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APPLICATION OF PROJECT MANAGEMENT
TOOLS TO A PACKAGING PROJECT

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APPLICATION OF PROJECT MANAGEMENT

TOOLS TO A PACKAGING PROJECT

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ABSTRACT

APPLICATION OF PROJECT MANAGEMENT
TOOLS TO A PACKAGING PROJECT

by

Robert Kenneth Back

Project management tools have recently received increased attention in the business environment. The use of project management tools was once considered only in the construction industry but now is being considered by all. This thesis proposes the use of project management tools as a way to manage a labeling system project so that recommendations can be made to improve that labeling system.

The Work Breakdown Structure (WBS) and bar chart project management tools were employed to plan and control the labeling system project. It was determined from the recommendations made on the labeling system that the actual material and labor savings justified the approval of the project. Use of the project management tools managed the activities' timing so as to improve the labeling system and reduce the material and labor costs.

This thesis is dedicated to

Janet Wisniewski

for her encouragement and assistance
during the course of this and other projects.

Also to my Family

whose dedication to my personal development
will always be remembered.

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INTRODUCTION

Francis Webster, in "The Management of Projects--An Examination of the State of the Art as Represented by Current Literature" (36) defines a project and its activities in the following manner:

> Project--A unique, technologically determined sequence of purposeful, usually non-repetitive activities; involving the coordination of multiple, heterogeneous human and nonhuman resources representing a significant proportion of the performing organization's capacity; operating on an interrelated set of items; accomplishment of which will result in the achievement of a specified set of objectives for one or a few units of output and termination of that work effort; with primary managerial emphasis placed on timely accomplishment of the work effort as a whole (as compared to the managerial emphasis on other modes of work).
>
> Activity--A finite operation (physical or mental) performed on an item (concrete or abstract) to achieve certain specified technical objectives requiring the lapse of time and, generally, the use of resources (36:13).

Project management tools have not been widely recognized as a way of planning and controlling work efforts until recently.

> The last three decades, however, have witnessed a veritable explosion in the use of project management methods, not only in construction, but in the industrial and governmental sectors of society. The new factors generating this increased attention are the tremendously increased technical complexity of modern project efforts, the wide diversity of skills needed to accomplish such complex projects, and the new managerial tools that have been developed to aid in managing the modern project (2:1).

The growth of the "new managerial tools" arose because of problems involved in developing sophisticated products, such as military weapons. The problems have become so intricate that more advanced

project management tools have been developed to plan and control these work efforts.

There are numerous project management tools available that plan and control a project effort. Project management tools aid in the planning of a project by breaking down a work effort into activities and allocating resources to those activities to enable negotiation of trade-offs on time and cost forecasts. Project management tools can also help control a project by taking performance checks on planned versus actual happenings in the activities and their allocated resources. Differences in what is planned and what is actually happening in the activities and the resources are measured, evaluated, and/or corrected. If corrections are made, updates on the project plan are made to reflect the latest status and conditions of the project.

A project effort usually uses more than one tool to plan and/or control a particular work effort. A project is broken down into activities with the help of a tool. This tool will be the only necessary project management tool if it can also allocate resources. However, after negotiations on time and cost forecasts have been made on these activities and it is found that the tool cannot allocate resources, then further project management tools will need to be selected. The control of a project may require the use of another project management tool unless the tool employed to break down the project and/or allocate resources can also check performance.

The project management tool used to reduce a project into activities is designed so that the allocation of resources to the activities can be made. Time and cost forecasts are made to determine the

types and amounts of resources required to perform the activities of the project. Before the allocation process begins, the project activities must be divided and assigned to the project personnel who are responsible for allocating resources to the activities. Without the proposed plan on the breakdown of the project, the time-cost forecasts for the activities and the resources would be difficult to accomplish.

"There are five classes of resources to consider--labor, equipment, materials, space, and sometimes energy" (36:116). The resource forecast allocates labor, equipment, materials, space, and/or energy required for the activities involved in a project. The types and amounts of resources utilized depend on how the resources are allocated to the project activities. The process of allocating resources relies on the time and cost constraints desired by top management. Schedules forecast time-activity resource utilization requirements while budgets forecast the cost-activity resource utilization requirements. Schedules and budgets provide a basis for tracking time and costs spent on the activities and the resources.

The time-cost forecasts made on the allocation of resources to the project activities are negotiated by the responsible project personnel. The negotiated trade-offs between the project personnel will continue until an agreement meets the time or cost constraints desired by top management. Devoting too much time or costs in allocating resources will cause top management to demand a decision or compromise between the project personnel on the scheduling and budgeting resource requirements.

The time-cost negotiated trade-offs integrate the activities and the resources together. This establishes relationships between the activities and the resources. Since the activities and the resources are usually identified by a coding system, the project can list all the activities and/or the allocated resources in the sequence in which they occur. But during the negotiated trade-offs, changes may be made in the way the activities and the resources are integrated. If this is the case, the activities and the resources in the proposed plan are adjusted to reflect the latest status and conditions of the project.

Once the project is implemented, it is always being measured, evaluated, and/or corrected to discover differences between what is planned and what is actually being performed. When deviations are measured or evaluated, corrections may or may not be made depending on how far actual execution departs from the plan. If corrections are made in the plan, updates are made on the activities and the resources. The more corrections made to the project plan, the more frequently control is applied to the project. The number of corrections depend on the number of activities and the resources affected. Therefore, a project management tool or tools applied to plan and control a project, measure the success or failure of a project. Measurement consists of calculating the amount of time and money spent on the resources integrated into the activities, which is off-set by the revenue or cost savings generated from the work accomplished.

STATE OF THE ART:
PROJECT MANAGEMENT TOOLS

Webster's Work

Webster's Ph.D. dissertation, "The Management of Projects--An Examination of the State of Art as Presented in Current Literature" in 1978, and "Tools for Managing Projects" article in the Project Management Quarterly in June 1982 (37) presents a comprehensive listing and discussion of project management tools.

> Attempts at finding references in current literature to many of the tools which are familiar from practical experience were fruitless in most instances except for Gantt Charts and network based techniques. Thus, it was necessary to rely heavily on personal experience to develop a taxonomy of tools for managing projects. There is no claim that the material presented in this paper is exhaustive but, rather, that it provides a framework to which other tools can be related by those experienced in their use (37:46).

Webster's taxonomy of project management tools has two major classifications: techniques, shown in Table 1, and practices, shown in Table 2.

Webster also compiled a comprehensive listing and discussion of project management software packages in the Project Management Institute's (PMI) 1982 Survey of Project Management Software Packages. Webster's survey of software packages was developed through questionnaires, phone calls, and company literature. The listings and discussions of the software packages are made under various headings.

TABLE 1.--Taxonomy of Techniques for Managing Projects

Formal Techniques	Entity		Types of Information			
Schedule/Progress	**Events**	**Activity**	**Time**	**Resources**	**Technical Performance**	**Cost**
Lists						
Bills of Materials (BOM)						
Engineering				x		
Assembly				x		
Construction Take-off				x		x
Task List						
Punch List		x				
Time Line	x					
Work Sheet						
Matrix (Combines BOM & Task List)		x		x		
Spread Sheet (Matrix with dates)		x	x	x		
Budget						
Administrative (by function)						x
Project (by Component)						x
Work Order System		x				x
Graphic						
Schematic Diagram	x			x		
Work Breakdown Structure		x		x		
Bar Chart		x	x			
Gantt Chart		x	x			
Milestone Chart	x	x	x			
Manhour Chart	x	x	x	x		
Histogram (Manpower) Loading Chart			x	x		
Process Chart		x				
Network Diagram	x	x	x			
Forward (early) Schedule (Including Harmonogram)						
Backward (late) Schedule (Including Lead Time Chart in LOB)						
Network Based						
Critical Path Technique	x	x	x			
PERT	x		x			
CPPS	x	x				x
Resource Management		x	x	x		
DART		x	x	x		
PERT/COST		x	x			x
LOB	x		x			
PERT/LOB	x		x			
Decision CPM	x	x	x			
GERTS	x	x	x			
RMI	x		x		x	
Other Formal Techniques						
Configuration Management		x	x		x	
Design Cost Control		x	x		x	x
Informal Techniques						
Tickler File		x	x			

SOURCE: Francis M. Webster, "Tools for Managing Projects," Project Management Quarterly, Vol. XIII, No. 2 (June 1982): 46-58.

