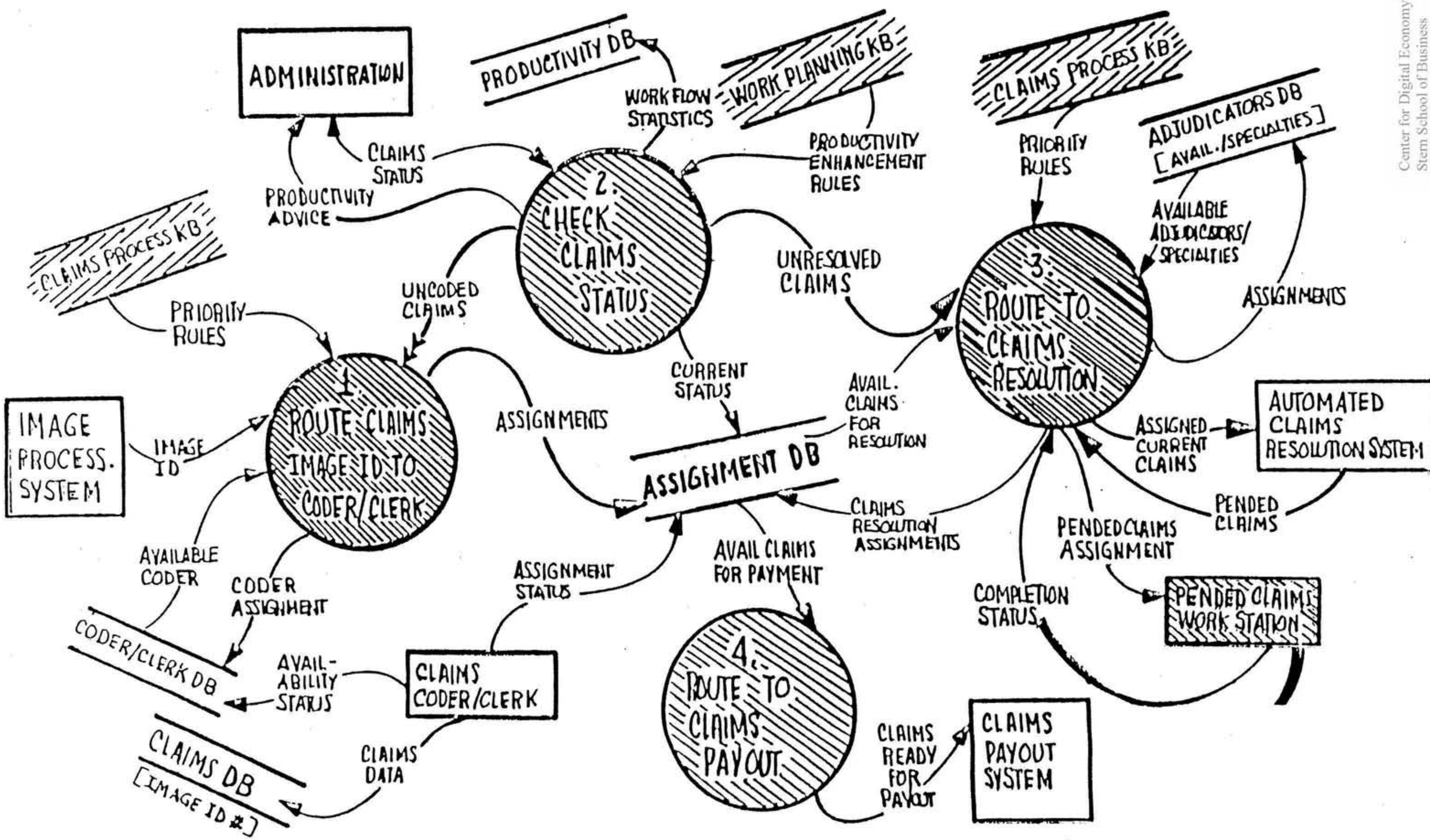


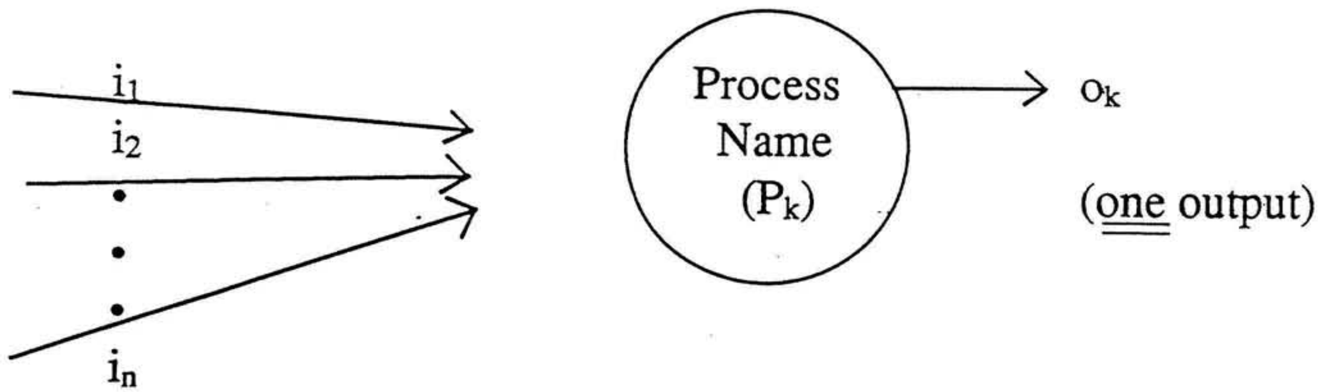
FIGURE 2 : LEVEL 2 CONTEXT DIAGRAM — [CLAIMS WORKFLOW MGMT.]

To illustrate, if metrics of interest are identified for an atomic process such as the one shown in figure 3, these can be aggregated ("rolled up") for the higher level processes as shown in figure 4. Basically, the aggregated value is some function of the component values, where the function can be specified as part of the model or infered (when processes are completely independent or when the "weakest link" principle is used, i.e. when an activity is done in parallel, the total time for the activity is of the component that takes the longest).

The above attributes are illustrative only. Doubtless, there are likely to be other attributes or interest depending on the domain. The important thing to note is that we have associated **values** with processes. Depending on the metrics of interest, these provide a precise measure of the **value of the business process**. Even more importantly, it becomes possible to **aggregate** these values so that a business process can be analyzed at any level of abstraction. For example, at the highest level, the **claims workflow management** can be viewed as performing several functions and it might have associated with it aggregated properties such as processing rates for various types of claims (i.e. on average, 1 out of 10 health claims is routed to an adjudicator for resolution whereas 1 out of 100 property claims needs adjudication, health claims are processed at an average of 100 per day with an average fraud/creep rate of 3 percent, property and casualty claims at 2,000 per day with a fraud rate of 1 percent, the average processing rate for all claims is 1,000 claims per day, and so on). Where do these numbers come from? From the lower level processes that deal with the specific types of claims (in Figure 2, and from more detailed "blow ups" of its processes).

This type of functionality requires a sort of "reverse inheritance", where the attributes of a higher level object are a function of those below it. For the **objective** attribute, the function is simple: it is simply the set of objectives of the objectives of the processes below it. For attributes such as cost, it should be the sum of the costs of lower level processes. For other attributes, this could get more complicated if processing times overlap or resources are shared. Figures 5 and 6 list the process and resource/value objects involved in representing the claims function.

