Chapter XII

Info-Mathics –
The Mathematical Modeling of Information Systems

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ABSTRACT

This chapter reviews Information Systems (IS) modeling techniques, including relational algebra, structured design, architectural design, and Unified Modeling Language. A new technique “info-mathics” (i.e., mathematical description of the hierarchical systems architecture) is defined to secure the system reliability and quality. The classification of IS categories and its attributes such as components, structure, relationships, system level, system product, system deepness, system width, system list, system end, and other are presented. Examples of the mathematical notations are provided and their meaning for the practical implications of info-mathics in system analysis and design are indicated.

INTRODUCTION

The design of IS evolves from the art towards engineering as systems evolve from simple to more complex. The introduction of relational databases triggered the application of relational algebra (Merrett, 1984). Its application is limited to the database design. The structured design of systems, introduced in the 1980s, was a step forward after structured programming was offered in the 1970s (Kowal, 1988). However, this approach is applied mostly at the very low system level of data flow diagrams and, is used mostly
in file updating or transaction processing. The architectural system design was a step beyond Data Flow Diagrams (DFD) and aimed at the large scale-system (Targowski 1990).

**BACKGROUND**

The recent trend in system design emphasizes a technique called Unified Modeling Language (UML) (Siau & Halpin 2001). It is aimed at the design of object-oriented software at the level of programming. To design higher-level application systems it is necessary to apply similar techniques as have been applied in mechanical or civil engineering, where the main product solution is based on a Bill of Material Processor (BOMP). BOMP lists product components and indicates their assembling sequences (Pawlak, 1969). This study presents a mathematical modeling of application information systems leading to the development of a Bill of Systems Processor (BOSP). This is a step for transforming the art of system design into information engineering.

**GRAPHIC MODEL OF A HIERARCHICAL INFORMATION SYSTEM**

As an example of an information system, we will analyze an Hierarchical Management Information System (MIS) which is composed of only three systems:

- **Enterprise Information Portal (EIP).**
- **Enterprise Performance Management (EPM).**
- **Data Mining System (DMS).**

at the following management levels (Figure 1):

- **The headquarters level (ex.: General Motors Corporation):**

  \[ \text{HMIS}^c = \{(\text{EIP}^c, \text{EPM}^c, \text{DMS}^c), R^c\} \]

  Where \( R \) – structure of relationships among systems

- **The group level (ex.: Buick-Oldsmobile-Cadillac):**

  \[ \text{GMIS}^g = \{(\text{EIP}^g, \text{EPM}^g, \text{DMS}^g), R^g\} \]

- **The plant level (ex.: Cadillac):**

  \[ \text{PMISP} = \{(\text{EIP}^p, \text{EPM}^p), R^p\} \]

In the current IS practice, the graphic modeling (also called the architectural planning), is the only technique applied. However, in more complex IT environments this technique is limited. Graphical modeling in sciences is a superior technique versus the scenario technique, but is an inferior technique to mathematical modeling.

We attempt generalizing an IS definition by applying the mathematical technique.
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