TABLE 2.--Taxonomy of Practices Useful in Managing Projects

Written Practices
- Narrative Reports
  - Accomplishments
  - Status
  - Projection
- Organization Chart
- Linear Responsibility Chart
- Organization Manual
  - Organization Responsibilities and Authority
  - Policy
  - Procedures
  - Operating Instructions
  - Technical Instructions
- Planning Documents
  - Proposals
  - Technical Plans
  - Dissemination Plans
  - Termination Plans
- Memoranda

Verbal Practices
- Individual Meetings
  - Progress, Status, Plans
  - Problem Solving
  - Individual Performance Review
- Staff Meetings
  - Project Management Team
  - Total Project Team
  - Ad Hoc
- "Brainstorming"
- Plant Visits
  - Announced
  - Unannounced

Other Practices
- "Ag-Pos" (Agenda Position)

Integrated Management Information and Control System

SOURCE: Francis M. Webster, "Tools for Managing Projects," Project Managing Quarterly, Vol. XIII, No. 2 (June 1982): 46-58.

Other Authors' Research Not Covered by Webster

Wiest (1977) researched the improvement of network tools up to the Graphic Evaluation Review Technique (GERT) and summarizes his research on network models in the following manner:

> More specialized models are being developed (and have been) that overcome some of the shortcomings of the original models, relax some of their stringent assumptions, and meet specific needs. The largest problem in their use will continue to be their misuse, the mismatch of tool and problem, the gap between expectation and potential. But gradually--and this is the fervent hope of everyone who has tried to teach present and future managers how to solve quantitative problems--managers are becoming more knowledgeable about quantitative decision-making techniques, more sophisticated in applying them, and more successful in their efforts (40:35-36).

Digman and Green (1981) go one step further than Wiest in the historical development of network tools to include Venture Evaluation and Review Technique (VERT). Digman and Green make comparisons of VERT against popular network models including GERT. "A conceptual framework is required to provide project managers with a "roadmap" through the morass of information and decision needs, parameters, phases, techniques, and processing requirements" (12:11).

The PMI is interested in promoting software surveys so listings and discussions of the computerized project management tools can be evaluated. West (1980), Mills and Smith (1982), and Webster (1982) have developed surveys of project management software packages for the PMI. Mahler and Smith (1978) did a survey that was published in <u>Industrial Engineering</u>, April 1978, which was updated by Mills and Smith (1982) for the PMI. The PMI's book, <u>Implementing Project Management: A Professional's Handbook</u> (1981) chapter on

"Tools of Project Management" discusses the computer development of project management tools.

Spinner (1982) discusses certain project management tools in his book, summarized in the following manner:

> Among these tools are the following:
>
> 1. Planning, scheduling, and controlling time and costs.
> 2. Program reporting and forecasting time duration.
> 3. Cost reporting and forecasting total expenditures.
> 4. Use of computers, in conjunction with the above, especially for large and complex projects (31:1).

Kerzner (1982) researches the Work Breakdown Structure (WBS), Gantt Chart, the basis of network tools, as well as others. Gray (1982) presents his observations on network tools and their computerization in the following manner:

> Resources
>
> Through 1965 very little emphasis was given to scheduling resources. Prior to this time project managers developed a network plan with very little concern for materials, labor, and equipment. They assumed resources would be available on the dates specified in the plan. Since the likelihood of this occurring would be rare, some applications of project management techniques failed. In the past two decades, practitioners and scholars of project management have been stressing the importance of lining up the resources so they will be available when they are needed and not committed to another project at the same time. Several resource scheduling methods and computer programs have been developed to handle the resource availability problem. The rewards have been great to those astute enough to recognize the resource problem and its importance to project success.
>
> Cost
>
> This is another area that is currently receiving more attention. Since most project efforts carry a price tag indicating the expenditure of money, it is natural that project managers would continue to develop new and improved performance measurement schemes. Early in the development of project management techniques the government required (and still does) that contractors for the Department of Defense (DOD),

National Aeronautics or Space Administration (NASA), and Department of Energy (DOE) use the Cost/Schedule Control System of the respective agency. This system is being refined and improved constantly. The full potential of cost planning, scheduling, and controlling is only being realized today. Software developers are devoting significant effort and talent to developing cost and quantity packages for managing small projects. This is especially true in the contracting industry where new packages are coming out almost daily. Since the format of these systems is applicable to organizations that are not contractors, it is likely that the current surge will be followed by the development of "generalized packages" that will have wider applicability . . . .

Computer-Based Total Information Systems

The increased availability of computer software and the decreasing costs of hardware, software, and computer operation have all encouraged growth in the use of project techniques.

Computer software firms now are turning their attention to integrating their specialized project management packages (e.g., resources and cost packages). Emphasis is on all phases of project management-planning, scheduling, and controlling. Systems are now available to handle very large multiproject, multiresource project organizations. The construction industry has been working hard to develop total information systems designed for contractors. There will probably be spin-offs for other industries from this effort. Concurrent with the total information thrust has been increased development of packages which offer more features. Graphics and precedence diagraming options are increasing in availability, as are interactive and on-line systems for the smaller project users. There is little doubt that computer-based project management systems will increase in use and in systems available. The most notable changes will take place in new packages for small computer systems. . . .

Graphics

Bar charts have always been popular with managers. Generating bar charts is a very easy task for a computer, even for small ones, and most software packages include bar chart options. Drawing networks is a bit more complicated. Until recently, the plotting of network was reserved for large computers hooked up to an extensive plotting device. The state of art is developing quickly as the price of plotters continue to decrease. In the next few years exotic plotting routines using multiple colors will be available to a larger

> segment of project managers in both paper and television screen output (16:221-223).

These project management authors have developed similar listings and discussions on project management tools and software packages. But these authors only discuss one or at most a few of the project management tools which represent a small section of Webster's taxonomy on project management tools and/or software packages. Upon reviewing these discussions on tools and software packages, Webster's two major criticisms associated with project management literature remain valid. The two major criticisms are as follows:

> One of the major criticisms of project management literature is that too much emphasis is placed on network based techniques to the exclusion of a host of other tools that can be useful in managing projects . . . another criticism of project management literature is the inability to find guidance as to which tool, and which variant, to use under what circumstances (37:46).

Selected Tools Described

From all the project management tools in Webster's list on pages 7 and 8, two were selected for use in this application. The tools selected were Work Breakdown Structure (WBS) and bar chart (Gantt Chart). These are described in detail here, the reasons for selecting these particular tools are discussed in the section labeled "Statement of the Problem."

Work Breakdown Structure (WBS)

The WBS develops a logical breakdown of a project into levels of detail, defining the project activities (tasks) so they can be

manageable units for planning and controlling purposes. Kerzner (1982) discusses the most common WBS in the following manner:

> Although a variety of Work Breakdown Structures exists, the most common is the five-level indentured shown below:
>
> | Level | Description |
> |---|---|
> | 1 | Total Program |
> | 2 | Project |
> | 3 | Task |
> | 4 | Subtask |
> | 5 | Work Package (20:333). |

One of the difficulties in developing the WBS is in determining the level of detail needed in one area compared to the others, with more complex activities expanding into more levels of detail. "No attempt should be made to have the same number of levels for all projects, tasks, etc." (20:334). "There are no hard-and-fast rules for preparing a WBS; good judgment is the only criterion" (33:105).

Webster (1982) discussed the WBS in the following manner:

> The Work Breakdown Structure (WBS) is discussed in the DOD and NASA Guide: PERT COST (6, p. 28) and is defined in Glossary B of that document as follows:
>
> "Project Work Breakdown Structure--A family tree subdivision of a project, beginning with the end objective and then subdividing these objectives into successfully smaller work packages. The work breakdown structure establishes the framework for:
>
> - defining the work to be accomplished;
> - construction of the network plan;
> - summarizing the cost and schedule status of a project for progressively higher levels of management."
>
> WBS's particular advantage over the punch list or time line is the manner in which it related detail tasks to successfully higher order items or objectives. Although it does not show time relationships well, the start or completion dates can be noted with each element in the WBS. It is generally based on deliverable end items and their components except at the lowest levels. The lowest levels are "work packages" which consists of a set of activities related to cost purposes (37:49).