THE ATOMIC PROCESS

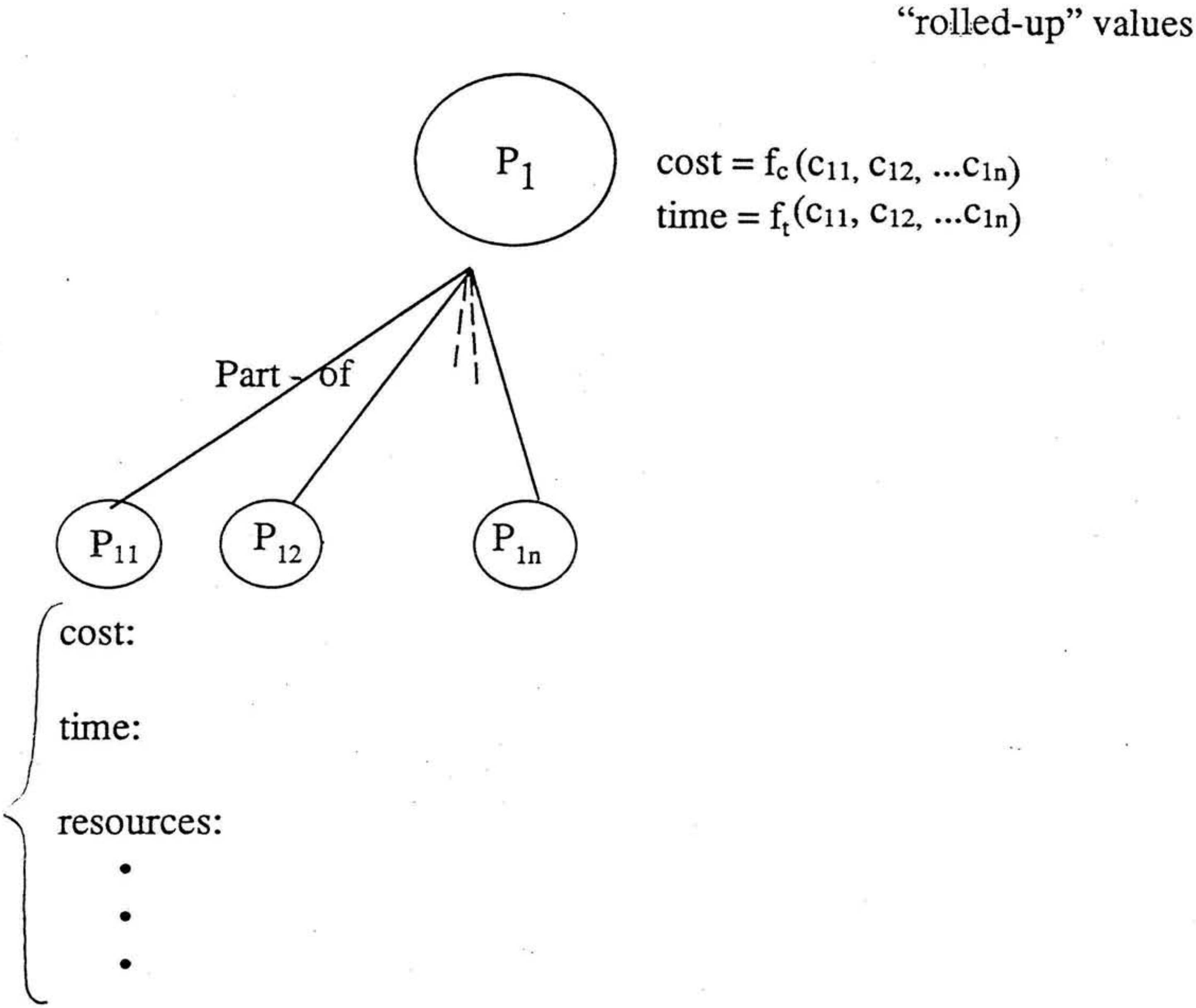


Process attributes:

- resources used $(\bar{x}_r \pm n\,\sigma_{\bar{x}_r})$
- processing time/rate
- cost (this is a function defined over other, resource objects)
- stability
-
-
-

Figure 3

AGGREGATED PROCESS



the attribute value of an aggregated process can be defined as some (arbitrary) function of the attributes of its lower level processes

