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インフォメーション・エンジニアリングと その支援ツールADW[1]の適用について

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インフォメーション・エンジニアリング（ＩＥ）とＡＤＷ（Ａｐｐｌｉｃａｔｉｏｎ Ｄｅｖｅｌｏｐｍｅｎｔ Ｗｏｒｋｓｔａｔｉｏｎ）は、それぞれ企業又はそれより小規模の情報システム構築手法とその支援統合ＣＡＳＥツールである。これらは，８０年代始めに研究開発された構造化分析／設計（ＳＡ／ＳＤ）と１９９０年代に提案されているオブジェクト指向分析／設計（ＯＯＡ／ＯＯＤ）の丁度合間の１９８０年代の中期～後期に開発されているが、その萌芽は１９７０年代後半のＩＢＭ社の考えたＢＳＰ（ビジネスシステムプランニング）手法にあり特にビジネスシステム構築について決して中間的はないユニークな手法を提案している。この論文では、ビジネス支援情報システム構築計画開発に関するＩＥ方法論の次の支援：

- ◆ゴール指向プランニング分析（要求分析）
- ◆企業情報システムの大構造の導出
- ◆企業の重要課題と開発投資効果を考慮した段階的順次実現

の概略と他方法論（特にオブジェクト指向分析／設計方法論）とその支援ＣＡＳＥツールとの基本的相違を述べる。更に、その様にして得られる情報システムの最上位レベルシステム構造とデータベースとその処理に関する分散システムの最適解計画情報が得られる事を示す。

On Applicability of Information Engineering and ADW[1] (Application Development Workstation)

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The Information Engineering and the supporting tool: Application Development Workbench (ADW) are overviewed and evaluated from the applicability view points. Although the concepts were developed during time period between 70's and 90's of Structured Analysis / Design and Object-Oriented Analysis / Design respectively, they are unique and not ones to bridge the other methodologies. Actually, the original IE idea began in late 70s as the name called BSP (Business System Planning) developed at IBM during late 70s.

This paper describes the (system) planning analysis, how IE is used in developing enterprise level information systems. Particularly the following unique supports are recognized: 1) Goal oriented business planning analysis, 2) First (high) level structure of enterprise information systems, and 3) Exact sequence of application subsystems to be developed. In addition, a simple small case study is presented to see the effectiveness of IE and ADW.

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1 ADW is a trade mark of Knowledgeware Inc..

2 Student of Japan-Mexico Exchange Program run at Kanazawa Institute of Technology during May-November 1995 Supported by Japan International Co-operation Agency (JICA).

Introduction

This paper describes overview and application of Information Engineering (IE) and Application Development Workstation (ADW), integrated methodology and the supporting CASE tool, for developing enterprise information systems. Although the concepts support wide scope of development activities, we concentrate on the planning analysis phase, and overview the following:

- Goal oriented planning analysis
- Finding the top level structure of enterprise information systems supporting the goals

where "goals", "critical success factors"(CSF), and "problems" are introduced, recognized and understood *commonly* over enterprise organizations as input for the analysis. To understand these first two topics more clearly, a case study was done assuming a small hypothetical company called Gameco, and the preliminary result is also presented.

It is clear that if planning analysis involves only end-users or consider enterprise's goals or objectives independently, the analysis result will not support regarding to the enterprise's ultimate goals which must be achieved. Therefore, goals need to be collected and understood enterprise widely. On such goals, the information system analysis can be accomplished.

IE's planning analysis approach

IE consists following components:

- System Planning for revealing essential set of information, business functions and the information system subsystems required to follow enterprise-level goals and strategies
- System Analysis for finding data and process models for business functions and/or subsystem,
- System Designing for defining databases, screens, transaction program structures etc..
- System Construction for generating code from the design

As does other methodologies, the enterprise level structures of (business) functions and organizations are specified using

- Decomposition diagrams showing current or new organizations, business functions, relevant locations etc. (each node shows a function or organization unit and linked each other showing hierarchical structure,
- Association matrices showing association or relevance between any two fundamental parameters. For example, the association matrix of organization units and functions shows that which organization unit is responsible for functions.

