

INTELLIGENT DECISION SUPPORT FOR TECHNOLOGY ASSESSMENT: THE CHEMICAL PROCESS INDUSTRY

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ABSTRACT

This paper describes the concepts behind and the software architecture of a simulation/optimization-based information and decision support system for the management of hazardous substances and their environment-technology interactions. This interactive system is implemented on a microcomputer workstation and combines data base management, system simulation and optimization, interactive data analysis and elements of decision technology with a symbolic display-oriented user interface. Important features of the interface are the use of several parallel or alternative styles of interaction and display, including color graphics and natural language. By combining quantitative methods with qualitative descriptions, and giving the user direct and interactive control over the system's functions, human knowledge is integrated with formal approaches into a man-machine system through an intelligent and easily accessible user interface.

Within this framework, component subsystems for the multi-criteria assessment of chemical technologies at the industry as well as at the plant and process level are discussed in more detail. At the plant level, a prototype application for the production of monochlorobenzene and chlorophenols is described. These examples of production processes in the chemical industry are connected with many highly toxic compounds including 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8 TCDD). These processes serve as an example for the application of the decision support system for technology evaluation and assessment.

Key words:

Model-based Decision Support Systems, Multiple-criteria Decision Making, Management of Hazardous Substances, Industrial Risk.

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1. INTRODUCTION

In the past, technological as well as economic forces dominated the evolution of industrial structures; these factors have been treated extensively in numerous studies. However, another major factor which has begun to have a decisive influence on the performance of the chemical industry is technological risk and public and environmental health considerations, in particular those related to toxic and hazardous substances used in industrial production processes. The issues of controlling process risk, waste streams, and potential environmental consequences of accidental or routine release of hazardous chemicals are rapidly gaining in importance *vis a vis* narrow economic considerations, and are increasingly reflected in national and international legislation.

In the context of several ongoing R & D projects aiming at the development of a new generation of tools for "intelligent" decision support, two related problem areas that have been identified are:

- (i) Structuring the industry or plant for the minimum cost of production as well as least risk – e.g., toxicity of chemicals involved. In this multi-criteria framework, we seek to resolve the conflict between industrial structure or plant design established by economic considerations and the one shaped by environmental concerns. This can be formulated as a *design problem for normal production conditions*. In section 3.1. and 3.2. an approach on how to deal with this problem at the industry and plant level is discussed.
- (ii) Providing software tools which support the *control and management of the production system in exceptional circumstances*. The aim of this type of decision support is to deal with a very complex situation and to provide the user (decision maker) rapidly with efficient alternatives to minimize the environmental and other damage caused by the exceptional situation. This can be understood as the *control or management problem in non-normal production mode* (e.g., runaway reactions, operator error, equipment failure, fire, explosion, etc. For a discussion of types and causes of accidents see Bützer, 1985). In section 3.3. an example of interactive decision support at the operational or plant level is presented.

Section 2 deals with a discussion of concepts of decision support systems (DSS) and their evolution, and we will derive our approach of "intelligent" DSS concentrating on the software and a discussion of its implementation.

2. THE CONCEPT OF "INTELLIGENT" DECISION SUPPORT

2.1. Evolution of Decision Support Systems

Underlying the concept of decision support systems in general, and expert systems in particular, is the recognition that there is a class of (decision) problem situations that are not well understood by the group of people involved. Such problems cannot be properly solved by a single systems analysis effort or a highly structured computerized decision aid (Fick and Sprague, 1980). Due to the mixture of uncertainty in the scientific aspects of the problem, and the subjective and judgmental elements in its socio-political aspects, there is no wholly objective way of finding a best solution.