Corporate Reengineering for MRPII Implementation: Via a Hierarchical Modelling Approach

Jimmy S. F. Chan[1], K. Y. Chau[2], and Y. K Chan[3]

[1] Engineering Mechanics, Materials and Design, School of Science and Technology, The Open University of Hong Kong, Hong Kong SAR

[2] Timax Electronics and Machinery Co., Hong Kong SAR

[3] Six Sigma Institute, Hong Kong

Abstract

Manufacturing Resources Planning (MRPII) is one kind of manufacturing information system that can help manufacturing companies gain competitive advantages. It is estimated that more than one hundred MRPII systems are available in the market, many of them are mature enough to solve most operational issues in accordance with users' requirements. More often than not, many of these systems provide more functions than a company expects. Manufacturing companies worldwide have attempted to implement these MRPII systems, however, many companies experienced failure (Turbide, 1996) due to managerial rather than technical issues. The authors propose an approach utilising a roadmap to integrate BPR and the MRPII implementation in order to overcome this difficulty. A detail road map is developed to guide this implementation, which is designed using a hierarchical analysis technique known as Integrated DEFinition Method (IDEF). IDEF is a systematic manufacturing management and integration-modeling tool. The proposed approach is implemented and illustrated using a reference company and the results indicated that 66% reduction in errors for maintaining the bills of materials system; 99% reduction in time to carry out material requirement planning; and 70% reduction in time previously taken for non-productive discussions.

Key Words: Business Process Re-engineering (BPR), Manufacturing Resource Planning (MRPII), Integrated DEFinition Method (IDEF0)

1. Introduction

With increasing international trade and opening of global markets, customers have a wider choice of products and services from around the world. In addition, companies are faced with severe competition among competitors and increasing demand of product variety, shorter production and delivery lead-time from their customers. This situation is further execrabated when the speed of information flow is significantly increased through the advanced information and computer technology which bring customers and suppliers in very close contact. In order to satisfy customer requirements, companies have implemented various techniques and systems, such as Business Process Reengineering (BPR) and Manufacturing Resource Planning (MRPII) are two notable methodologies. MRPII is the second generation development of Material Requirements Planning (MRP), initially proposed by Orlicky (1975). MRP determines the necessary components and materials required for producing a product; plans for optimal inventory level and optimises the production activities. MRP was developed to include other components in the manufacturing system, including capacity planning, financial control, purchasing and quality control functions. MRP was further developed to include the feedback of information such as capacity analysis, vendors' orders and delivery performance which enabled manufacturing firms to manage their material inventory and production schedules through an integrated information system. MRP has been evolved to a system known as MRPII which incorporates various other business functions into the system. It is not difficult to find a manufacturing company adopting MRPII as its vehicle to improve its manufacturing operations. Many software and hardware vendors have developed MRPII products, some of the popular ones are SAP, BPICS, JD Edwards, Oracle manufacturing, Baan and MFG/PRO (Landvater, 1992; Kappelhoff, 1997).

In general, MRPII functions can be grouped into three macro elements, namely Top Management Planning, Operation Planning and Execution (Yung et al., 1998). Figure 1 shows the framework of MRPII built up by these macro elements.

The theory of MRPII has been well discussed in many literatures with focus normally put on concept, methodology, application and future development of MRP. For instance, Luscombe (1993) and Plossl (1994) discussed the detail MRP mechanisms. Specific MRPII design can be found in Correll and Edson (1990) and Van Veen (1992). Wallace (1990) and Wight (1981) discussed on various issues of implementation management. There are however many reports of failure of MRPII. Some research study, such as Ang et al., 1994, Lau and Ip (1993), Turbide (1996) showed that few manufacturers were able to successfully implement MRP with many problems encountered during implementation. These problems are mainly concerned with incorrect implementation management. Various attempts have been made to overcome these problems. Wight (1981) proposed a check-list system to evaluate the likelihood of successful MRPII implementation for companies in the process of implementing. White et al. (1982), Cox and Clark (1984) and Burns and Turnipseed (1991) have identified critical success factors associated with the success of MRPII implementation. People, education and training are major problem areas associated with MRPII implementation. Thus, the major obstacle to successful implementation comes from the people side. Top management commitment, clear understanding of mission objectives, involvement and support from all levels of staff in the organisation are crucial factors for success. A study on human variable of MRPII system implementation (Turnipseed et al., 1992) concluded that managers considering or beginning to implement an MRPII system should utilise the classical approach to manage organisational change and involve as many of the affected personnel as possible in

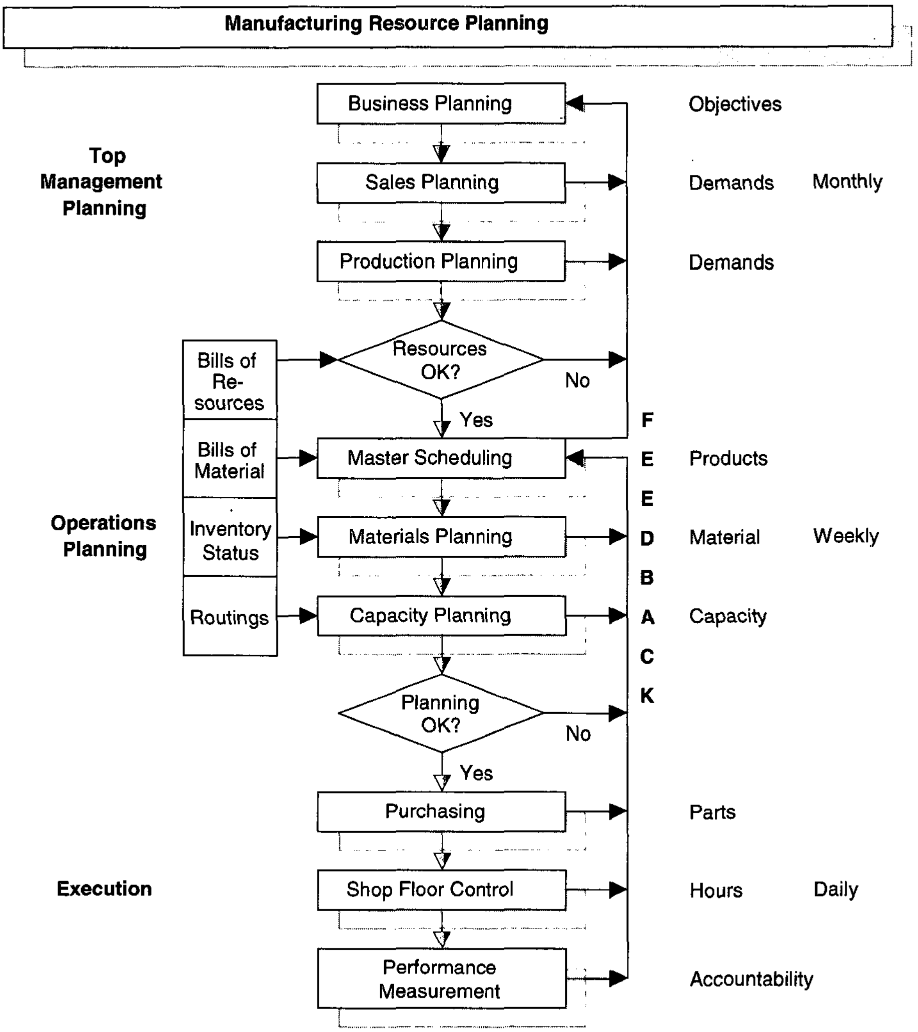

Figure 1. Framework of MRPII System

the brainstorming, planning and implementation stage. Also, the channels of communication should be opened and education the realistic benefit of MRP should be stressed. Involvement provides staff with a sense of belongingness, smooth transition and is a powerful determinant for successful implementation. Education is aimed at providing staff with better understanding of mission objectives and to reduce resistance to change. Training provides affected staff with an opportunity to gain more knowledge about the new system and hence enable them to be mobilised to fit well into new environment. Inadequate participation, education and training will lead to non-conformance to the objective of MRPII implementation.