Figure 4

Taxonomy of BSP (Process) Objects

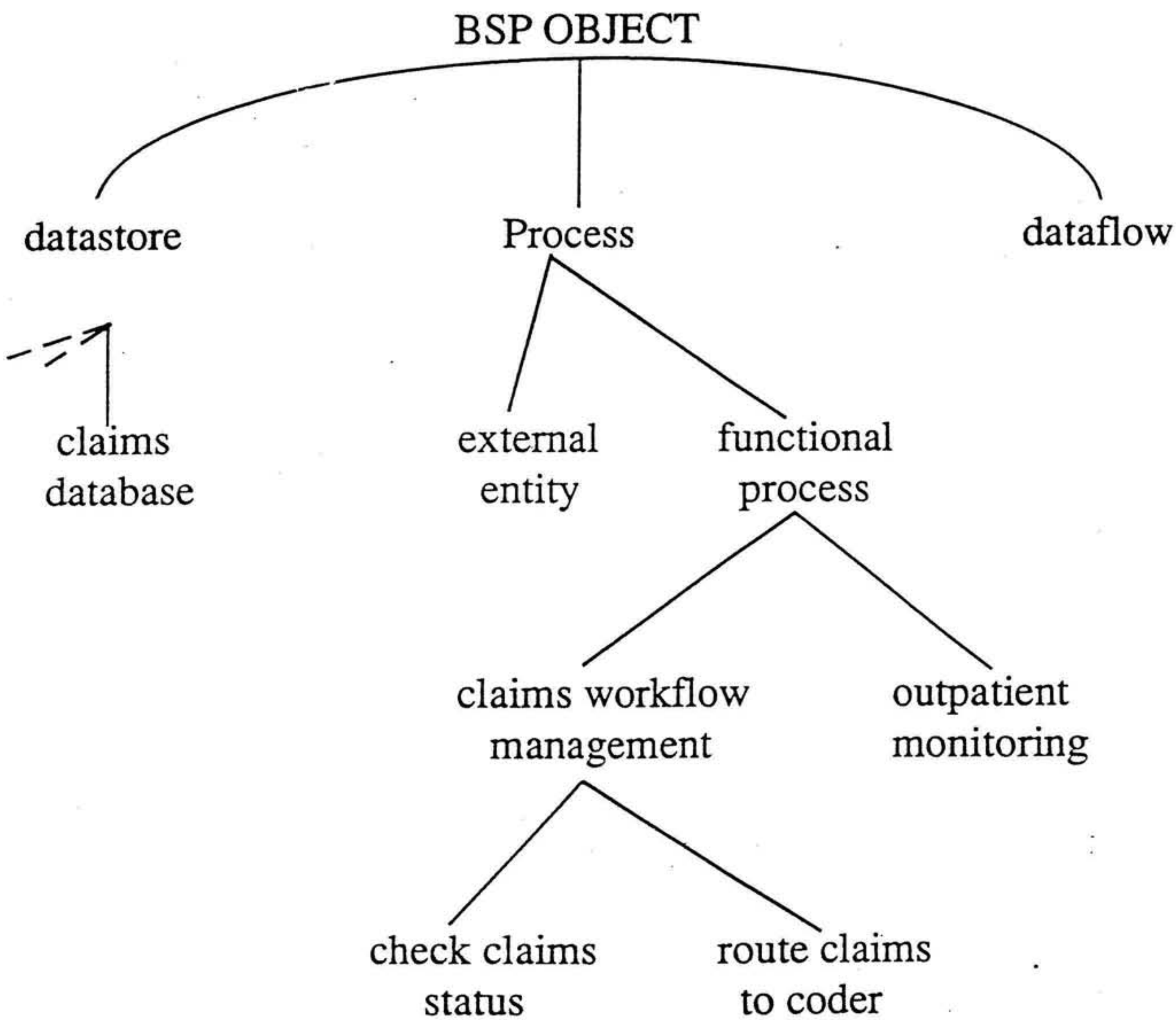


Figure 5

Taxonomy of Resource Objects

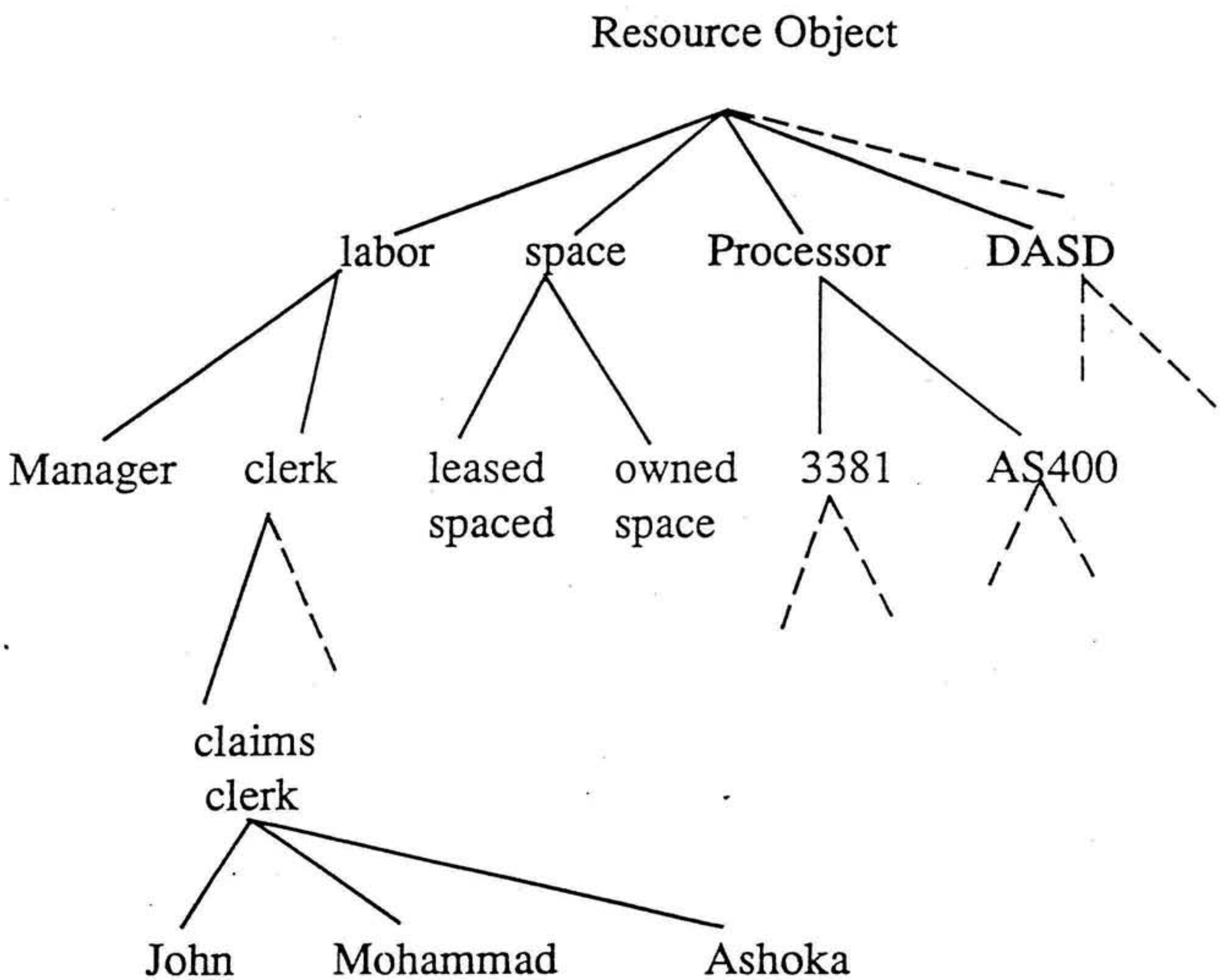


Figure 6

8 How exactly will the model be used?

How Can Impacts of Potential Technology or Process Changes be Analyzed? Conceptually, this problem can be translated into the following: given a specific firm (i.e. its current state of processing, use of information technology), and some "more desirable" state, how can we move to the latter (i.e. by applying technology and/or redesigning processes) and what are the costs/benefits involved? We can assume that there are several **archetypes** corresponding to the more desirable state. Presumably, these archetypes are driven by the differentiated product/service the firm is trying to achieve (such as offering a one day turnaround on cliams to clients) or by cost considerations. At one extreme, one could describe an **ideal** state, but this may require excessive resources to achieve.

We also need to be able to describe the existing state of affairs of a firm. This will also be done in terms of process flow models like those in figures 1 and 2. Once the process flow structure has been specified, attribute values of interest would have to be specified for the lowest level processes; these would then be aggregated as described previously.

The "more desirable" scenarios could be stored in the system, or be specified by the user. It is possible that the scenarios being compared have different structures, thereby posing the problem of how they will be compared. For example, consider figure 7 which shows a segment of claims workflow management (a little different from that of figure 2). In this scenario, the input **unresolved claims**, which is fed from the process **check claims status** is fed to a process called **clerk approval** which might approve a majority of the standard cases, and pass on the unresolved ones to a high level manager (called **manager approval**). This might be contrasted with the a scenario where an expert system manages the cases (figure 7).

How can the two scenarious be compared, particularly since they involve different processing structures? At the next higher level, since they presumably pertain to the same higher level function (in the example above, claims resolution). At the next higher level, the values would be aggregated, permitting a comparison of the two scenarios. In effect, different ways of engineering a business process are compared at the next higher of abstraction. In this way, arbitrarily different ways of organizing a business function can be compared.