IE methodology introduces unique information such as "goal"s, "problem"s, "critical success factor"s (CSFs), "technology impact"s etc., collected over enterprise organizations. CSFs are actions, controls, processes etc. needed to achieve the goals. Since they can be listed in the order of the importance rating (ranking) given after the enterprise level justification, it is possible to select (keep or filter out) more important sets of goals, problems, CSFs, functions, entitiy-types, etc. in such a way that the sets support each other as more important sets of goals, CSFs, problems etc..

It is noted that the association matrix between functions and entity-type sets (data subjects) is one of the key results obtained by the planning analysis. This matrix has marks in matrix elements if the element's function and data subjects are relevant. Further more, if the matrix shows clustered marks in a rectangular box, such clusters may be defined as an application subsystem respectively. The matrix *also suggests* the first possible view of distributing the subsystems over multiple processing nodes (systems) connected communication channels, because the matrix shows the cross reference of data subjects and functions across the subsystems .

The general processes of the planning analysis may be described as follows:

- ◆Create the structures of enterprise-level organizational and functions and entity-types and the relationship diagrams
- ◆Analysis on goals, problems, CSFs and Technology Impacts
- ◆Find key sets of goals, problems, CSFs, entity-types(data subjects), functions (filtering)
- ◆derive data subjects and proper functions and the proper association matrix
- ◆define possible application subsystems

A Case Study - Gameco: a small company

The outline of a simple case study on the IE application is described. Although the analysis has not reached to a complete level, this case study is useful to see how IE and ADW work to help planning analysis. The goals of this study is to find all application subsystems and to define the exact order of the identified application subsystem to be developed.

"Gameco" is a hypothetical small company of 50 employees who market and distribute game products such as Virtual Flight, Unmortal Combat, VR Star Trek etc.. The organization and the functional structures are analyzed and described using the decomposition diagrammer tool provided by ADW (the figures are not shown in the paper although).

The six goals are selected and shown as follows: Increase Profitability in 15% (99), Remain leader on Customer Satisfaction (99), Increase Sales in 20% (90), Maintain Quality Reputation (85), Expand Product Lines (80), and Increase Market Penetration (80). The numbers shown in ( ) are the ranking (importance rating) respectively.

Critical success factors can be functions, actions, controls etc. which are needed to achieve the goals. In our case, five CSFs (Market Acceptance (95), Obtain Experienced Staffs (80), Control Expense (75), Products meet User Requirements (65), Increased Growth (60)) are selected. **Figure-1** shows the associations of the goals and the CSFs. A mark indicated the row (goal) and column (CSF) are relevant each other, i.e., the goal is supported by columns (CSFs) with mark. Less important CSF does not have marked to any goal and can be dropped (eliminated) from the matrix.

Assuming that Gameco functions have been identified, **Figure 2 and 3** show the function associations with the goals and CSFs respectively and tell you which functions support which goals and / or CSFs, even when you listed too many ones during the analysis. If a row (function) is not marked to any column (goal or CSF), it can be ignored or may be eliminated as needed or while desirable.

Figure 4 shows entity-type relationship diagram (ER diagram). One ER diagram (local ER diagram) is derived for each business function listed in the above. It is noted that the system level ER diagram (the global ER diagram) is the collection of all such local ER diagrams, where an entity type is "person", "thing" (product etc. which is visible or not visible), etc..

Figure 5 shows the association matrix using different marks: i.e., the symbols "C", "U" ,"R" and "D" indicating that the function does the operation of "create", "update", "read", or "delete" to the database respectively.

A function row has "CURD" symbols one or more to entity-type columns in the matrix. An entity-type column has also one or more symbols to function rows conversely. However, you may easily find randomly located symbols over the matrix. This is because of the randomly ordered function columns and entity-types rows. We make the matrix simple and meaningful more by applying the next two processes:

- Order the functions in the business process sequence (Ordering)
- Aggregate strongly associated entity-types / functions to larger ones by making columns / rows moved left and right / up and down (Aggregation)
- Decompose functions / entity-types if there exists *interference* among different function and entity-type sets (Decomposition)

Figure 6 is an updated version for the functions and data subjects. Compared to the previous version, you recognize that the new matrix shows less number of "CU(R)D"s aligned diagonally. This property leads that the functions and the data subjects are associated in much less interference.