Having discussed the MRPII and its associated implementation problems, it is emerged that there is a need of radical changes in the way of what we are usually doing work. The Business Process Reengineering (BPR) concept can help to effectively achieve these changes. There are many definitions of BPR, Hammer and Champy (1990) defines BPR as the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measurements of performance, such as cost, quality, service and speed. Malhotra (1998), give a definition on BPR as an approach to planning and controlling changes. It envisaged that BPR involves rethinking of current business processes, redesign and implement new processes, planning and controlling changes. During the rethinking and redesign processes, a series of questioning and evaluation should be employed to derive at new solutions. In BPR, the scope of change is radical and the orientation is towards business processes that may cut across different functions within the organization with a goal of reaching dramatic levels of improvement, for instance, productivity by 80% and overhead cost decreased by 60%. The authors propose a model and a road map for the integration of MRPII and BPR so as to reap the benefits. Their integration is illustrated through a case study of a reference company as elaborated in the following section.

1.1 Company Background

The company has its headquarter in Hong Kong, and operates manufacturing plant in China. These factories specialize in the manufacture of medical devices on contract manufacturing basis, catering to electronics markets in Japan and western countries. The company has employed around 1700 employees in the China plant. In view of the fiercely competitive marketplace, strong emphasis on quality and short lead-time, the company needs to re-design their business strategy. The information system must be changed to provide rapid responsiveness to customer orders, eliminate raw materials and improve production lead-time.

A project group was formed to establish a manufacturing information system as part of the business strategy in 1995. The authors were employed to implement MRPII, and the concept of using BPR to support MRPII was proposed. The aim was to ensure that MRPII would be successful and that the large amount of investment in terms of money and human resource would be justified. The MRPII system would be used for providing the right resources at the right time. The right resource includes raw materials, parts, labour, and facilities. The right time means producing right products to meet the production and delivery dates. BPR would be employed to smooth/simplify the MRPII implementation problems mentioned earlier, enable continuous improvement, ensure teamwork and ascertain culture behaviour changes.

2. A Proposed Integrated Model of MRPII and BPR

MRPII is an information system which enables a company to better manage its resources. The degree of success depends on whether it can overcome the implementation difficulties; management problems, technical problems, and people problems. Management problems centre around poor prior planning and a lack of co-operation among different departments. Technical problems concern system design, master scheduling/capacity planning, database structure and file integrity. People problems include insufficient management support, poor communication, education, and user participation. In order to ensure the successful adoption of the MRPII system, there must be a methodology to guide the organizational changes. BPR is one of the useful philosophies, which emphasizes re-optimisation of the processes and structures within the company. BPR means radical transformation of the systems a company to achieve dramatic improvements. The concept of BPR is addressing cross-functional process and driven by top management, and proving to be the answer to competitiveness and long term survivability for companies (Davenport and Beers, 1995). BPR can therefore lead the company in the desired direction, develop of an organizational structure, identify and link the strategy of the business with the required organization processes to ensure that the strategy is actually allied (Luber, 1995).

A proper integration of BPR and MRPII leads to synergy. They can lead to the success of MRPII implementation and overcome difficulties encountered during implementation. They can work together to increase customer satisfaction, improve delivery schedule, decrease production cycle time, and reduce defective rate. In this case study, the authors proposed a conceptual model for the integration of BPR and MRPII which is aimed to achieve manufacturing excellence. The model blends these two elements with MRPII system acts as the core system based upon which reengineering activities are centred around (see Figure 2). Since MRPII itself is already an integrated (re-engineering) system employing good information technology, the authors based upon this system as the first step towards re-engineering.

With MRPII as an anchoring system, the authors adopted IDEF0 (Winosky, 1987; Hill, 1995) Structured Analysis Technique to model other business activities to support the integrated MRPII system. The result is a reengineered business operation model, with hierarchical levels of activities established around an integrated MRPII. Through the consistent application of the model following the roadmap developed by IDEF0, the company will gradually lead to the successful transformation of the organization from the current state to the desired goal. Figure 2 shows a simple schematic diagram describing the inter-relationship of MRPII and BPR.

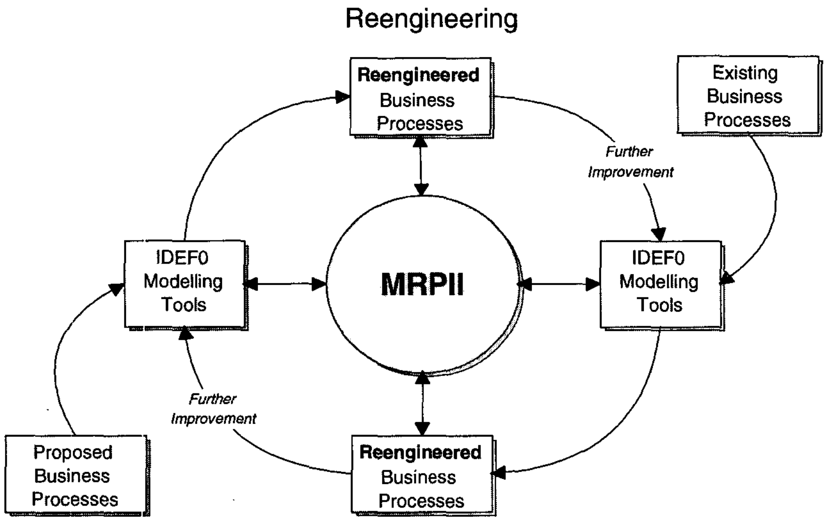

Figure 2. Schematic Diagram of Proposed Methodology

Although BPR is characterized by making drastic changes to the business operations, it is always risky to an on-going company when drastic changes become too drastic, causing detrimental effects to the organization. With the above methodology, we attempt to handle the matter in a modular and regulated manner.

As an illustration to the above point just mentioned, most MRPII software contain the control of BOM (Bill of Materials) in its integrated, electronic mode of functions. No doubt that the management of BOM in an integrated software system is a drastic change (hence an outcome of a reengineering process). However, this is far from being the whole story. Changing from say, a manual BOM management process, to a computer-based BOM module in an MRPII system requires associated changes in other processes within the company in order to cope with the changes. For examples, new forms and/or procedures (form handling procedures, approving procedures, etc.) have to be re-designed. These are equally important than reengineering the core processes. An organization is a complicate entity in which people, processes, structure are constantly in interaction. The success factor rests on how well these factors are coordinated (Nwabueze and Kanji, 1997). If the people-controlled procedure of updating BOM fails, so will the MRPII, and so will the BPR.

3. Hierarchical Design of the Implementation of the BPR & MRPII through IDEF Model

Coloquhoun and Braines (1989) provided an IDEF model for process planning, Hargove (1995) further applied the same approach to the design and planning of machine fixtures. Their success in the application of IDEF in the design and implementation of CAE/CAM problems have motivated our research into this implementation model. IDEF, derived from the US Air is a structured analysis and design method based on graphic and text descriptions of functions, information and data. It includes guidance for modelling, together with rules for model syntax, diagram and model format and text presentation, as well as structured model validation, document control procedures and interview techniques.

An IDEF model is supported by information and object, such as (1) input, (2) control, (3) mechanism, (4) output. Relationships among tasks in Figure 3 are categorized into the following four activities:

Input: Represent things used and transformed by activities. For example, raw materials are inputs to a machining activity.

Control: Things that constrain activities. It could also mean information that directs what activities do. For example, customer-supplied process plan determines what tools to be used to fulfil the requirements.

Output: Things into which inputs are transformed by the activity. So machined parts are outputs of a machining activity to which raw materials are inputs to the activity.