Kerzner (1982) suggests a sample criteria for developing a WBS discussed below:

- The WBS and work description should be easy to understand.
- All schedules should follow the WBS.
- No attempt should be made to arbitrarily subdivide work to the lowest possible level. The lowest level of work should not end up being a ridiculous cost in comparison to other efforts.
- Since scope of effort can change during a program, every effort should be made to maintain flexibility in the WBS (20:335).

Many project management authors find that a WBS is an essential tool to use in managing a work effort. For example, the PMI's book, Implementing Project Management: A Professional's Handbook stresses the importance of the WBS in the following manner:

> The project Work Breakdown Structure (WBS) is the heart of the project planning effort. It is more than just an element of the project plan, it is the framework on which the project is built. No realistic overall project plan is possible without first developing a WBS that is detailed enough to provide meaningful identification of all the tasks that must be accomplished. . . . The purpose of the WBS is to break the total project down into sufficiently small subdivisions to permit accurate cost estimates, and to permit adequate visibility and control. A second purpose of the WBS is to ensure that the smallest subdivisions represent tasks that can be readily accomplished within the estimated cost and schedule. Thus, the WBS is not only an important control tool, but it is extremely useful as a planning and estimating method (33:105, 42).

Bar Chart (Gantt Chart)

The bar or Gantt Chart develops its own activity breakdown or institutes another project management tool to break down a project. Resulting activities can be plotted against time or sometimes cost to plan and control a project.

Bar charts are most commonly used for exhibiting program progress or defining specific work required to accomplish an objective. Bar charts often include such items as listing of activities, activity duration, schedule dates and progress-to-date. Figure 1 shows nine activities required to start up a production line for a new product. Each bar in the figure represents a single activity. Figure 1 is a typical Bar chart which would be developed by the program office at program inception (20:320).

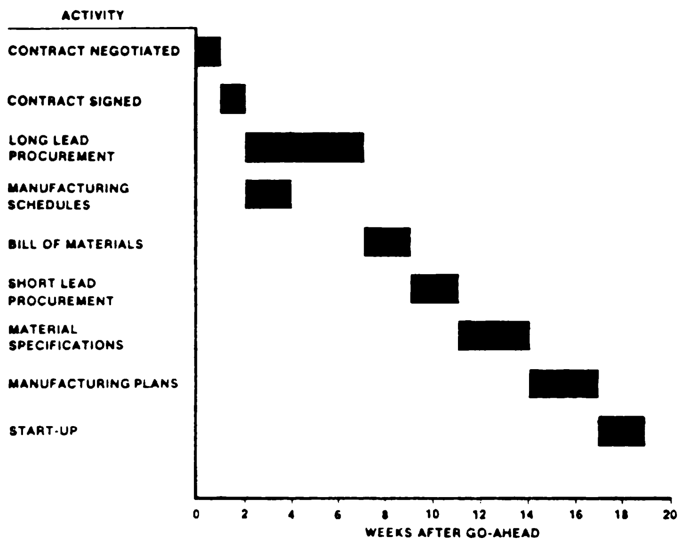


FIGURE 1.--Bar Chart for Single Activities

SOURCE: Harold Kerzner, Project Management for Executives (New York: Van Nostrand Reinhold, 1982), p. 321.

Kerzner (1982) presents a comprehensive sample of bar charts in the "Scheduling for Inhouse Control and Customer Presentations" chapter. He discusses the advantages and disadvantages of bar charts in the following manner:

> Bar charts are advantageous in that they are simple to understand and easy to change. They are the simplest and least complex means of portraying progress (or lack of it) and can easily be expanded to identify those specific elements which may be either behind or ahead of schedule.
>
> Bar charts provide only a vague description of how the entire program or project reacts as a system. There are three major discrepancies in the use of a Bar chart. First, Bar charts do not show the interdependencies of activities, and therefore do not represent a "network" of activities. This relationship between activities is critical for controlling program costs. Without this relationship, Bar charts have little predictive value. . . . The second major discrepancy is that the Bar chart cannot show the results of either an early or late start in activities. . . . Bar charts do not reflect true project status because elements behind schedule do not mean that the program or project is behind schedule. The third limitation is that the Bar chart does not show the uncertainty involved in performing the activity and, therefore, does not readily admit itself to sensitivity analysis. . . .
>
> Even with these limitations, Bar charts do, in fact, serve as a useful tool for program analysis. Even the earliest form of Bar chart, as developed by Henry Gantt, still has merit under certain circumstances (20:320-321).

Webster (1982) discusses the bar chart in the following manner:

> The "Bar Chart" first gained prominence as a result of its application by Henry L. Gantt to the production scheduling at the Frankford Arsenal in 1917, primarily for manufacturing types of work. The chart develops an explicit relationship between work and time. Many variations have been developed including its application to project work; it is probably the single most widely used technique for graphically portraying a project plan on a time scale. Even so, the bar chart has significant deficiencies. It can be considered static in that it requires redrawing to make appreciable changes. On large projects it is necessary to draw the bar chart in a summary form. This factor often draws such comments as "It conceals more than it reveals!" or, to quote O'Brien, "The bar chart often suffers from the morning glory complex. It blooms early in the project but is nowhere to be found later on" (17, p. 5). A summary chart can be supplemented by detail charts, each covering only one or a few bars on the summary chart. Coordination of these various charts is often very difficult and certainly tedious.
>
> Considerable effort is required to revise a schedule shown in this form. This problem has largely been overcome

by making this a standard output from a network based system. The amount of information that can be portrayed, even on a 54" by 72" sheet of paper of a flat bed plotter, is limited. Nevertheless, its popularity continues, particularly on relatively small projects (37:49).

STATEMENT OF THE PROBLEM

Ren Plastics' Labeling System Project-Overview

In March 1982, Lee Hill, Purchasing Manager at Ren Plastics, was approached by Rob Back, a graduate student from Michigan State University (MSU) School of Packaging, about a possible joint project between Ren Plastics and the School of Packaging. The project would require the graduate student to consult with Ren Plastics in an effort to improve their labeling system. The graduate student would use the labeling system information as part of his thesis for a Master of Science degree in Packaging. The research objective was to review available project management tools, select one or more of them for use in this application, analyze their effectiveness, and make recommendations for future selection of tools. The thesis advisors from the School of Packaging, Dr. Bruce Harte and Dr. Hugh Lockhart, would direct the graduate student. The graduate student would use selected project management tools to plan and control the improvement of Ren Plastics' labeling system and as a thesis project, analyze the applicability and effectiveness of these tools.

In June 1982, Lee Hill, Dr. Bruce Harte, Dr. Hugh Lockhart, and Rob Back met twice at Ren Plastics to prepare a memo and an outline for the labeling system project presented in Appendices A and B. The overall plan of the labeling system project was to acquaint the graduate student with the existing labeling system at Ren Plastics,

after which the graduate student would make recommendations on improvement alternatives associated with the problems in Ren Plastics' present labeling system. The final actions taken on the recommendations would be left to the discretion of the Plant Manager, Nick Tartaglione. The memo and outline were presented to Nick Tartaglione on June 15, 1982. On July 15, 1982 he approved the labeling system project, but stressed that he wanted the project to be completed in eight weeks as stated in Appendix A.

The labeling system project began on July 19, 1982, with a meeting between Lee Hill (Purchasing Manager), Dick St. John (Engineering Manager), Gary Smith (Production Manager), and Rob Back (Project Consultant). Lee Hill, Dick St. John, and Gary Smith presented their ideas on improving the labeling system. The responsibility of reviewing improvement alternatives for Ren Plastics' labeling system was turned over to the Project Consultant by the managers attending the meeting. The amount of authority delegated to the Project Consultant was limited. Friendship, trust, and mutual respect developed between the Project Consultant and Lee Hill. This enabled the Project Consultant to have access to top management via Lee Hill. Access to top management was essential for resolving conflicts and removing obstacles between the managers. The accessibility to top management for the Project Consultant proved to be a fundamental requirement to accomplish the project.

Directing the labeling system project by the Project Consultant dealt with motivating and coordinating the Production, Engineering, and Purchasing managers in order to accomplish the activities in the

outline within a reasonable amount of time. The majority of the activities that were accomplished by the Project Consultant required little assistance from the managers. However, when the Project Consultant requested information, assistance, and/or meetings with managers, it required continual motivation and coordination.

