Available online at www.sciencedirect.com
ScienceDirect
ISA Transactions 46 (2007) 437–442
www.elsevier.com/locate/isatrans

The economic valuation of improved process plant decision support technology

Douglas C. White*

Emerson Process Management, Houston, TX, United States

Received 15 December 2005; accepted 18 January 2007
Available online 16 April 2007

Abstract

How can investments that would potentially improve a manufacturing plant's decision process be economically justified? What is the value of "better information," "more flexibility," or "improved integration" and the technologies that provide these effects? Technology investments such as improved process modelling, new real time historians and other databases, "smart" instrumentation, better data analysis and visualization software, and/or improved user interfaces often include these benefits as part of their valuation. How are these "soft" benefits to be converted to a quantitative economic return? Quantification is important if rational management decisions are to be made about the correct amount of money to invest in the technologies, and which technologies to choose among the many available ones. Modelling the plant operational decision cycle – detect, analyse, forecast, choose and implement – provides a basis for this economic quantification. In this paper a new economic model is proposed for estimation of the value of decision support investments based on their effect upon the uncertainty in forecasting plant financial performance. This model leads to quantitative benefit estimates that have a realistic financial basis. An example is presented demonstrating the application of the method.

Keywords: Process plant decision modelling; Decision economics; Technology investment valuation; Information technology benefits; Return on investment; ROI

1. Introduction

More rigorous process models. More sophisticated plant data analysis software and databases. Better system user interfaces with better data visualization. These and other systems oriented technologies are commonly proposed as valuable investments for process manufacturing plants. The proponents for these investments often justify them based on "soft" benefits — "improved information", "better integration", "improved cooperation", and/or "enhanced flexibility". These features are said to improve a plant's "decision process" and so are often called investments in "decision support". Some hardware investments such as upgraded networks and other infrastructure improvements, "smart" instrumentation and new online analysers also use these justifications as well. But how can "soft" be turned into "hard"; how can these benefits be quantified?

The management in a process plant always has limited capital and expense money to allocate. These new decision support applications must compete for available funds with required regulatory and environmental investments, requests for new process equipment, new product developments, and training programs and systems. Which one or ones should be chosen for funding? Any non-mandated investment must produce measurable gains and these gains are compared in the investment evaluation as choices are made on which projects to fund. In addition, how much is it justified to spend on the technology — other than the amount requested by the technology vendor? When is a technology just too expensive?

An issue raised by these types of investments, and a common point of debate/confusion, is that their value is only recognized when an actual decision is implemented. As stated above, what is the value of information or an application that offers the *potential* to improve a decision/plan? The question, again, is how can the concepts of "better decisions", "more flexibility" and/or "better integration" be quantitatively valued? To answer these questions, a realistic estimate of the expected real financial return on these technology investments is needed.

* Tel.: +1 713 529 5980.
E-mail address: dcwhite@att.net.

0019-0578/$ - see front matter
doi:10.1016/j.isatra.2007.01.003

With this estimate rational comparisons can be made with other potential investments.

Modeling the equipment, reactions, and hydraulics in a process industries' plant and evaluating the economically optimum way to operate is relatively common. New investments can then be evaluated by the change in the optimum with and without the investment. It is less common to model how organizations conduct their daily work activities and more specifically how they make decisions. In this paper, the focus is on a particular class of decisions typically made by operations personnel — called the operations decision cycle. Modelling this decision cycle allows us to better understand qualitatively the effect of new technologies and a new approach to quantitatively estimate the expected future value of plant operations with and without the new technology. By comparing these estimates the technology's financial impact can be assessed and a return on investment calculated.

2. Background and previous work

Among decision support applications, attempts to quantitatively estimate the benefits of modern information technology have been popular since the early days of its use. A survey by Berghout [1] identified over sixty distinct approaches to evaluating benefits. Other reviews would be the ones by Thorp [11] and Digrius and Keen [5]. Not all of these commentaries are favourable towards IT investments, most notably the books by Strassman [10] who uses a macro economic approach to analyse their benefits and a recent article by Carr [4] who considers individual corporate competitive factors. Restricting the subject to typical manufacturing information and automation technology, there are fewer previous references on benefits. White [15] discusses these issues further and used an earlier version of the analysis proposed here for evaluating some information technology investments.

Decision modeling has a long and well populated history as well. The reference by Raiffa [8] is considered a thorough modern introduction to the overall subject. One significant area of decision modelling in a plant operations environment has concerned abnormal event responses as noted in the survey recently by Venkatasubramanian et al. [12].

Some decision support investments may result in a direct reduction in operating, overhead and maintenance costs for performing a required business function. For example, a plant data historian and aggregation system may reduce the time required by production staff to retrieve required data for analysis and problem solving. A laboratory information system that connects to and automatically retrieves information from laboratory analysers may reduce the requirement for manual entry of data. If the labor costs for these activities can actually be eliminated or shifted to higher valued activity there will be a net quantitative benefit. In these cases, the financial analysis is straightforward. However, as mentioned previously, many decision support system applications do not have such clear cost reduction effects and are justified on the basis of improved plant operation. How then, is this improved plant operation to be valued?

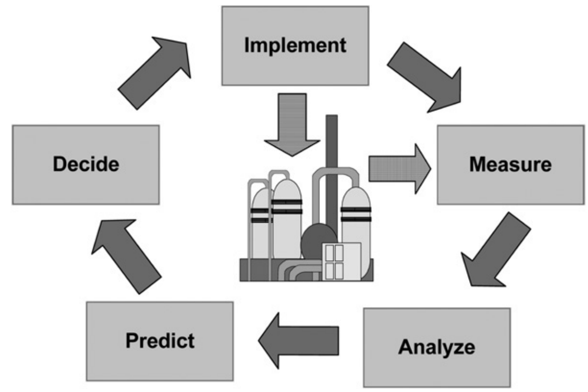

Fig. 1. Operational decision cycle.

3. Operations decision modeling

There are many types of decisions — negotiations to reach agreement on complex issues among multiple parties, choices on how much to bid for an asset one wants to purchase, etc. In this paper the focus will be on operations decisions in process manufacturing environments.

As discussed in a previous paper [13], the cycle, shown as Fig. 1, is a useful model for many operational decisions in a plant such as how many different products and the quantity of each to produce, what and when maintenance should be performed on equipment, and plant production problem troubleshooting.

The initiation of the cycle is the detection of a problem or potential problem, a deviation from plan, or an opportunity for improved operation. The first step is then to *measure* relevant current conditions, either in the plant or the downstream market, or to *detect* changes of state to provide base data and set some bounds on the situation. At this point there is a preliminary definition of the scope of the problem/opportunity and most importantly, how much time is available to develop an answer. Whatever data is available is next *analyzed* to obtain the best possible estimate of the current performance of the plant and its history, to potentially spot an anomaly, to identify the uncertainties and to estimate the cost and time requirements for obtaining more information. This further refines the problem/opportunity statement and the relevant time frames. The outcomes of future alternative action scenarios are forecast. The criteria for *decisions* are developed and a recommended action plan is proposed, including timing. Based on preferences (maybe prejudices) and system constraints, again most particularly time constraints, a plan is actually *implemented*. After this, the cycle repeats.

Note that this is not a universal model for all plant decisions. It is not the way decisions are made on who to promote, who should be designated for working a particular shift and a host of other similar questions, particularly personnel related. It is, however, similar to decision models in other areas where choices must be made to solve an operational problem with time constraints. John Dewey, the well-known educator, used the similar cycle of invention, observation, reflection, and action, to describe learning [9]. The popular