Mechanism: Things that determine how the activities are performed. They represent the physical aspects of an activity (e.g., storage places, people, organizations, devices). Thus the machine shop personnel are mechanism to the machining activity.

The first step in IDEF modelling is thus concerned with establishing the objectives of the modelling effort. Moreover, this is a top-down method which starts from general applications and moves on to more specific issues, from a single page that represents an entire system to more detailed pages that explain how the subsections of the system work. It includes both procedure and a language for constructing a model of the decisions, actions, and activities in an organization. "DESIGN/IDEF" software package was selected to be the modelling tool to build the BPR & MRPII model. Based on this methodology, a set of guideline and procedures was generated and the required documents and forms were also produced to match these procedures.

In adapting the techniques provided by IDEF, all the activities involved in the implementation of the BPR & MRPII model for the manufacturer are modelled firstly by defining the most important input, output, control functions and required mechanisms. Figure 3 shows the top diagram A0 of the model.

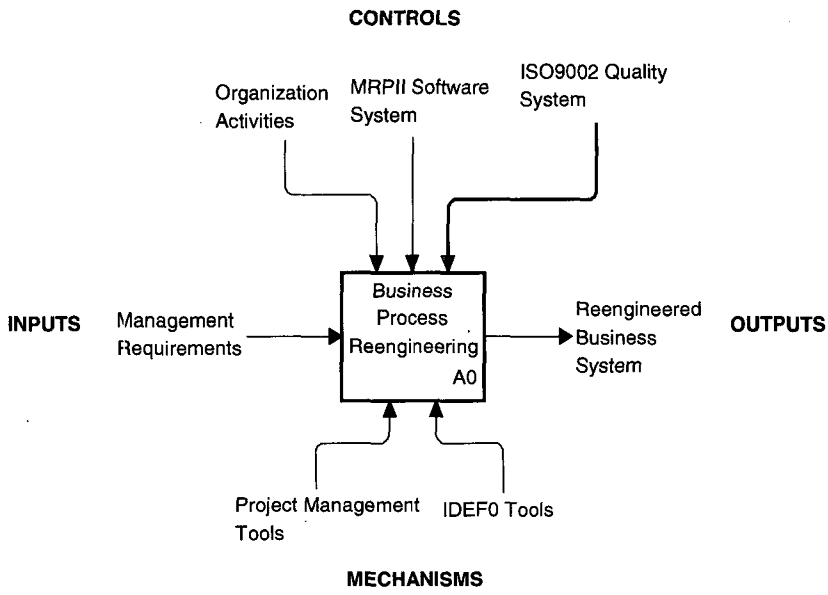

Figure 3. Node A0 of the BPR & MRPII implementation model

3.1 Inputs

It can be seen from Figure 3 that the input includes resources needed to plan the development activities, create the BPR & MRPII system and monitor the progress of this project. The details of input can be classified as follows:

a. Management Requirements

• Expertise in MRPII and BPR

The expertise involved in the design includes those who design the logical flow of the system, determine its database structure and configure the hardware and networking. The designer should be well versed in the MRPII and BPR philosophy. This renders a vision of what the future system will be.

• Understanding the Business Operation

The analysts and designers should closely examine the current operation by investigating major documents within the organization, identifying their sources and recipients, and thus establish the existing information flows.

• Project Management Skills

Since the scope of the MRPII system covers a wide variety of functions in the company, its design demands company-wide resource commitment, and this calls for managerial control and an allocation of resources regarding manpower and time. Project management skills are central to the effective co-ordination of manpower, and will ensure that project goals and deadlines are met.

3.2 Mechanisms

The mechanisms as shown in Figure 2, defines the tools and techniques used to perform the design and project management functions. The details of mechanisms can be classified as follows:

• Project Management Tools

Much project management software such as PERT charts and GANTT charts, which are the basic tools for BPR and MRPII project management.

• IDEF0

IDEF0 is a functional model methodology whereby the functions of a complex manufacturing environment can be graphically represented. It can also be used to develop and validate the work procedures of the hierarchy, layered and modular systems to operate the integrated system, e.g., BPR & MRPII model.

3.3 Controls

The controls are the guidelines and procedures which ensure that the desired outputs are derived from the input and other mechanisms. The details of the MRPII controls can be classified as follows:

a. Organisation Activities

• Business Strategy

The business strategy states what the company wants to achieve and gives rise to a set of organization objectives in order to fulfil this strategy. Its prime concern is to ensure survival despite the fierce competition imposed by competitors. The objective could include increasing product variety and offering at a lower price. The strategy and the objectives provide a basic premise for evaluation of MRPII system performance.

b. MRPII System

• User Requirement

User requirements come second in the order of importance concerning controls. High user acceptance of the MRPII system will bring about its widespread use within the organization and thus guarantee its success.

• Available Technology

System developer should consider the attainable opportunities offered by MPRII technology. Obviously, a state-of act system design that cannot be supported by the current available technology is unacceptable.

• Data Availability

Many types of data need to be managed by a company. It is necessary to collect these data for complete analysis before designing any system. However, they are not easy to obtain, and are usually related to different parts of the work, such as data relating to inventory and purchasing operations and their availability to affect the design of the MRPII system.

c. ISO9002 Quality System

The ISO9002 quality system provides the stepping-stone for continuous improvement, and provides the documentation of the daily operations.

3.4 Output

The output that comes from the model at different stages of the BPR & MRPII system design process can be classified as follows:

a. Reengineered Business System

• MRPII System Models

MRPII system models are produced in the early stage of system design. After the current working system has been thoroughly investigated and the business operation identified, models detailing the information flows and the relationships between various entities are produced and it is these on which the design of an MRPII system is formulated.

• Modular MRPII System Design

MRPII system design is the ultimate output from the model. Owing to the large scope and complexity of the MRPII system, it should be decomposed into subsystems and modules in order to preserve its simplicity and ease of access.

• System Performance Data

System performance data are collected after an evaluation of the proposed system has been completed. This output provides feedback for the design of each MRPII system, and may trigger a refinement in the design.

• Reengineered company

Figure 4 shows the detailed node tree of the BPR & MRPII model. This is generated by the Design/IDEF software and illustrates the node tree decomposition of the model, giving the relevant titles and page numbers. Moreover, based on the top level A0 of the model, it is split into several levels.

Figure 5 illustrates the decomposition of the implementation model derived from A0 of the node tree at Figure 4. These are: (A1) define project requirements, (A2) select MRPII software, (A3) Redesign business processes, and (A4) implement MRPII system.

Node Tree for D:\DISSER~2\FULL-MTD.IDD

- [A0] Business Prccess Reengineering
  - [A1] Define Project Requirements
  - [A2] Select MRPII Software
  - [A3] Redesign Business Processes (BPR)
    - [A31] Design BOM Information System
      - [A311] Review Requirement (Marketing)
      - [A312] Prepare BOM (Project Engineer)
        - [A3121] Prepare Drawings, Specs, Etc. (Project Engr)
        - [A3122] Build Protiotype, if required
        - [A3123] BOM Approved by Engineering Head
      - [A313] Review Draft BOM (Mkt, Engg, QC, Finance)
      - [A314] Approve BOM (Customer/ In-house)
    - [A32] Design MRP System
      - [A321] Receive Request (Marketing)
      - [A322] Order Review Procedure
        - [A3221] Rough-cut Capacity Planning (Production)
        - [A3222] Review Material Status (Materials)
        - [A3223] Joint Review & Approval
        - [A3224] Approve Order Receipt (Mkting Mgr)
      - [A323] Schedue Production & generate MRP
        - [A3231] Generate Production Schedule
        - [A3232] Generate Work Order
        - [A3233] Generate Material Requirement Plan
      - [A324] Execute Purchase Procedures
    - [A33] Design Finance System
  - [A4] Implement MRPII System
    - [A41] Conduct Education & Training
      - [A411] Define Project Goal
      - [A412] Conduct Awareness Training
      - [A413] Establish Implement- ation Plan
      - [A414] Establish Project Team
    - [A42] Install & Test Run MRPII
      - [A421] Install MRPII System
      - [A422] Gather Data
      - [A423] Pilot Run the Modules
    - [A43] Implement & Evaluate Result
      - [A431] Cut in Operation
      - [A432] Audit & Assess Result
      - [A433] Carry out On-going Education
      - [A434] Identify Other Improvement Area