Project Management Tools Selected and Why They Were Chosen

The outline prepared by Lee Hill, Dr. Bruce Harte, Dr. Hugh Lockhart, and Rob Back in Appendix B is referred to by project management authors as a WBS tool in project management. An outline is selected because it is a basic planning technique. It is coincidental that the outline is a project management tool. The construction of the outline (WBS) is based on the construction of the project. If the project is simple then so is the breakdown of activities. And if the project is complex, then it follows that the outline (WBS) is complex. As a result, the outline (WBS) can be used on any project. The small number of activities involved in the Ren Plastics' Labeling System Project outline (WBS) is a result of a simple project selected for planning and control.

Nick Tartaglione specified that a duration time of eight weeks would be the important variable in planning and controlling the Ren Plastics' Labeling System Project. The outline (WBS) does not consider the time factor, thus another project management tool needed to be selected. A search through Webster's taxonomy of tools presented in Tables 1 and 2 showed the bar chart to be the most relevant

project management tool, so it was selected for the Ren Plastics' Labeling System Project.

The bar chart presented in Appendix C was chosen for three reasons. Number one, the bar chart can incorporate the outline (WBS) developed in the beginning of the project. Since the bar chart must break down the activities of the project, incorporation of the outline (WBS) into the bar chart avoided duplicating the process. The second reason the bar chart was selected was because the bar chart develops specific relationships between the activities of the project and time. Time awareness enabled the Project Consultant to accomplish the activities in the allocated time frame. The final reason for the bar chart selection was that bar charts are simple to understand and are used by many people in the business world.

RESULTS/DISCUSSION

Ren Plastics' Labeling System Project

Detailed Examination

The Project Consultant incorporated the outline (WBS) presented in Appendix B into a bar chart shown in Appendix C to plan and control the accomplishment of the activities involved in the Ren Plastics' Labeling System Project. A detailed examination of the Ren Plastics' Labeling System Project can be found in Appendix D. The detailed examination in Appendix D contains descriptions made by the Project Consultant of the activities in the outline (WBS). The statements in the following paragraphs refer to the timing of the activities involved in the bar chart.

The solid white bar on top of the solid black bar on the bar chart shown in Appendix C represents the planned versus the actual time needed to accomplish the activities of the project. The Project Consultant surveyed the bar chart daily to learn what planned activities needed to be started, continued, and/or finished during the course of the project. At the end of each week, the Project Consultant drew in the solid black bar along the activities on the bar chart to show which activities had been started, continued, or finished in that week. This gave an up-to-date picture on the progress of the activities as well as compared the planned versus the actual time involved in the project activities. Activities that required more time than anticipated

were known as conflicts. The Project Consultant was able to detect these conflicts in advance, by comparing the planned versus actual timing of the project with the aid of the bar chart, thus solutions were worked out that enabled the project to be completed in the time specified.

Lee Hill, Dick St. John, and Gary Smith desired the Project Consultant (Rob Back) to find an in-line imprinting machine that would replace the two present expensive in-line and off-line hot-stamp imprinting machines (review Appendix D for further details). After the first week of the project, the Project Consultant had obtained sufficient information on Ren Plastics' labeling system to begin locating imprinting machines capable of replacing the present hot-stamp imprinting machines. After talking with many labeling machinery manufacturers in the first three weeks of the project, it was concluded by the Project Consultant that a new imprinting machine was too expensive ($60,000) and also that a new machine could offer no guarantee that it would work in Ren Plastics' particular production application.

The Project Consultant's first conflict was the cost of the new imprinting machine. The reason the conflict existed was because this new imprinting machine held no guarantee of handling Ren Plastics' needs. The bar chart warned the Project Consultant that by the end of the third week a decision had to be made on how to handle the new imprinting machine conflict. An outcome on settling this dispute needed to be reached, otherwise the start of the Productivity sub-activities in the fourth week would be delayed. The decision reached by the Project Consultant was termination of the idea to purchase a new

imprinting machine. At the beginning of the fourth week, the Project Consultant informed the managers that no in-line imprinting machine existed that could replace Ren Plastics' present machines that met their particular production application and financial needs. After much discussion, the managers agreed with the Project Consultant's conclusions to terminate the new imprinting machine idea. The Project Consultant then presented an article from Modern Materials Handling (June 7, 1982), entitled "Computer Controlled Labeling: On-site printing that's flexible and fast." After reading this article, the managers approved the search by the Project Consultant for an off-line computer labeling system that would cost less money and work in Ren Plastics' particular production application.

During the fourth week of the project, the Project Consultant worked on the Productivity sub-activities on the bar chart and coordinated the visits of various vendors who could possibly supply Ren Plastics with an off-line computer labeling system. Three obstacles existed that computer vendors had to overcome to meet Ren Plastics' particular production application. These obstacles were: having computer labels finished in roll form, the speed of imprinting the computer labels, and service back-up if the system went down. The roll form was needed because all pint and quart labels are automatically attached by a roll-fed labeler (review Appendix D for further detail). The rate at which the label is printed is important because the amount of information needed on the label varies. If the computer labeling system went down, Ren Plastics would have to stop production. Thus, the requirements for service back-up is important.

In the fourth week, while working on the Productivity sub-activities as well as coordinating computer vendor visits, the Project Consultant learned that Ren Plastics had no way of measuring productivity on their labeling system. This missing measurement became the Project Consultant's second conflict. Recommendations were given to the Project Consultant by the thesis advisors and managers with the primary suggestion being a productivity study. The Project Consultant spent many hours in the fifth and sixth weeks trying to develop productivity studies for Ren Plastics' labeling system. At the beginning of the seventh week, the Project Consultant reviewed the bar chart and realized the project could not be completed on time if the productivity studies were to be performed. The Project Consultant explained to the managers and the thesis advisors the problem of conducting productivity studies on the labor involved for 250 products packaged in six different containers within a three-week period. The managers and thesis advisors suggested the Project Consultant estimate the labor involved in labeling at Ren Plastics. These estimates were completed by the seventh week of the project.

While reviewing the work progression in the seventh week the Project Consultant became aware of the differences between anticipated computer vendors' visits and actual visits. This difference lead to the third conflict. The third conflict developed because of delays in computer vendors follow-up visits due to scheduling problems. Delays in computer vendor follow-up visits delayed the progress of the bar chart's section on Problems Facing Ren Plastics' Labeling System and Recommendation activities.

During the middle of the seventh week, the Project Consultant asked Lee Hill to OK a two-week extension on the project via Nick Tartaglione. The extension would allow the Project Consultant to narrow the scope of computer labeling vendors as well as complete the two project components, Problems Facing Ren Plastics' Labeling System, and Recommendation. The Project Consultant would not charge Ren Plastics any more money for the additional two weeks in consultant fees. Lee Hill presented the Project Consultant's proposal to Nick Tartaglione at the end of the seventh week. Nick Tartaglione granted the two-week extension to the Project Consultant.

The number of computer labeling vendors were narrowed considerably because many vendors could not overcome the three obstacles presented earlier. At the end of the eighth week, only Standard Register and Weber Marking Systems would attempt to solve the obstacles associated with Ren Plastics' labeling application. Standard Register and Weber Marking Systems were planning on bringing their machines into Ren Plastics during the next two months for trial runs. By the end of the tenth week all the activities in the project had been completed and the descriptions were written for Appendix D.

Limitations of the Project

The ultimate objective of this study was to select project management tools that would aid planning and control of the Ren Plastics' Labeling System Project. The outline (WBS) and bar chart tools were selected and applied to supply background information, identify problems, and develop recommendations for the Ren Plastics'

Labeling System Project. In conducting the investigation, the material costs of labeling were obtained from Ren personnel and the labor costs of labeling were estimated by the Project Consultant. The material cost figures of labeling given by Ren employees were accepted as accurate by Ren personnel. The labor cost figures developed by the Project Consultant were estimated because Ren does not have a productivity measurement system for labor involved in labeling. The Project Consultant drew up estimates on labor costs involved in Ren's labeling system. The Project Consultant believes these estimates are conservative.

The material and labor costs (presented in Appendix D), make it possible to identify Ren's labeling system problems as well as offer material and/or labor cost saving recommendations. The material and/ or labor cost saving recommendations were taken from label vendors and trade magazines. Consequently, any change or modifications in the present labeling system of Ren Plastics, except those recommended by the Project Consultant in Appendix D, will not be considered within the scope of this thesis.

