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# Phased Development Strategy for Complex Expert Systems: A Shipbuilding Scheduling Case

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## ABSTRACT

Three phased development approach is proposed to handle the development of complex systems. The three phases are vision revelation, data dependent realization, and prospective enhancement. The vision revelation phase pursues ideal design and corresponding data requirement. The data dependent realization phase studies the data availability and degrades the ideal design to realize a data dependent version. The prospective enhancement phase guides the data collection systems toward the targeted design and enhances the system gradually as the data become available. This approach is effectively adopted to the develoment of complex scheduling expert systems for Daewoo Shipbuilding.

## 1. INTRODUCTION

There have been three typical system development methodologies: systems development life cycle(SDLC), prototyping, and mixed approaches. The classical SDLC approach linearly follows through the following activities (Senn 1989) :

1) Preliminary Investigation
2) Determination of System Requirements
3) Design of System
4) Development of Software
5) System Testing
6) Implementation and Evaluation

The SDLC is appropriate when there exists little uncertainty like transaction processing systems. When there exists a high uncertainty, incremental enhancement via prototyping is an economical, perhaps the only choice we can take (Naumann and Jenkins 1982, Alavi 1984). When the usage stage of prototypes can eliminate uncertainty in the user requirements, the mixed approach can be adopted(Burns and Dennis 1985). According to the mixed approach, there are two steps. The first step adopts the prototyping approach to clarify user requirements. Once the requirements can be clearly defined, the SDLC approach is adopted if the scale of problem is too big to be handled without some structured methodologies (Yourdon 1986).

We propose Three Phased Approach as a variant of mixed approach, which was experienced while developing a set of very complex scheduling expert systems for shipbuilding. In this approach, we consider not only user requirements, but also data availability. Although this approach is applied to expert systems development, it should also be applicable to a wide range of decision support systems developments.

The phased approach has the following three phases as depicted in Figure 1 :

1) Vision Revelation Phase
2) Data Dependent Realization Phase
3) Prospective Enhancement Phase

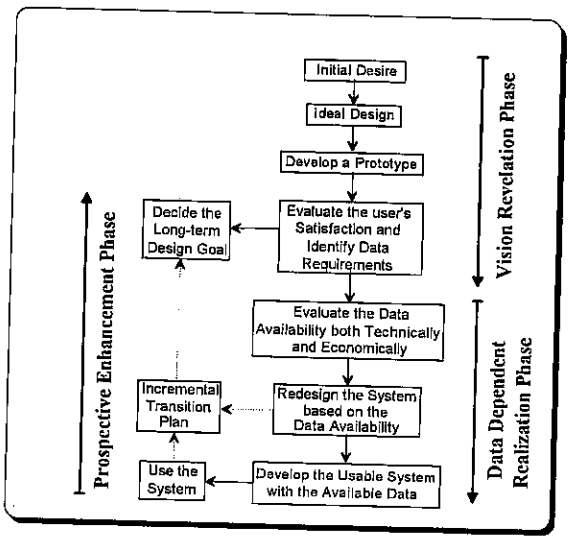


Figure 1. Three Phased Development Methodology

## 2. PHASE I : VISION REVELATION

The characteristics when the adoption of phased approach is appropriate are the followings.

1) Users and managers should have a strong desire for solving the problem although they do not know how to achieve it. To be like this, the effect of successful implementation should be strategical critical to the company. Bitter experience of failures with the other packages may be necessary to seek a fundamental research to solve the problem. Nevertheless, they cannot set a specific development target because they do not exactly know the benefits of alternative approaches, necessary investments, data requirements and data availability.
2) There should exists a reliable and competent leader who can initiate the project with a strong commitment. The leader should be lucky enough to find a professional group like professors or consultants who can envision the problem solving methods and can persuade the users and management.

### Daewoo Shipbuilding Case

1) Background

Daewoo shipbuilding is the second largest shipbuilder in Korea. Scheduling the erection of blocks at docks and the assembling blocks at the indoor shops has been a nightmare. Poor scheduling keeps workers awaiting for the prerequisite subassemblies; causes fluctuation of work loads resulting in expensive overtime works; causes delay in delivery. These problems are not new to the management at all. However, management does not have solution for these problems.

Daewoo has attempted many project management softwares like PERT packages. But the specific problem at Daewoo was not solved at all, because the schedule should balance the workloads between docks and indoor shops. Besides, the spatial resources with material handling equipments like cranes are bottlenecked resources. No software could support the dynamic spatial layout yet. The spatial scheduling is especially important at the indoor shops with the pinned work plates to place curve-bottomed blocks.