Figure 4. Detail Node Tree of the BPR & MRPII Implementation Model

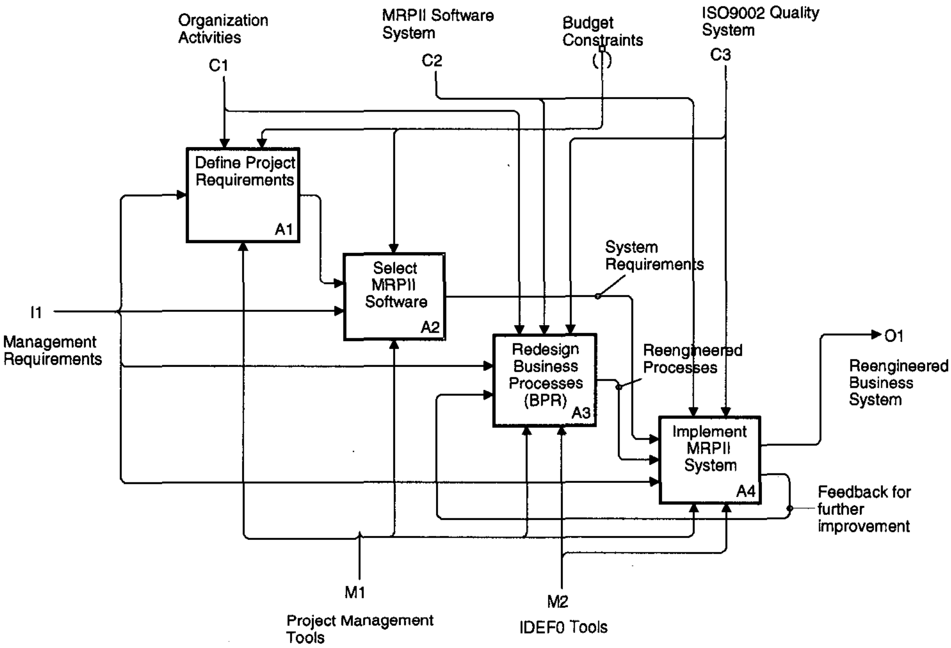

Figure 5. Breakdown of Diagram A0

(A1) Define Project Requirements

- *Develop company mission* - It is the process of conceiving a desired future condition of the company and a target for the company to achieve. This process transforms management's commitment to excellence and it ensures a consistent and constant transformation of the company.
- *Build Commitment* - this is the process of transforming leaders' motivation to improve into a commitment to excellence. Top management commitment is essential to improve the company during the transformation of the company. The commitment is required before the transformation starts to ensure constant and consistent improvement. *Build Commitment* is the allocation of resources. Resources include people, time, money, equipment and other assets available to the enterprise. Top leaders demonstrate their commitment to the transformation process by developing a "resource budget" for improvement.

Assess environment is the process of transforming the existing strategic direction of the enterprise into an assessment of its environment and the enterprise itself, a set of issues and constraints and a set of assumptions.

Assessing the enterprise provides information concerning strengths and weaknesses of the enterprise. Strengths help identify core competencies and weaknesses help identify potential obstacles to transforming the enterprise. The assessment provides leaders with an understanding of the enterprise's current performance and why it has reached this level. It forces leaders to formally consider their strategic direction, structure and policies, culture, processes, products, and technology. Assessing the enterprise ensures that strategies developed in the plan are realistic. Resources, knowledge, skills and capabilities will be known such that a realistic plan can be developed.

The assessment process provides an opportunity for the Steering Team to share and debate divergent views, stimulate creative thinking, and break down old paradigms. It can become a team building process that helps the Steering Team to develop a greater understanding of each other's opinions and progression of logic concerning existing and potential problems.

(A2) Selection of MRPII Software

Most commercially available MRPII packages are capable of providing benefits a basic MRPII system can bring offer (Gray, 1987). By basic MRPII system, we refer to the minimum elements a system must contain in order to be called an MRPII system. I have met enough facts that can be used as good guidelines in evaluating MRPII package and more importantly, the software vendor. A good evaluation of good software package and vendor can save lots of hazards in later days.

Christopher Gray proposes a workable approach to evaluating MRII software (Gray, 1987). The steps are shown in below:

a. Reviewing Vendor Documentation

Review the full set of documentation from the vendor, including both user and technical documentation. The purpose is to understand if the software system in concern matches with the company requirements.

- Compare the technical documentation with an established MRPII system. Darryl Landvater and Christopher Gray's book on MRPII standard system can be used as good reference in determining whether a software is qualified enough to be called an MRPII system (Landvater and Gray, 1989).
- Get a general feel from reading the documentation about the vendor - whether they are thorough and technically capable enough to provide the solution required.
- Identify areas that need clarification in later phases of discussions.

b. Meeting with Vendor

The meeting with vendor can be used as an opportunity to come into direct contact with personnel from the vendor. This is good chance to review if the vendor has technically capable personnel who could answer questions raised in earlier documentation review, or if the vendor is courteous in helping customers.

- Software demonstration is normally part of a vendor meeting. Make the most out of it by making sure that the software is functionally capable.
- Have a feel about whether the vendor personnel, particularly the technical support staff, have the thorough knowledge and care to solve your problem.

c. Reviewing Sample Output from the Software

- Review major reports generated by the software and verify if all required elements in an MRPII system are present (by using standard system).

d. User Reaction (Reference Check)

- A good way to get field knowledge about the acceptance level of the software.
- Should visit at least one user of the software package and contact several reference companies for comments about the software. Wallace suggests that the software buyer must insist on seeing the package is working in a Class A or Class B company (Wallace, 1990).
- Whenever possible, try to visit company that has successful experience in using the software.

(A3) Redesign Business Process

The A3 task can be divided into 2 major activities, they are:

- Task one - integrated BOM Maintenance Function

A Bill of Material (BOM) is one of the most important modules in an MRPII system. It records and stores the confirmed structure of a product (Luber, 1995). For an MRPII system to function properly, a well maintained BOM system is needed. Luber asserts that a good BOM module under a MRPII system can significantly improve productivity among the design engineer and inventory management personnel.

In integrating the BOM system, the IDEF0 diagram of the methodology described in

Figure 3, and Figure 5 were used and decomposed further to demonstrate the functional capability of the methodology. The A3 task in Figure 5 labelled "Redesign Business Processes" was further decomposed to reveal the different areas of works in which re-engineering activities are to be conducted to bring about a final re-engineered business system. As shown in the schematic diagram (Figure 2) of the methodology, the proposed way of re-engineering is done in a progressive manner, meaning that the existing business processes are analysed and re-engineered progressively. The BOM, MRP, and the finance system were identified as the areas in which re-engineering activities would be carried out first.

Figure 6, illustrates the decomposition of the implementation model derived from A3 of the node tree at Figure 3. The elements are: Design BOM information system, design MRP system, and design financial system.