Outcome of the Project

The Project Consultant developed three groups of potential material and labor saving recommendations presented in Appendix D, on September 24, 1982. A year after the recommendations were made on the Ren Plastics' Labeling System Project, the Project Consultant reported the actual material and labor savings made on his three recommendations. The following recommendations were given on

improving Ren's Labeling System Project. Some of these suggestions have resulted in immediate implementation, while others are still under consideration.

There were four recommendations in the first group: (1) using cheaper label material for the standard labels; (2) reducing the price of the imprint material; (3) having vendors print Department of Transportation (DOT) information on the shippers instead of hand-affixing pressure-sensitive DOT labels by hand; and (4) standardizing the existing twenty-eight label formats down to four. The \$26,920 spent on high gloss standard labels (\$4,500 for small standard labels plus \$21,700 for large standard labels, plus \$720 for wasted standard labels presented in Appendix D, Table III), convinced the Purchasing Manager to reduce the expensive material costs of those labels. He was able to reduce the material cost of the expensive high gloss standard labels by forty percent through purchases of larger quantities. This represents a material cost savings of \$10,768 (\$26,920 times forty percent) to Ren Plastics. There will be an increase in Ren's label inventory costs. The Plant Engineer is in the process of evaluating non-gloss labels to improve the imprint quality of the hot-stamp imprinter and further reduce the material costs. The results of his examination of other labeling material will not be known for several months.

Another implementation of the Group One recommendations was a reduction in Ren's imprint material cost by fifty percent during the labeling system project through negotiations between the imprint material vendor and the Purchasing Manager. This reduced the price

of the imprint material from $26,196 (smaller imprint material roll $4,356 plus large imprint material roll $21,840 presented in Appendix D, Table III), to $13,098 ($26,196 times fifty percent) shown in Appendix D, Table VIII. Since then the Purchasing Manager, through competitive bidding, has reduced the imprint material cost by another fifty percent. The imprint material now costs Ren $6,549 ($13,098 times fifty percent). This results in a total material cost savings of $19,647 ($26,196 minus $6,549).

Ren has instituted the printing of DOT information on pint and gallon shippers instead of hand-affixing pressure-sensitive DOT labels to the shippers that are included in Group One recommendations. The printing of DOT information on quart shippers cannot be done because of the variations in hazard classes in the quart products. Every time Ren switches from hand-affixing DOT labels to printing them on the shipper, Ren saves 11 cents per DOT label presented in Appendix D. There are 15,000 pint shippers with one DOT label per shipper and 100,000 gallon shipper with two DOT labels per shipper (Appendix D, Table II). This results in 15,000 DOT labels affixed to the pint shipper and 200,000 DOT labels affixed to the gallon shipper for a total of 215,000 DOT labels. Ren has printed the DOT information on sixty percent of the pint and gallon shippers. This represents a $14,190 savings in material and labor costs (215,000 DOT labels times sixty percent equals 129,000 times 11 cents). Lee Hill negotiated the price of printing the DOT information on the shipper with the shipper vendor so it would not cost Ren any money. But Ren would have to

order 5,000 of each different shipper each time Ren orders shippers. This will increase Ren's shipper inventory costs.

Also, in the first group of recommendations, Ren could have material cost savings by standardizing their twenty-eight label formats. The Engineering Manager decided not to standardize the formats because the products required different information on each label to avoid breaking government and shipping regulations. However, the Project Consultant sees potential in reducing the number of label formats through negotiations between Dick St. John and the regulation agencies. The Project Consultant estimated a $6,730 savings in material (Appendix D, Table VIII) by reducing the twenty-eight label formats to four. Therefore, the actual cost savings of $44,605 (Table 3) from Group One recommendations have been achieved by Ren one year after the project was completed.

TABLE 3.--Group One Actual Cost Savings.

Material cost savings due to buying the label in larger quantities	$10,768
Material cost savings due to two fifty percent price reductions in imprint material	19,647
Material and labor cost savings by switching from hand-affixing DOT labels to pint and gallon shipper to printing them on the shipper	14,190
TOTAL Savings	$44,605

The comparison of the potential Group One savings of $37,904 in Appendix D, Table VIII is lower than actual savings of $44,605

presented in Table 3. This is without any potential cost savings due to standardizing the twenty-eight label formats and savings by switching from glossy to a non-glossy label material.

For Group Two recommendations, consideration of the off-line computer labeling system that could replace the two hot-stamp imprinters was notable but the technology had not been developed to fit Ren's applications. Ren brought in two computer labeling systems on a trial basis. The slow speeds of the two computer printers were not acceptable for Ren's needs. The printing speed on the computer labeling system is five times slower than the present hot-stamp imprinters. In addition, a slitter would be required to remove the tractor feed holds that guide the label through the printer. Finally, the fact that the off-line labeling system could break down and halt production since the labels would be produced right before they are affixed to the container, left Ren skeptical of the printers. Therefore, after the trial period, Standard Register and Weber Marking Systems machines were shipped back. However, Ren is still interested in a computer labeling system because of the potential material and labor savings of $26,286 in Appendix D, Table IX.

The relocation of Ren from South Cedar, Lansing, Michigan, to Dawn Avenue, East Lansing, Michigan caused Ren's capital expenditures for 1982 and 1983 to be used. Therefore, a label affixer and jet-spray imprinter for the gallon line suggested in Group Three recommendations, will be unattainable in 1982 and 1983, but are being considered for purchase in 1984. Estimates of the labor hours in Appendix D, Table X spent on hand-affixing standard labels to gallon

cans and hand-stamping the product number on the gallon shipper represent $9,180. The Engineering Manager and the Plant Manager recognize the avoidance of an expense of $9,180 would then allow the purchase of the label affixer and jet-spray imprinter for the gallon line. This purchase has a payback period of less than one year. Therefore, an actual savings of $44,605 in labor and material costs, as well as possible future savings from other recommendations, offsets the original consultant fee of $1,680 (Appendix A).

Effectiveness of the Tools

The incorporation of the outline (WBS) and the bar chart aided considerably in the planning and control of breaking down the activities and maintaining the Ren Plastics' Labeling System Project within a ten week period. The project was broken down into Background Information on Labeling, Background Information on Ren Plastics' Labeling System, Problems Facing Ren Plastics' Labeling System, and Recommendations activities. These activities are further broken down into sub-activities that are presented in the outline (WBS) shown in Appendix B. The descriptions made on the activities shown in Appendix D presents a case study on the Ren Plastics' Labeling System Project. The bar chart (Appendix C) kept track of the planned versus actual time involved in accomplishing the activities and sub-activities of the Ren Plastics' Labeling System Project. Comparisons made between the differences in planned versus actual time on the bar chart warned the Project Consultant in advance about any conflicts affecting project completion.

The first conflict of not being able to find an adequate in-line imprinter to replace the two existing hot-stamp imprinters, threatened the length of the project in the fourth week. The solution to the first conflict was to find a computer labeling system. The decision on the conflict enabled the Project Consultant to start the Productivity sub-activities in the fourth week as planned.

The Productivity sub-activities turned into the second conflict. Ren Plastics' productivity measurements were to be studied by the Project Consultant in the fourth, fifth, and sixth weeks to determine the labor costs associated with the labeling system in the seventh week. However, Ren Plastics did not have productivity measurements on their labeling system. Because the thesis advisors and managers wanted productivity studies, the Project Consultant had to then try to develop productivity studies in the fifth and sixth weeks of the project. But productivity studies on the labor involved for 250 products packaged in six different containers threatened the length of the project in the seventh week. The solution to the second conflict was to take estimates instead of doing the productivity studies. These estimates allowed the Project Consultant to start working on the Problems Facing Ren Plastics' Labeling System and Recommendation activities as planned. But the Project Consultant was not able to start those activities in the seventh week because the third conflict arose.

This conflict was schedule problems between the Project Consultant and computer labeling vendors. The Project Consultant needed to meet with computer labeling vendors in the seventh and eighth week,

so as to narrow down the possible vendors who could supply Ren Plastics with a computer labeling system. Since the Project Consultant knew he was going to exceed the project time limit in the seventh week, he asked for, and was granted, a two week extension. This extension allowed accomplishment of the Problems Facing Ren Plastics' Labeling System and Recommendation activities in the ninth and tenth week of the project.