2) Is expert system a solution?

Middle managers in the MIS division have heard that the expert system is an intelligent and flexible software. But they do not know exactly what the expert system can do for Daewoo. However, they had belief that the researchers in Intelligent Information Systems Laboratory at KAIST(Korea Advanced Institute of Science and Technology) can develop something good for them, because the IIS Laboratory has accumulated many experiences on industrial problems with a high reputation. There is no guarantee that the IIS team can solve the problem, however, there is definitely no other better choice.

3) Invitation of KAIST team

Director of IIS Lab, professor Lee, was invited to do something for Daewoo. Lee has prepared an initial draft what he think Daewoo should pursue. It was fascinating, but management was not sure whether it can be fulfilled. However, Lee seems the only hope who can deliver such expert systems for them whatever the expert systems are. Obviously, managers major concern is not the expert systems per se, but a big profit.

4) Ideal Design and Prototyping

Lee has persuaded that the project named DAS(Lee et al. 1992) is not a mere system developmen, but needs a theoretical research on the following issues.

- Constraint-directed graph search for erection scheduling considering the work loads at the preceding indoor shops.
- Spatial scheduling
- Line balancing with flexible process planning
- Processing time estimation using neural network
- Interface and coordination among multiple expert systems and relational databases

These issues are explored during 1991, and prototypes of following systems are developed using the tool UNIK(Unified Knowledge) on SUNSparc workstations. All data are stored in frames in UNIK-FRAME.

**DAS-ERECT**: Erection scheduling based on graph search and partially forward chaining rules. So the search system is uniquely developed (Lee and Choi 1993)

**DAS-CURVE**: Theories for spatial scheduling is developed along with the prototype. The system is a totally new one (Lee and Lee 1992).

**DAS-PANEL**: Line balancing using the forward chaining rules.

**DAS-MH**: Man-hour and processing time requirements are estimated using neural networks. The neural network outperformed the expert's judgments and regression analysis.

**DAS-**: Coordination between frames in the expert systems and DBASE files are accomplished.

These systems could successfully demonstrate the vision, although the prototypes could not provide satisfactory speed.

## 3. PHASE II: DATA DEPENDENT REALIZATION

The steps in the data dependent realization phase are as follows :

1) The ideal system in phase I is developed regardless the data requirement.
2) Evaluate whether supporting the required data is technically possible and economically feasible.
3) Determine the currently supportable data.
4) Downgrade the sophistication level of ideal system's design considering the data availability.
5) Propose the data collection system for the future.

### Daewoo Shipbuilding Case

1) Check the Data Availability

Daewoo peoples were frustrated because the current data system could not support the phase I design. However, it was a good checking point of identifying which data were available and which were not. This process required a close communication with design division, because the phase I design requested to generate design specification from the CAD tools. The specifications could be used to automate process planning and man-hour estimation. These data could not be provided until the current CAD system is upgraded to solid modeler which was not technically feasible at that point. The other data that could not be supported were erection sequence dependent man-hour and processing time requirements.

2) Data Dependent Design

Considering the data availability, the phase I designs were degraded as follows :

**DAS-ERECT**: Generate search space within the supportable man-hour and processing estimations
**DAS-CURVE**: No Change
**DAS-PANEL**: Do not include the rules that seek the best process plans
**DAS-MH**: No Change
**DAS-X** : No Change

Management became very happy because the systems could run based on the current data although they were not ideally good. Phase II system were developed using C version of UNIK to enhance operational speeds. The systems were installed in the fields at 1992 and took tests under the real world situation.

## 4. PHASE III : PROSPECTIVE ENHANCEMENT

The characteristics at the prospective enhancement phase are as follows :

1) During the prospective enhancement phase, the current version will be incrementally enhanced as the prototyping approach does. However, a difference is that the enhancement is oriented toward the target set at the end of phase I.
2) The major enhancement will be realized as the necessary data become collectable. Thus data collection system should be prepared accordingly.
3) Enhance the current version gradually as the data become supportable.

### Daewoo Shipbuilding Case

1) Preparation of Data Collection System

To achieve the ideal design eventually, projects which experiment the data collection from the solid modeling CAD tools and the automation of the process planning are contracted. The success of these projects may take time, however the initial vision will guide the evolution of data collection system.

2) Data Dependent Gradual Enhancement

As the data become available, the system will be enhanced that far in future.

## 5. CONCLUSION

Three phased development approach is proposed with an example of complex scheduling systems in Daewoo Shipbuilding. The approach focuses on the data requirement generation, data dependent system realization and enhancement, and guidance to data collection system. This approach should be applicable to may complex system developments

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