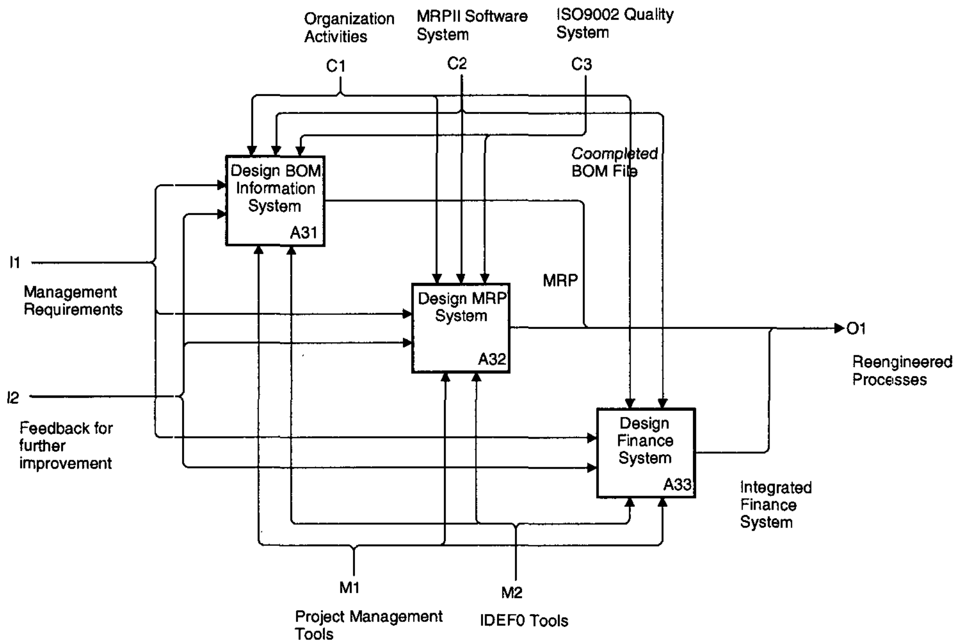

Figure 6. Breakdown of A3 Diagram

A31 - Designing a BOM Information System

In implementing an MRPII system, a complete and documented BOM file (product structure and part structures) that are in compliance with the requirements of the software would become inputs to the MRPII system. Thus the reengineering task, using IDEF0 technique, at a more macroscopic A31 level, was modified as indicated in Figure 7.

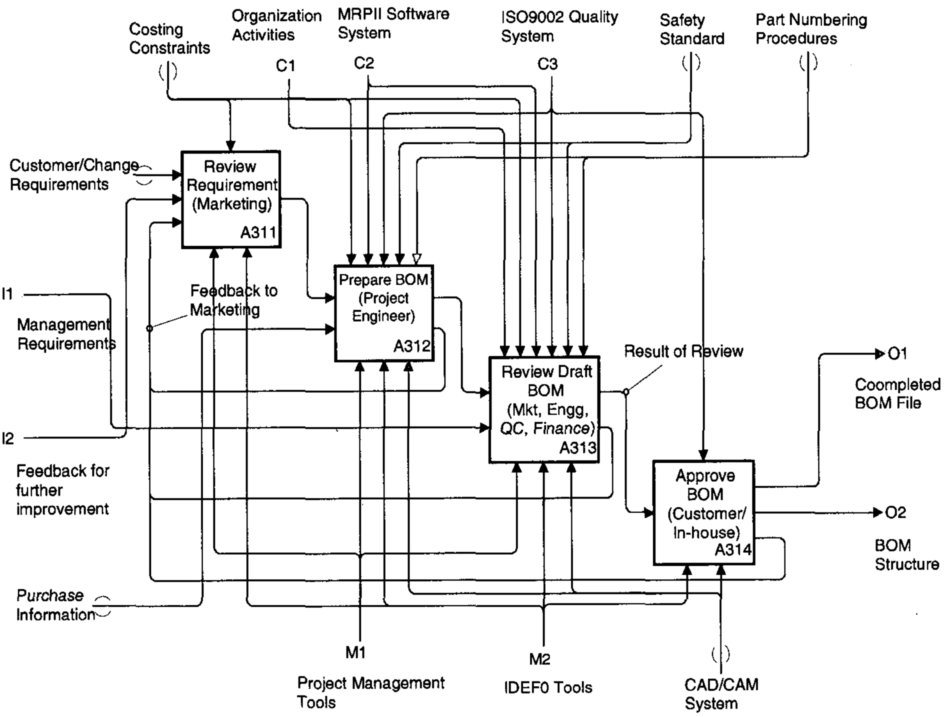

Figure 7. Activities to establish BOM System

As can be seen in Figure 7, the higher level, macro task of preparing BOM information (A31 Task) was readily decomposed into its next lower hierarchical level of 4 sub-tasks, each numbered from A311 through A314. Thus just by reviewing the number at the lower right corner of the task box, one can identify which hierarchical level the task is referring to.

With the IDEF0 software, all the ICOMs are linked and numbered. This ensures that multi-level systems can be established and close-looped during development. At each level, additional ICOMs can be added meaning that more information (inputs, controls, etc) can be brought into the system. These items of newly added information will be shown in the next lower level of diagram.

In the selected case, A31 Task was decomposed into 4 tasks. It was reviewed that A311, A313, and A314 tasks were straight forward such that no further breakdown of them was necessary. For Task A312 (Prepare BOM by the Project Engineer), more details were needed to describe the processes involved. As a result, A312 was put under further analysis. The resulting diagram is shown in Figure 8.

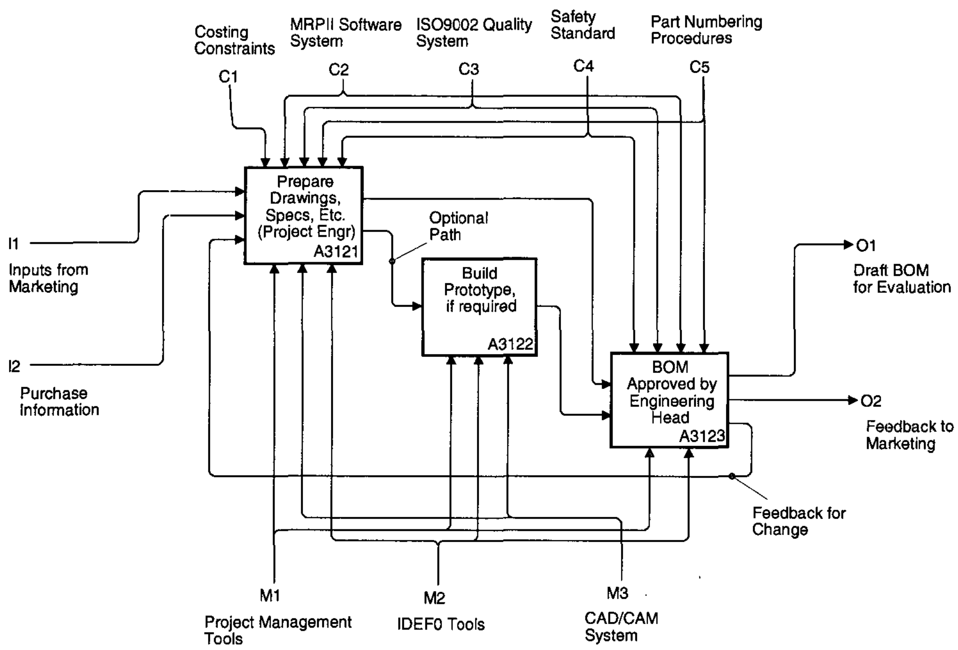

Figure 8. Breakdown of A312 Task

The A312 Task has been decomposed into sub-tasks A3121 to A3123. If deemed necessary, each of those A312x tasks could have been knocked down further for closer description of the tasks. In this case, it was agreed that no further decomposition was necessary.

To augment the graphical representation of these tasks, written procedure was created to give verbal description how the tasks were to be performed.

In IDEF0 methodology, "kits" are generated and maintained to act as the information/communication vehicles among members of IDEF0 project (Marca and McGowan, 1998), (Luber, 1995). For reason of integrating with ISO9002 documentation system, the procedural documents were used instead to augment the IDEF0 diagrams. With procedure authors and subsequent revision(s) clearly recorded and documented, the objective of "IDEF0 Kits" were achieved.