The actions taken on the three conflicts by the Project Consultant were necessary in order to control the length of the project. The conflicts could not be avoided and resulted in a two week project extension. Without the outline (WBS) and bar chart, the Project Consultant's planning and control of Ren Plastics' Labeling System Project would probably have taken more than ten weeks. This is because the incorporation of the outline (WBS) into the bar chart explicitly showed the Project Consultant the relationship between the activities and time, thus allowing the project to be finished in the earliest possible week. Therefore, the effectiveness of the outline (WBS) and bar chart tools of the project can be measured in the actual material and labor cost savings of $44,605. Consequently, even with the consultant fees of $1,680, the project still had an actual cost savings of $42,925 ($44,605 minus $1,680).

CONCLUSION

Guidelines for Selecting the Proper Tool for a Specific Project

Project management tools do break down a project into activities and estimate costs and time involved in the activities through resource allocations, but project management literature gives limited guidance on tool selection and usage in certain circumstances and has an over-emphasis on network based tools. Therefore, the key to selecting the tool or tools to manage a specific project is applying awareness gained from literature but more importantly knowledge gained from actual project experience. Consequently, proceeding through Webster's taxonomy of tools and/or survey of software packages presents the most comprehensive listing of project management tools, but the tools chosen for a particular project depend on the particular project characteristics and on the previous experience of the tool selector.

The Project Consultant chose the WBS and the bar chart for the Ren Plastics' Labeling System Project because of the simplicity of the project and the tools. The Project Consultant did not have any experience in the use of project management tools until the Ren Plastics' Labeling System Project. The Project Consultant relied on what was written in literature for deciding upon the tools. Based on the experience gained from the Ren Plastics' Labeling System Project, the Project Consultant can now present some guidelines for selecting the proper tools for a specific project.

The first guideline is to break down the project into activities with the help of a WBS. The more activities, the more complex the project will be. The Ren Plastics' Labeling System Project has four activities and seventeen sub-activities. The small number of activities and sub-activities made the activities of the Ren Plastics' Labeling System Project easy to watch. But if there were more than four activities and seventeen sub-activities involved in a particular project, it would be difficult to watch the activities. The WBS may be the only tool necessary to plan and control a particular project, depending on the capabilities of the project management.

Once the project has been broken down into activities, it can then be decided if other tools are needed to manage the project. Other project management tools may be incorporated with the breakdown of activities to estimate the costs and/or time involved in the activities by resource allocations. The second guideline for selecting the additional project management tools for a specific project is to compare the tools in Webster's taxonomy of tools and/or survey of software packages to one another. The reason for this comparison is to learn what additional tools are needed, in addition to the WBS tool, for managing the particular project application. For example, an important constraint of the Ren Plastics' Labeling System Project was the time schedule put forth by the Plant Manager. This constraint is why the Project Consultant needed another project management tool, besides the WBS, to watch the time involved in the Ren Plastics' Labeling System Project. The bar chart was compared against the other project management tools and was selected because it can

incorporate the WBS, develops a specific relationship between the activities of the project and time, and is simple to understand. The bar chart does not take into consideration the breakdown of time and costs associated with material, labor, equipment, space, and/or energy resources. If the resources had to be broken down into time or costs associated with the activities and sub-activities of the Ren Plastics' Labeling System Project, the Project Consultant would have found the bar chart ineffective to plan and control the project. The bar chart examines the schedule or budget associated with a particular project broken down into their time or costs, not both. The bar chart used for Ren Plastics' Labeling System Project, effectively planned and controlled the timing of the activities and sub-activities since the Project Consultant was the only resource involved and the budget of the project had already been broken down in the form of consultant fees. The Ren Plastics' Labeling System Project bar chart does show actual versus planned time involved in the activities and sub-activities but it does not show the breakdown of time and costs associated with various resources which may be necessary in other projects. Therefore, time and cost tracking of resources are needed when there are more than two resources involved in a particular project. Consequently, there are many project management tools to choose from but the tools decided upon depend on the particular project characteristics and the previous experience of the tool selector.

APPENDICES

APPENDIX A

MEMO ON THE PURPOSE AND OBJECTIVE OF THE REN PLASTICS' LABELING SYSTEM PROJECT

REN PLASTICS
5656 South Cedar Street
P.O. Box 23037
Lansing, Michigan 48909
Telephone 517 393-1500
a CIBA-GEIGY Company

File

TO: Nick Tartaglione DATE: June 15, 1982

FROM: Lee Hill

SUBJECT: Packaging Program

As you have requested, this is an attempt at justifying a mini-project on our labeling systems. The proposed project would be done by personnel outside of Ren through Michigan State University. The personnel would include one graduate student and two faculty members. The graduate student would be doing all the field work, time studies, visitations and write ups. The faculty personnel would be responsible for consultations, contacts, lab work, and generally overseeing the end of the project.

The cost of the project would be as follows:

1 graduate student @ \$5.25/hr.	20 hrs. x 8 wks. = 160 hrs. x \$5.25 =	\$ 840
MSU faculty supervision @ \$42/hr.	2 faculty members = 20 hrs. x \$42 =	840
	TOTAL COSTS	\$1,680

There has been no denying that we need to complete this project as it relates directly to the can lining project we finished last year. Timing and coordination are keys to success on any project and I feel we don't have enough time to adequately coordinate this project ourselves. The consolidation project, production changes, and the physical inventory are all taking up valuable time in the next few months that would be spent in this area. The amount of contacts and reviews that we would have to deal with in vendors, products and processes would be limited due to our time frame. The MSU group is suited especially well in taking our communications and ideas and making contacts and getting feedback to us as soon as possible.

I feel this project originally had a yearly savings projection of \$30,000. I still feel the same way although this figure should be a minimum number and not an average. This is an opportunity for production, engineering and purchasing to communicate better and coordinate more thoroughly the specific needs each requires. The \$1,680 that would be required to complete the project could be minimal compared to the benefits and savings we could receive.

Please review this request and respond as soon as possible as the time schedule would start July 15, if at all.

Thank you,

Lee Hill

Lee

LH/ig/1/B-13

APPENDIX B

OUTLINE OF THE REN PLASTICS' LABELING SYSTEM PROJECT ACTIVITIES

REN PLASTICS' LABELING SYSTEM PROJECT

I. Background Information on Labeling

A. Label machinery

B. Label material and adhesives

C. Label imprinters

II. Background Information on Ren Plastics' Labeling System

A. History

B. Types of labels

1. Standard labels

2. DOT labels

3. Specialty labels

C. Packaging lines

D. Hot-stamp imprinting machines (in-line and off-line)

1. In-line hot-stamp imprinting machine

2. Off-line hot-stamp imprinting machine

3. In-line and off-line hot-stamp imprinters' imprint plates

E. Other imprinted information

F. Productivity

1. Ren's present productivity measurements

2. Project consultant's measurements of productivity

III. Problems Facing Ren Plastics' Labeling System

IV. Recommendations

APPENDIX C

BAR CHART OF THE REN PLASTICS' LABELING

SYSTEM PROJECT SCHEDULE OF ACTIVITIES

REN PLASTICS' LABELING SYSTEM PROJECT - BAR CHART

Activities	7/19/82 Weeks 9/24/82
	1 2 3 4 5 6 7 8 9 10

I. Background Information on Labeling

A. Label machinery

B. Label material and adhesives

C. Label imprinters

II. Background Information on Ren Plastics' Labeling System

A. History

B. Types of labels

1. Standard labels

2. DOT labels

3. Specialty labels

C. Packaging lines

D. Hot-stamp imprinting machine (in-line and off-line)

1. In-line hot-stamp imprinting machine

2. Off-line hot-stamp imprinting machine

3. In-line and off-line hot-stamp imprinters' imprint plates

E. Other imprinted information

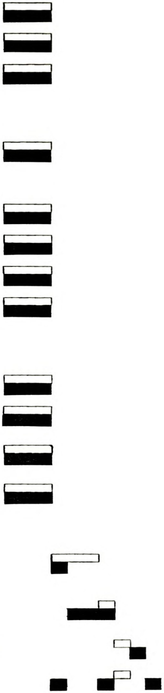
F. Productivity

1. Ren's present productivity measurements

2. Project Consultant's measurements of productivity

III. Problems Facing Ren Plastics' Labeling System

IV. Recommendations



Note - The solid white bar was planned time
The solid black bar was actual time

APPENDIX D

DESCRIPTION OF THE ACTIVITIES INVOLVED IN THE REN PLASTICS' LABELING SYSTEM PROJECT

REN PLASTICS'

LABELING SYSTEM REPORT

I. Background Information on Labeling

A. Labels machinery

B. Label material and adhesives

C. Label imprinters

Response - The most helpful information on labeling was obtained from two books published by the Packaging Machinery Manufacturers Institute on Labeling and on Coding, Marking, and Imprinting. Packaging Engineering's 1982 encyclopedia on "Imprinting Individual Packages," "Labeling, Glue, and Thermoplastics," and "Labels and Label Methods" further educated me in the area of labeling. Also, labeling equipment vendors contacted by the project consultant helped clarify the readings on labeling and further explanation of labeling production was gained.