Figure 7 shows a set of possible subsystems derived using the cleaned matrix shown in Figure 6. A subsystem with functions and data subjects is specified by a rectangular box (primarily) enclosing "CUD" symbols. The boxes must be mutually exclusive (not overlapped) each other. This big picture should support the enterprise goals and the detailed system analysis and design will be following in the following phases.

It is noted that the interfaces among the defined subsystems are transactions (messages). A subsystem needs to send to the service subsystem a transaction for kicking the desired functions to access the associated databases. This suggests that how subsystems can be distributed over different nodes if the transaction traffic ratios are given.

Roles of IE / ADW to Object-Oriented Analysis

Currently there are many OOA methods proposed but they do not use the information of "goals", "problems", or "CSFs" etc. in the analysis, since the methods start with the task of identifying objects and their relationships of "is-a" and "has" types and then of creating the object diagram or object scheme. The OOA methods suggest to define application subsystems by segmenting the object schema or object diagram. However, no segmentation rules are provided..

Therefore the approaches may not provide rules on what object types and message processing functions must be included in the designated also on how to find subsystem boundaries in the object diagram.

It is noted that higher level management or end-users of the information systems to be developed may not be able to understand the analysis results from the view points of "what the system should do for you". This situation is similar to the case that database designers or experts who do not know enterprise level of "goals" or "application functions" (business rules) try to come up with the enterprise level database schemes. In this sense, the OOA approaches will need to be integrated with IE's planning analysis approach.

Summary

We overviewed IE's planning analysis and the fundamental mechanism to derive enterprise level functions and data subjects. Since the process directly requires the information on goals, problems, critical success factors etc. at the enterprise level, the resultant functions and databases should work in supporting the goals and resolving the problems.
However, quantitative analysis will be needed in identifying CSFs, functions, entity-types etc.. Accordingly, such information systems will be understood and used easily by higher level

management and the end-users who do actual operations in their fields.

The object-oriented approaches proposed by many authors may lack analysis process to introduce the information on goals, problems, critical success factors etc.. Still the analysts who may not know business environment or enterprise business rules very well are required to make decisions on what object types and functions i.e., classes and messages / methods ones are to be added to information systems.

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	Market Accept. of GAMECO Centru	Obtain/Retain Experienced People	Control Expense / Revenue Ratio	Product Meets User Requirements	Manage Increased Growth
Increase profitability in 15%			✓	✓	
Remain Leader on Customer Satisf		✓		✓	
Increase Sales in 20%	✓			✓	✓
Maintain Quality Reputation				✓	
Expand Product Line	✓		✓		
Increase Market Penetration	✓	✓			

Figure-1 Association between Goals (row) and CSFs (column) To find more detailed association, the decomposition, aggregation and dependency analysis (fish born structure analysis) can be applied.

	GAMECO GOALS	Increase Market Penetration	Maintain Quality Reputation	Increase profitability	Remain Leader on Customer Satf	Expand Product Line	Increase Sales
Requirements				✓			
Inventory Control							
Invoicing							
Auditing							
Budgets							
Legal							
Payroll							
Training			✓				
Personnel							
Public Relations							
Sales Analysis							
Selling		✓		✓			✓
Customer Service			✓		✓		✓
Distribution Network		✓	✓	✓	✓		✓
Market Research		✓		✓	✓	✓	✓
Advertising		✓		✓	✓	✓	✓
Pricing		✓		✓	✓		✓
Purchasing			✓	✓		✓	
GAMECO Functions							
Selling Functions				✓	✓		✓
Marketing Functions		✓		✓	✓	✓	✓
Acquisition Functions				✓			
Finance							
H.R. Functions							
Accounting							

Figure-2: Association between functions and goals. Rows with no marks may be considered less important functions. On the other hand, columns with no mark means missing functions to support the goals.