As in usual ISO9000 quality management systems, these IDEF0 diagrams, supported and explained further by written procedures, were thoroughly documented. Issuance and collection of these IDEF0 diagrams and procedures (which combined to form the integrated *procedures*) were managed under a documentation control system that was in compliance with ISO9000 quality system requirements.

As a result, tasks of managing BOM information, which were once managed loosely by non-integrated functions, were pulled together by the MRPII system (the Information Technology Enabler of BPR). And the associated tasks that generated the required BOM information (Task A31 shown in the IDEF presentation) were also reengineered, using IDEF0 technique, to provide the required set of information as inputs to the MRPII system.

• Task Two - Reengineered the Material Requirement Planning

The second task embarked was to re-engineer the materials requirement process. The scope covered tasks from receiving customer's request (by Marketing) to sending out purchase orders to vendors for fulfilling the Materials Requirement Plan. Before the process was re-engineered, the tasks were handled by different functions in a loosely organized manner. For example, acting with the hope of ensuring that there were enough materials in the warehouse - so that they would not be blamed when lines were down due to materials shortage, materials department would request materials there were not needed in the near future, or would request higher quantity.

Without proper checking mechanism and method, purchasing department was not motivated to verify if the materials were really needed. Even if someone was dutiful enough to be willing to check for sure, he would be swamped and quickly de-motivated by the massive data he was faced with. This prompted the requirements of having automated solution to calculating and determining the quantities and due dates materials were required in the plant.

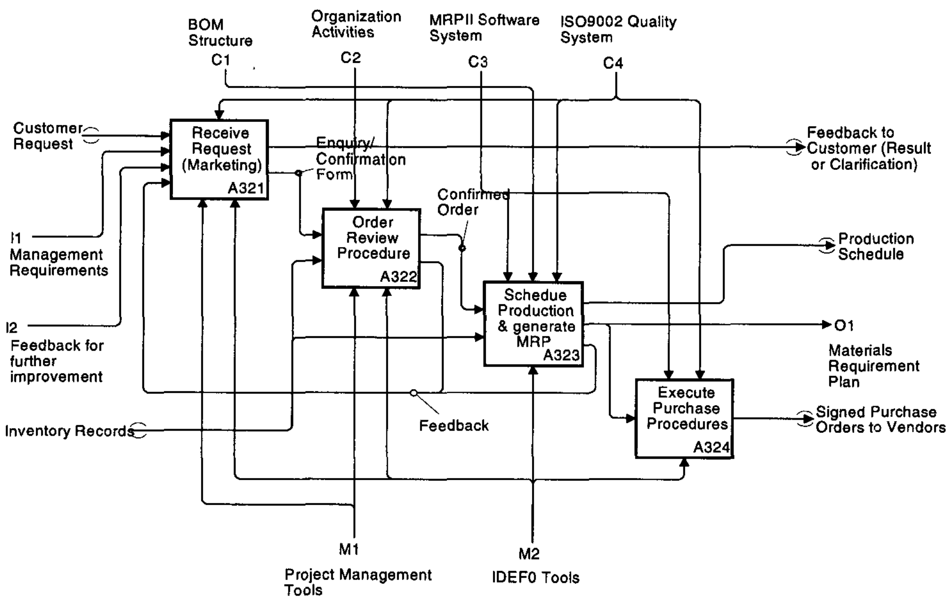

Figure 9. Breakdown of A32 Task

As in handling Task One (Figure 6), the A32 diagram - Design MRP System, was decomposed into its next level of activities (see Figure 9).

Four sub-tasks were identified, namely:

- A321 (Receive Request) - Marketing Department receiving request from customer.
- A322 (Order Review Procedure) - An ISO9002 procedure covering tasks to be performed in handling customer order/request.
- A323 (Schedule Production and Generate MRP) - Once the order is confirmed, the confirmed order, in the form of a confirmatory document under the ISO9002 quality management system, will be released to production and materials departments for generating production schedule and material requirement schedule.
- A324 (Execute Purchase Procedures) - The material requirement plan will be passed onto purchasing department for materials sourcing.

Decomposing Task A322

The Task A322 (Order Review Procedure) was further analyzed, showing the subtasks needed in handling order and/or requests from customer. The Order Review Procedure is required procedural element under Section 4.3 of ISO9000 standard. The decomposed tasks of A322 are shown in Figure 10.

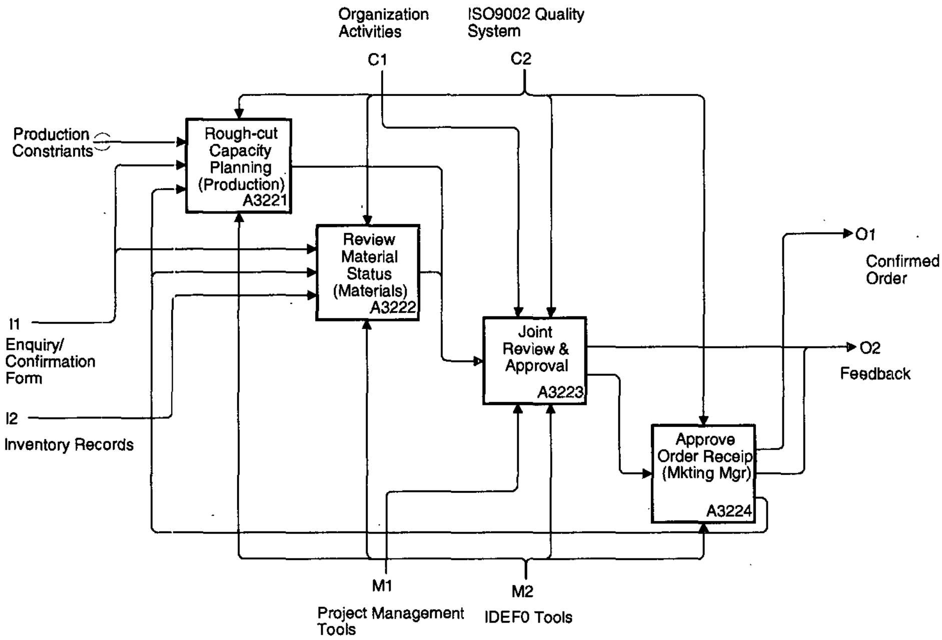

Figure 10. Breakdown of A322 Task

Decomposing Task A323

Likewise with above section, it was agreed that task A323 could be decomposed further to reveal the more detailed tasks required in generating material requirement plan. Thus task A323 was further broken down into the following subtasks as shown in Figure 11.