II. Background Information on Ren Plastics Labeling System

A. History

Response - Ren Plastics is one of the divisions of CIBA-GEIGY. CIBA-GEIGY has many divisions throughout the world, with its world headquarters in Switzerland and U.S. headquarters in Ardsley, New York. CIBA-GEIGY ranks among the world's top chemical companies engaged principally in the discovery, development, manufacture, and marketing of chemical products. CIBA-GEIGY serves the U.S. market with hundreds of products in the pharmaceutical, agricultural, dyestuffs, pigments, epoxy resins, specialty chemicals, and in many other consumer areas.

Ren Plastics has been a pioneer and leader in plastic tooling for the past forty years. Tooling is a basic stage of production that requires prototypes, patterns, and molds. Ren established the advantages of plastics for tooling for the automotive, foundry, aerospace, and many other varied industries. It did not take long for industry to become aware of these advantages and for Ren to become the innovator and major supplier of tooling plastics and technology.

With plastics, tooling time and costs can be cut as much as fifty percent. The resulting tools are light, easy to handle, and very durable. In case of damage or design changes, plastic tools can easily and quickly be repaired or modified. They set at room temperature and require no special storage.

Ren Plastics' tooling plastics are used in the automotive industry for reproducing patterns and die molds; in the foundry industry for reproducing patterns and die molds; and in the aerospace industry for thousands of segments of an aircraft which are first formed in plastics to provide prototypes and tooling master models.

Ren also uses their plastics for an adhesive. Ren's adhesives are made out of plastics that bond a variety of similar or different materials for archery bows, pre-cast concrete segments for roadways and bridges, mass transit vehicles, giant communications towers, skis, and many other applications.

Development and testing new formulations is a never-ending process at Ren laboratories. The laboratory complex at Ren includes extensive facilities for quality control, research and development, material and application testing, sample testing, product modification, and experimental processing. Research and development labs include a pilot plant for production development.

Once a product has been tested, marketed, and enough demand has been requested, the product is moved out of research and development and into production, where larger batches of the product can be made more economically. Ren's existing product line of 250 products are mixed, filled, and packaged by hand or semi-automatically in a batch type (job-shop) fashion. Ren has a number of mixers, fillers, and six different kinds of packages to put their products in, creating the potential for many different batches to be produced at the same time in various stages of production. Ren produces and packages resins and hardeners in separate batches. It is up to Ren's customers to mix the resins and hardeners in the right ratios so they will set into molds or prototypes.

In 1982, Ren will have total sales of $12 million dollars. In the past, the automobile industry has dominated Ren's sales and customers. Through a gradual shift over the years, the aerospace industry now dominates Ren's sales and customers. Boeing, Rockwell, McDonnel Douglas, and General Motors are a few of the customers of Ren.

In order for Ren to become more efficient, changes were needed. A noticeable improvement came when Ren moved its facilities to one location and reduced the number of employees. Recently, Ren transferred everything to the Dawn Avenue site in East Lansing. Prior to this, there were two sites: one in Lansing on South Cedar Street and the other on Dawn Avenue. Ren enlarged the laboratories and offices at Dawn Avenue to accommodate the South Cedar employees. Two years earlier, Ren rid itself of numerous warehouses in the Lansing area and added two warehouses to the Dawn Avenue site. By consolidating into one facility, Ren has saved tremendous amounts of money in handling raw materials and finished goods, expenses of owning and operating numerous warehouses, mistakes and delays related to communication barriers between the two facilities (South Cedar and Dawn Avenue), and eliminating employee conflicts arising from locality differences.

Two years earlier, Ren reduced the number of employees by 60 to 70 percent. Now, Ren has 20 production workers and 50 salaried people. The reduction created a confusion as to who was responsible for the new work load due to the lay-offs. The confusion is gradually coming to an end and Ren has a great opportunity to expand its market in an improved economy.

B. Types of Labels

1. Standard labels

Response - Ren uses three types of labels on their six primary and/or three secondary packages. The three types of labels are the standard, Department of Transportation (DOT), and specialty labels. All three types of labels are pre-printed on pressure-sensitive labels. The six primary packages are the pint can, quart can, gallon can, two and five gallon pail, and the fifty-five gallon drum. The three secondary packages are the cartons that contain six pint cans, six quart cans and one gallon can.

The standard labels have two sizes: the 1-5/8" by 11" and 4" by 11" labels. The smaller label has ten different formats and the larger label has eighteen different formats. A sample of one of the smaller and larger label formats are presented in Figure-I in the back of this report. The smaller and larger standard labels in Figure-I have been reduced in size. The smaller label is only affixed to the pint can. The standard labels are pre-printed on high gloss paper.

The standard labels are broken down into three pre-printed sections. The first section has first aid information and the Society of Plastics Industry (SPI) classifications for DOT regulatory reasons. The second section has the Ren logo and address on the top, with the blank area below for the variable information (imprint), and a warning on what the product might do below the blank area for DOT regulatory reasons. The third section is the disclaimer which explains the use of the product to the customer.

The standard labels are stored on shelves containing the twenty-eight different formats. The information already printed on the labels (not including variable information) is performed by the label vendor with a print plate. Ren owns the plates, consisting of ten small and eighteen large label plates, which create the pre-printed information on the twenty-eight different formatted labels. To change the information on the print plates, it requires a new plate to be made at a cost of $300 dollars. Recently, Ren needed to change the address on all their labels because of the move from South Cedar in Lansing, Michigan to Dawn Avenue in East Lansing, Michigan. The cost to Ren amounted to $8,400 dollars (28 formatted labels times $300 dollars a print plate). Ordering labels from a vendor, not only includes the label cost and the print plate charges, but it also consists of supplier fees for switching the print plates during the printing of the formatted label. When the label supplier switches a formatted label, it requires a different plate at a cost of $50 dollars. There will be sixty print plate switches in 1982, costing Ren $3,000 dollars (60 plate switchings times 50 dollars each time).

Ren will be using 412,000 standard labels in 1982. The larger standard labels are affixed to quart cans, gallon cans, two and five gallon pails, and fifty-five gallon drums. Drums are labeled twice. The smaller standard labels are affixed to pint cans.

Table-I Standard label usages on their respective packages at Ren in 1982

Pint cans	15,000 cartons (6 pints per carton)	90,000
Quart cans	25,000 cartons (6 quarts per carton)	150,000
Gallons cans		100,000
Two and five gallon pails		40,000
Fifty-five gallon drums	10,000 drums are labeled twice	20,000
Wasted labels	3 percent estimate (400,000 times 3 percent)	12,000
		412,000 standard labels

The smaller standard labels cost 5 cents each and the larger standard labels cost 7 cents each. Ren will be spending $26,200 dollars in 1982 on these two standard labels (90,000 times 5 cents plus 310,000 times 7 cents plus 12,000 times 6 cents). The 12,000 wasted standard labels are a 3 percent estimate of the 400,000 labels used on Ren's packages. The 6 cents is an average price of the large and small standard label costs (7 cents for the large label and 6 cents for the small label).

The variable information shown on the standard labels is imprinted with a hot-stamp machine or a rubber-mat-stamp by hand. The variable information that is placed on the labels is the product number, product name, mixing ratios, and weight. The hot-stamp material will cost Ren $26,196 dollars in 1982 (smaller imprint material 121 rolls times $36 dollars each plus larger imprint material 455 rolls times $48 dollars each). The variable information that is affixed with a hot-stamp imprinting machine requires an imprint plate that costs Ren $20 dollars. Ren will be ordering 100 new imprint plates in 1982 which will cost Ren $2,000 dollars (100 new imprint plates times 20 dollars).