COMPARISON OF ALTERNATIVE SCENARIOS

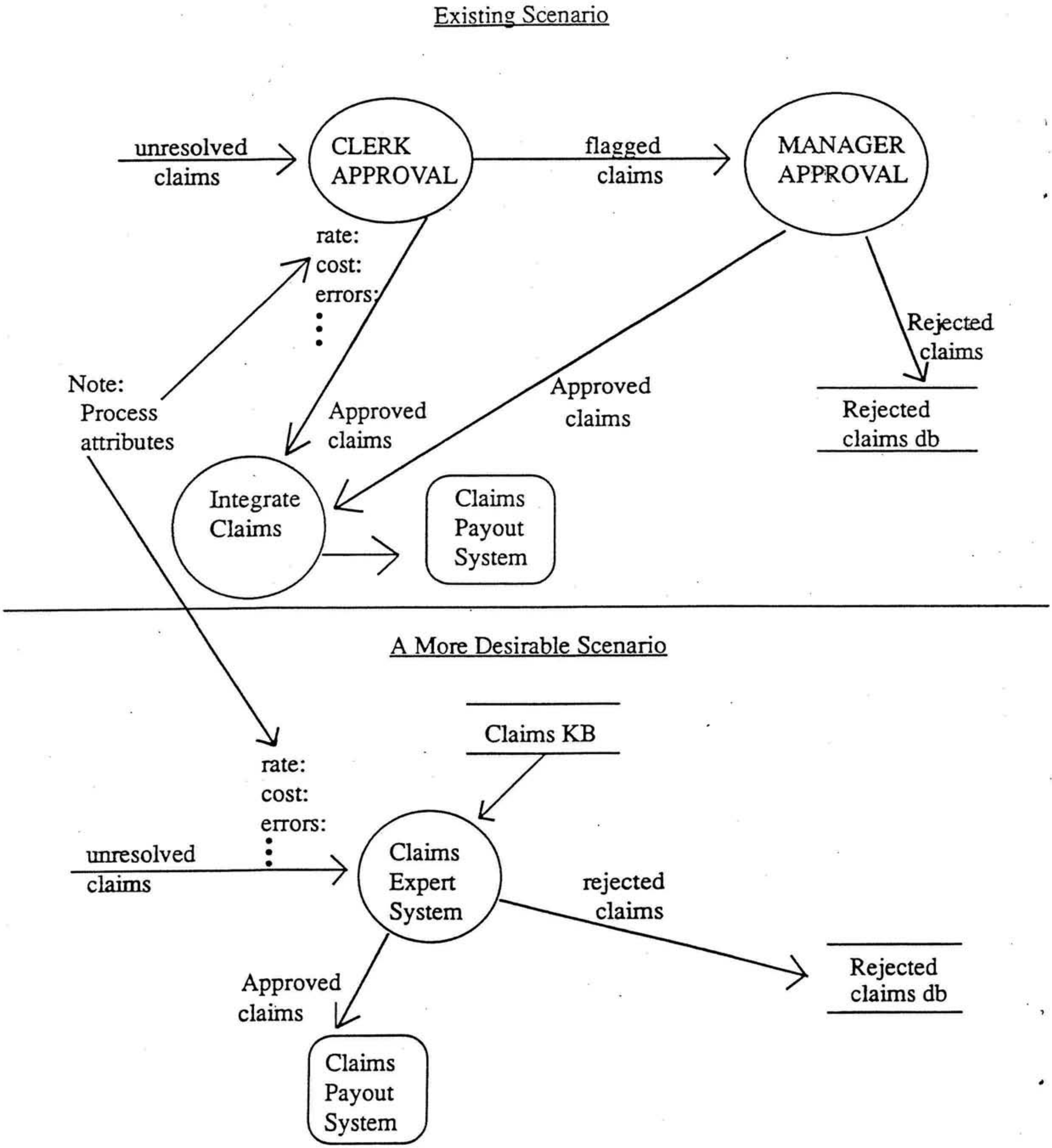


Figure 7

9 The User Interface

It is important that the user interface permit easy perusal of the value chain. Existing scenarios should be easily translatable into process oriented graphs like those in the figures. It should then be possible to click on processes and examine their components and how the values are aggregated. In this way, it should become easy to assess the specific business impacts of technology and process changes.

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