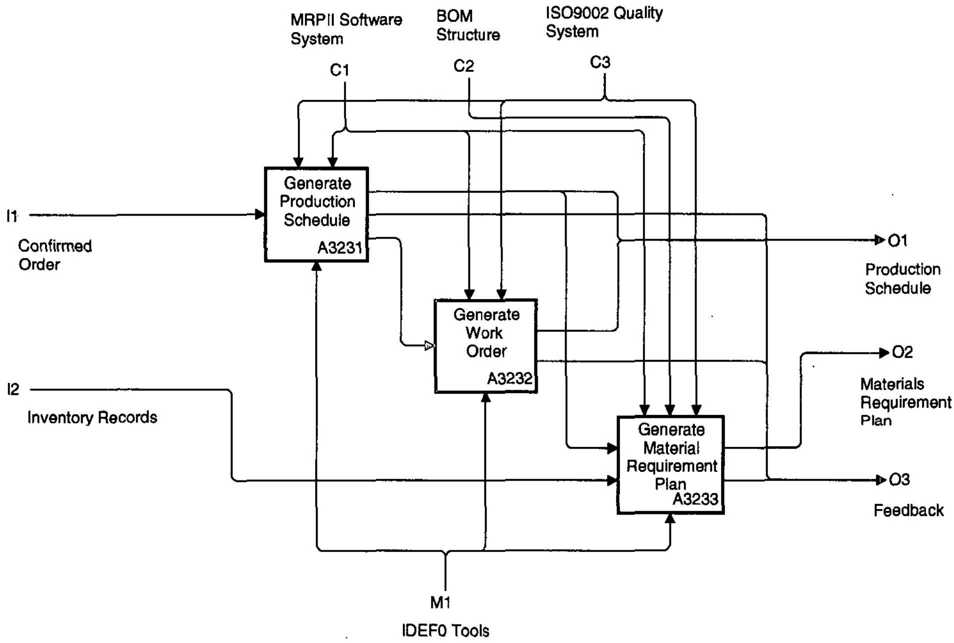

Figure 11. Sub-tasks of A323

(A4) Implement MRPII System

Even with the help of IDEF0 tools to develop reengineered processes to fit with the MRPII system, the implementation of MRPII places a great challenge to the company. Lo et al (1997) finds that despite many researches have provided valuable lessons and insight which affect MRPII success, a generic structural model of the functional activities for the implementation of MRPII has seldom been reported. Darryl Landvater proposed a "Proven Path" that described the critical activities and the sequence which should occur in implementing MRPII [40]. Yet it is too generic in nature and was unable to provide definite road map based upon which successful MRPII implementation is ensured.

• MRPII Implementation Plan (Using IDEF0 Technique)

As the proposed methodology demonstrates, IDEF0 is a good tool to plan and design activities. Thus it is logical that IDEF0 can also be used in planning and guiding the implementation of MRPII system in a company. As shown in Figure, the A4 Diagram is "Implement MRPII System". The diagram can be further decomposed to show how MRPII implementation is done. Having implemented some modules of MRPII in-house, the author can reasonably say that the plan shown in Figure 12 is a concise and workable path towards MRPII implementation. Using the universal tool of IDEF0 techniques, an MRPII implementation IDEF diagram can be developed to form an integral part of the whole overall game plan. As a result, the A4 Diagram is decomposed into the following sub-diagram:

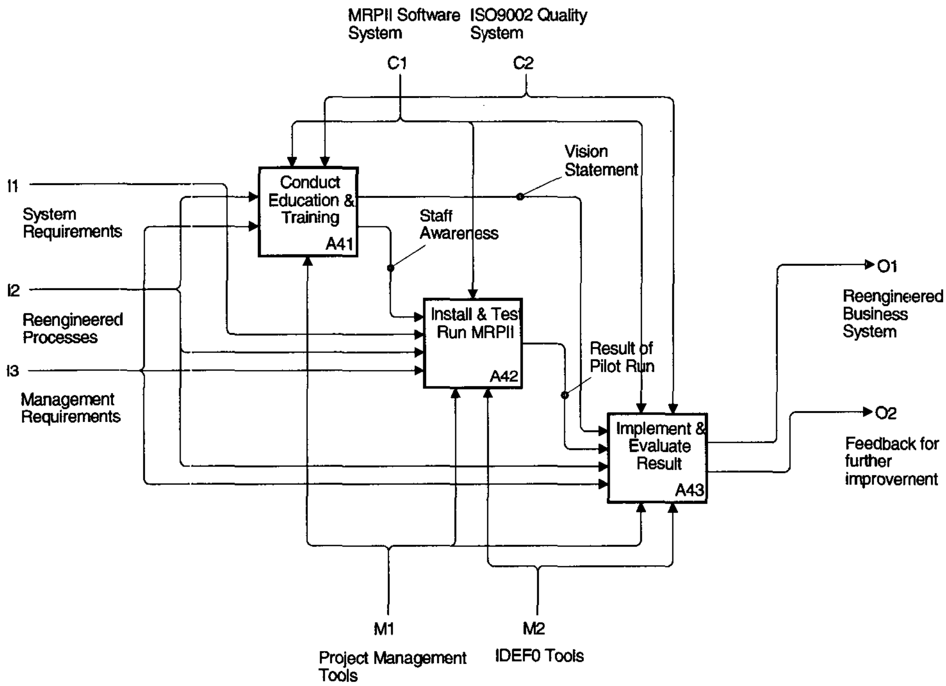

Figure 12. Implementation of MRPII

In essence, MRPII implementation involves three subtasks, namely:

- A41 (Conduct Education and Training) - Almost all writers indicate the need of carrying out education and training in the initial phase of MRPII implementation. MRPII requires changes in ways of doing things, it is through education and training that lead to substantial behavioural changes. A vision statement would be necessary in order to spell out the goal that the organization aims to achieve with using the MRPII system.

- A42 (Install and Test Run MRPII) - The selected MRPII software (covered in Diagram A2) is installed and test run before full implementation.
- A43 (Implement and Evaluate Result) - The pilot run result will be fed into this phase for preparation for full implementation. Results will be evaluated for establishing future goals and identifying other improvement processes that can be implemented.

Each task in the general implementation plan can be further decomposed into their own sub-tasks as shown in Figures 13, 14 and 15:

As such the whole project of MRPII implementation under a reengineering approach can be planned and carried out using IDEF0 techniques. As will be seen in the following diagram showing the node tree of the entire integrated project, the whole game plan can be extended further to cover other areas at which reengineering activities will be planned. Just as the propose methodology shows, the reengineered activities can then be fit into other modules of the MRPII system. This allows flexibility to companies which will plan their implementations using a progressive approach. The node tree, showing the hierarchical business model in a tree format, is shown in Figure 4.