	Control Expense / Revenue Ratio	Product Meets User Requirements	Obtain/Retain Experienced People	Market Accept. of GAMECO Centru	Manage Increased Growth	[illegible]
Requirements	✓					
Inventory Control						
Invoicing						
Auditing						
Budgets	✓					
Legal						
Payroll						
Trainning					✓	
Personnel			✓			
Public Relations			✓		✓	
Sales Analysis	✓					
Selling	✓					
Customer Service	✓	✓				
Distribution Network	✓					
Market Research		✓		✓		
Advertising						
Pricing		✓		✓		
Purchasing	✓					
GAMECO Functions		✓				
Selling Functions	✓	✓				
Marketing Functions				✓		
Acquisition Functions						
Finance	✓					
H.R. Functions						
Accounting						

Figure-3: Association between functions and CSFs. Rows with no marks may be considered less important functions. On the other hand, columns with no mark means missing functions to support the critical success factors.

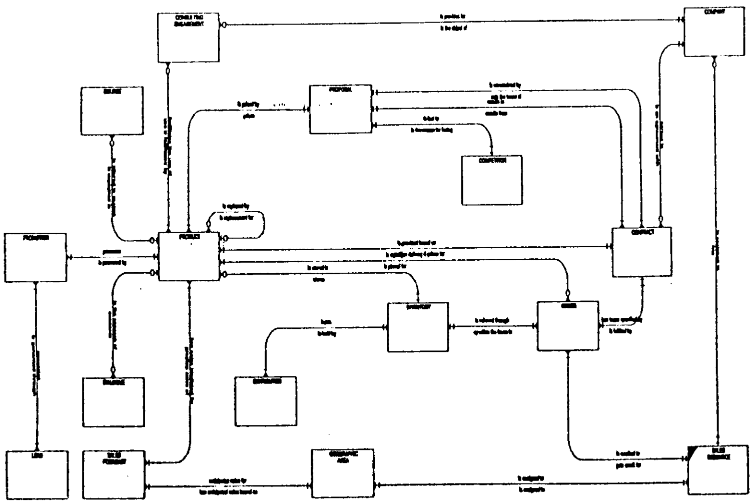


Figure-4: Entity-Type Relationship Diagram.

Each box represents a entity-type and a link line between boxes shows the relationships (bi-directional). Entity-types are "observable" units which states (values) can be measured and the relationships are "general functions or mappings" between them.

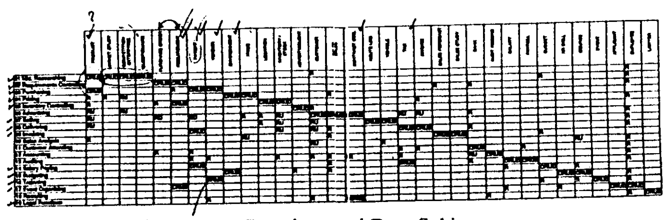


Figure-5: Association matrix between Functions and Data Subjects.

The row / column are the functions / entity-types respectively. "CURD" symbols indicate create, update, read, delete information units (records) which lifecycles are easily traced.

Figure-6: Normalized association between Functions and Data Subjects. The first data subject shown in Figure-5 is decomposed into two data subject, which eliminated the CUD symbols specified in the third row of the previous matrix. Several aggregation and decomposition would be possibly applied.

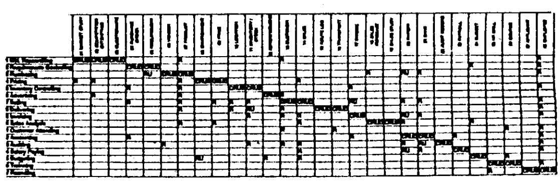
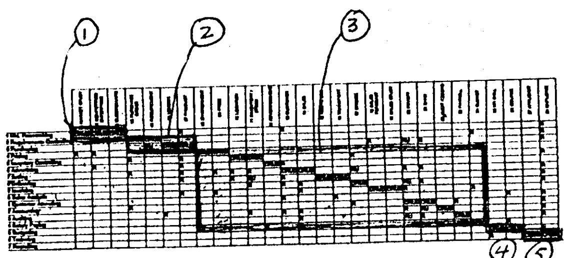


Figure-7: Application Subsystems identified. Each rectangular box represents a subsystem which includes the functions and data subjects (databases). The detailed database schemes and functions will be fixed in the following phases, system analysis and system design.



1:Market Study, 2:Product Planning, 3: Marketting Support, 4: Education, 5:Recruiting