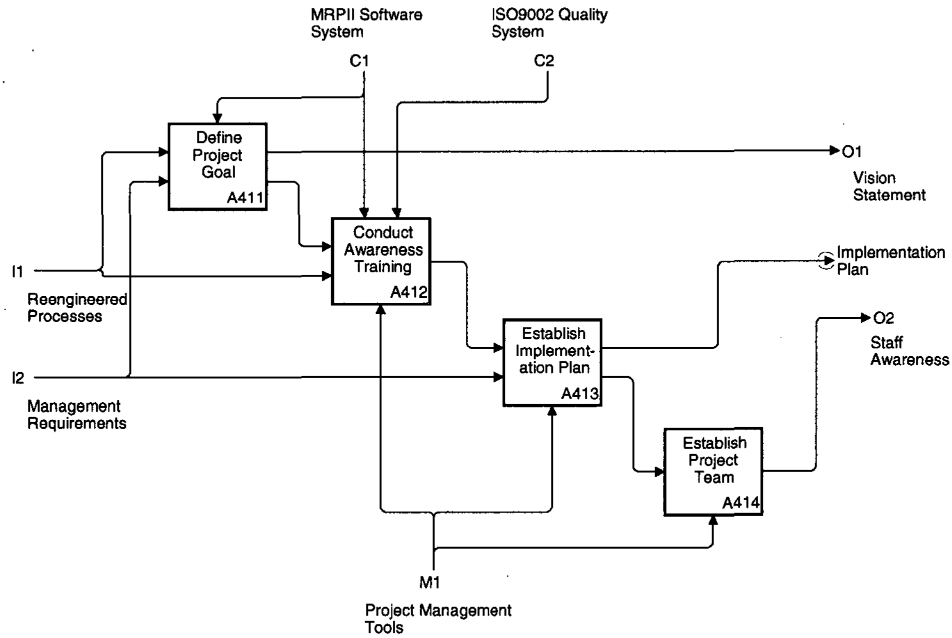

Figure 13. Breakdown of Task A41

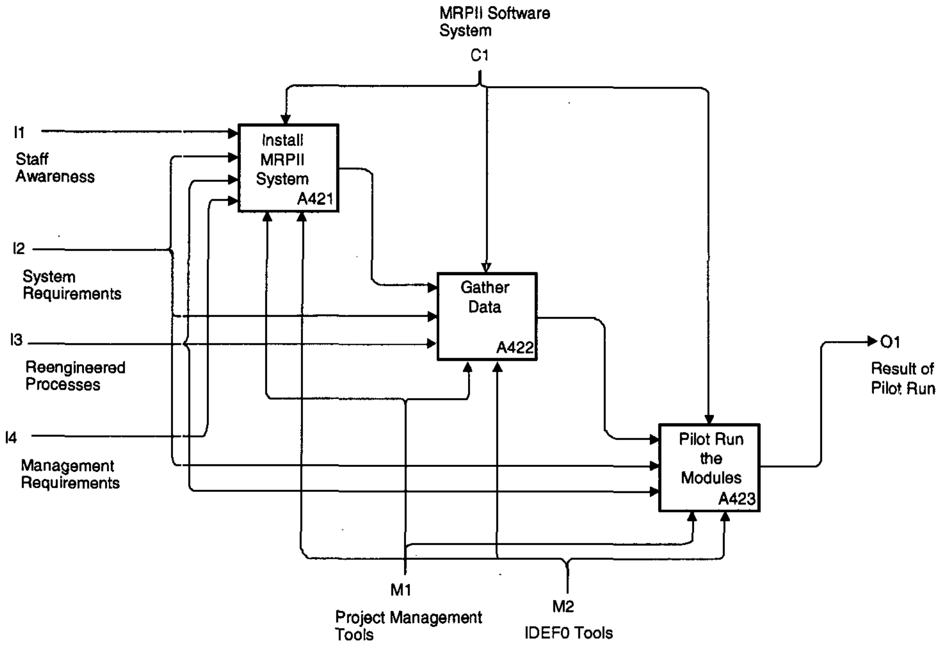

Figure 14. Subtasks of Install and Test Run MRPII (A42)

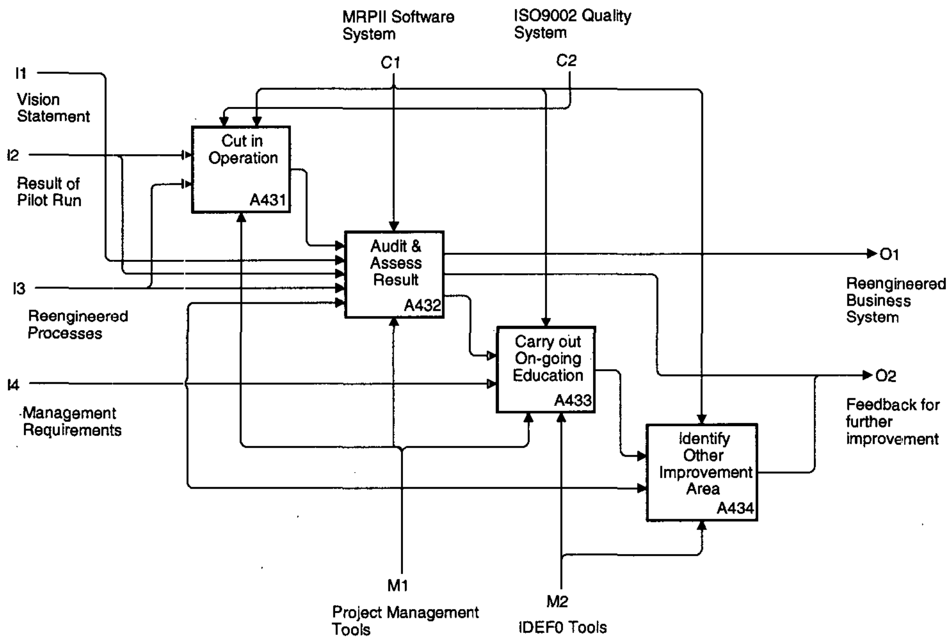

Figure 15. Subtasks of Implementation & Evaluation of MRPII (A43)

4. Implementation Results

In the reference company mentioned in this paper, the results of implementing MRPII modules using the proposed methodology are dramatic and encouraging. As described in Task One & Task Two respectively, BOM maintenance and Material Requirement Plan functions were reengineered and integrated into the MRPII system. The following major improvements were identified:

With Integrating BOM Maintenance System

- The established centralized database of BOM information saved lots of efforts due to previously duplicated (if not contradicting) recording and documentation. Preliminary finding reported a 60% reduction in number of papers used to maintain the BOM distribution system.
- Prior to establishing the BOM module in the MRPII systems, five controlled copies of BOM information were distributed to different departments within the company. After the computerized BOM module was established, only master copies of bills of material information were kept. Reduction in use of paper due to lesser hard copies made was offset by increased use of paper for documenting the BOM system, thereby giving the 60% reduction in use of paper mentioned above.
- Accuracy of BOM information was ensured by allowing users to tap into the system via computer terminals along the network. Accuracy was also improved by not allowing casual changes to BOM information except with appropriate procedural authorizations. During the four months' period of investigation, reports on discrepancies of BOM information among departments reduced by 66% - from three incidents per month to one per month.
- Because people can access the BOM information via the system, rather than asking around for update (as in the past), there was less trivial communication. As a result, employees became more concentrated in work and were more assured of quality of the information acquired from the system.

With Reengineering the Material Requirement Planning

- Prior to implementing the MRP function, one full time staff (48 hours per workweek) was required to plan and monitor the materials activities. The implementation of MRP reduced such tasks to around 30 minutes per week. - a 98.96% improvement, not to mention quality of work.

- Reduced anxiety among material planning staff because they longer have to rely on their error-prone computations.
- Improved alertness on possible material shortage - such that immediate actions could be taken to deal with the situation.
- Improvement in inventory levels was not revealed due to implementation of MRP when the division was still at development stage - at low inventory level.
- Improved coordination among planning and purchasing staff. In one survey, staff in planning and purchasing departments reported an average 70% reduction in time taken for expediting materials.

5. Conclusions

MRPII system covers a wide spectrum of works across a company, its implementation requires significant changes to the company's present ways of doing things. Thus MRPII implementation should be taken from a reengineering approach. In this paper, the authors proposed a methodology to cater for changes within a company in adopting MRPII system under the macroscopic context of reengineering through BPR. IDEF0 structured design tool fits well into the picture by providing the missing link between the vague reengineering concepts and the company-wide total manufacturing solution. IDEF0 tool provides a practical vehicle through which subsystems of work connecting to the core MRPII system can be redesigned, validated and documented. In addition to many intangible benefits, some notable tangible results were achieved as a result of the implementation, such as, 60% reduction in paper usage in the BOM distribution system, 66% reduction in errors for maintaining the bills of materials, 98.96% improvement in the material requirement planning. system; and 70% reduction in time previously taken for non-productive discussions.

With rapid advancement of computing and software technology, MRPII has become more accessible to small and medium size company. However, one should not settle merely with the massive computing power of MRPII system. The automation of massive simulation and computing activities could hide lots of inefficiencies at work.

The importance of human factor in implementing any company-wide project is not to be undermined. After all, it is through people that MRPII system gets done, it is through people that reengineering activities can be planned and discussed, let alone the implementation of the reengineered activities. Hardware and software of MRPII are not the most important factors but people cause differences. To change a system, it is always wise to change the people first. It is through education and training that knowledge and facts are brought across to people's minds, thus entailing behavioural change. The sharing of common mental models and shared visions among workforce also foster organizational learning and teamwork.

The MRPII implementation project in the reference company demonstrates that the proposed methodology is workable. Despite there was fear of change among people in the company, the project team had been able to drive through the changes required in a constructive manner. The proposed methodology, with its ability to depict a complicated company-wide project implementation in structured, modular, and concise presentation, helped clear lot of anxiety among staff in the company. Once their resistance to change was reduced, they became more participative in developing the general, higher level IDEF0 chart in their work areas. They then were shown and encouraged to break down their tasks into their next hierarchical IDEF0 charts. In such a way, the methodology helped in inducing corporate changes in a progressive, modular and harmonized manner.

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