2. DOT labels

Response - There are twelve different DOT labels that will be used in 1982 by Ren. A sample of the flammable DOT labels in their three different size labels are presented in Figure-II. The poison, alkaline, and corrosive DOT labels also have the same three different size labels. So altogether, there are twelve corrosive, poison, alkaline, and flammable DOT labels. The DOT labels are affixed by hand on the pint, quart, and gallon cartons but not on their cans. The two gallon pails, five gallon pails, and drums have the DOT label hand-affixed on the container. Ren will be using 340,000 DOT labels in 1982.

Table-II DOT label usages on their respective packages at Ren in 1982

Pint cans	15,000 cartons (one DOT label per carton)	15,000
Quart cans	25,000 cartons (one DOT label per carton)	25,000
Gallons cans	Two DOT labels for each gal.(100,000) carton	200,000
Two and five gallon pails	Two DOT labels for each pail (40,000)	80,000
Fifty-five gallon drums	Two DOT labels for each drum (10,000)	20,000
		340,000 DOT labels

DOT labels cost between 3 to 7 cents with an average price of 5 cents each. Therefore, $17,000 dollars will be spent on DOT labels at Ren in 1982 (340,000 DOT labels times 5 cents).

3. Specialty labels

Response - There are thirty-nine different specialty labels that will be used in 1982 by Ren. A sample of three specialty labels are presented in Figure-III. Specialty labels are affixed by hand to low volume product packages. Specialty labels cost between 10 to 20 cents each with an average price of 15 cents. Ren will be ordering 15,000 specialty labels in 1982, but only 1,500 will be used on product packages. Therefore, $2,250 dollars in 1982 will be spent on specialty labels (15,000 labels times 15 cents).

Table-III Cost of standard labels, new imprint plates, switching print plates, imprint material, DOT labels, and specialty labels at Ren in 1982

$ 4,500	Small standard label costs (90,000 labels times 5 cents each)
21,700	Large standard label costs (310,000 labels times 7 cents each)
720	Wasted label costs (12,000 labels times 6 cents each)
2,000	New imprint plates (100 new imprint plates in 1982 times $20 dollars each)
3,000	Switching print plates (60 changes times $50 dollars each change)
4,356	Smaller imprint rolls (121 rolls times $36 dollars each)
21,840	Larger imprint rolls (455 rolls times $48 dollars each)
17,000	DOT label costs (340,000 times 5 cents each)
2,250	Specialty label costs (15,000 times 15 cents each)
$77,366* dollars	

*This figure does not include label machinery costs, label machinery operating costs, labor costs involved in labeling, and the cost incurred due to Ren moving to Dawn Avenue in East Lansing, Michigan from South Cedar Street in Lansing, Michigan which changed the address on the standard label print plates at a cost of $8,400 dollars.

C. Packaging lines

Response - There are two packaging lines in operation at Ren Plastics. One is the gallon line while the other is the pint and quart line. The gallon line is not as automated as the pint and quart line, but both lines are semi-automatically run. The two gallon pails, five gallons pails, and drums are mixed, filled, and packaged with the help of machinery but they are not processed on any type of packaging line. The pint, quart, and gallon cans are sometimes filled in their respective packaging lines but the product is always mixed in different areas.

D. Hot-stamp imprinting machines (in-line and off-line)

1. In-line hot-stamp imprinting machine

Response - The pint and quart packaging line affixes the standard labels automatically with a label affixer and hot-stamp imprinter that is in one unit. The in-line hot-stamp imprinter and label affixer are fed with a roll of labels that unroll through a series of guides to the label affixer's peel bar. The peel bar separates the label from the backing of the pressure-sensitive label when the labal attaches to the can. After separation by the peel bar, the backing of the label is re-rolled under tension. The label affixer and hot-stamp imprinter are located between the can-topper and the hand-carton packer accumulator shown in Figure-IV. The label affixer is on a conveyer with the hot-stamp imprinter. The roll of labels travels through the label imprinter, and the label affixer, and then the label attaches itself to the the edge of the can. The can in turn spins around by a friction belt which wraps the whole label around the container. The label attachment is triggered by an electric eye.

2. Off-line hot-stamp imprinting machine

Response - The gallon cans, two gallon pails, five gallon pails, and drums have standard labels affixed by hand but are imprinted with the off-line hot-stamp imprinter. The off-line hot-stamp imprinter is very similar to a reel-to-reel tape deck for a stereo. It is fed with a roll of labels that unwind through a series of guides where the label is imprinted. The backing and the label of the pressure-sensitive labels are rolled-up and stored on storage shelves waiting hand application to the gallon cans, two and five gallon pails, and drums. Ren usually has a month's quantity of gallon cans, two and five gallon pails, and drums imprinted labels on shelves waiting to be hand-affixed. This process takes on operator four days to print up the variable information on the labels for that one month's supply. It frequently happens that Ren does not have the right imprinted labels on the shelves. This then requires a special batch of imprinted labels to be printed up, so Ren will be able to handle their month's supply.

3. In-line and off-line hot-stamp imprinters' imprint plates

The in-line and off-line imprinters are composed of an imprint plate which is made of alloys that screw into a housing that slides into place between two jaws of the imprinter. The in-line and off-line imprinters use the same imprint plates. One of the jaws pushes against the other by air pressure. The closing of the jaws pushes the imprint plate against the imprint material and the label. The imprint plate is heated and the imprint material is heat sensitive. The imprint material that touches the backward raised letters and numbers of the imprint plate is then transferred frontwards with the product number, product name, mixing ratios, and the weight on the label. There are roughly 1,250 imprint plates currently being used for Ren's products. There are 1,000 imprint plates for the larger standard label and 250 imprint plates for the smaller standard label. The imprint material also comes in two sizes: small and large rolls. The 1,250 imprint plates in inventory cost Ren $25,000 dollars ($20 dollars per plate times 1,250). This inventory cost does not include the 100 imprint plates that will be used on 1982 for new products. Nor does the cost take into account the imprint plates not used anymore. Ren has a sizeable collection of old imprint plates that are never used due to the product never leaving the development stage, product discontinuation, or the product replacement. For example, 500 new imprint plates were ordered when Ren standardized their primary packages in 1980. This standardization changed 500 weights on the 1,250 imprint plates currently being used. This resulted in replacing imprint plates with the wrong weight with new imprint plates with the right weight. This standardization cost Ren $10,000 dollars ($20 dollars per imprint plate times 500 new imprint plates).

E. Other imprinted information

Response - The date, product number, and batch number have to be imprinted on either the standard label and/or the surface of the carton. The date, product number, and batch number are imprinted on the pint and quart cartons automatically by a Marsh jet-spray carton imprinter. The standard label that is hand-affixed on the gallon cans has the date and batch number imprinted first on the label surface with a rubber-mat-stamp. The gallon cartons have the product number imprinted by hand with a rubber-mat-stamp on the carton surface. The label that is put on the two gallon pails, five gallon pails, and drums have the date and batch number imprinted by hand with a rubber-mat-stamp on the label surface. The product number does not have to be imprinted on the two gallon pail, five gallon pail, and drum labels with a rubber-mat-stamp since they already have it hot-stamped on the label and they are not enclosed in a carton like the gallon can.

Hand-imprinting with a rubber-mat-stamp on the standard labels or cartons requires time to devise the words and/or numbers necessary for imprinting. The required ink causes the image of the stamp to be messy and it does not create a consistent imprint quality. There is a longer set-up time for the hand-imprinting with a rubber-mat-stamp than the imprint plates, and the rubber-mat-stamp requires an operator to hand-imprint the surface. The products that do not have hot-stamp imprint plates end up using the rubber-mat-stamp for imprinting the product number, product name, mixing ratios, and weights.

F. Productivity

1. Ren's present productivity measurements

Response - Ren measures productivity in standard hours. The plant manager (Nick Tartaglione), production manager (Gary Smith), and plant engineer (Dick St. John) assign standard hours for mixing, filling, packaging, and their related set-up and clean-up times. The accountant then receives the figures on the total time needed for mixing, filling, packaging, and each set-up and clean-up times from the production manager's daily reports. The daily reports do not include the number of workers involved in each operation. The accountant then reviews the daily production reports and compares each batch time against the standard hours. The daily reports are then figured to see if production is above or below the standard hours and once calculated are then grouped together and put into a productivity report.

The only example of Ren improving productivity was performed by the plant manager (Nick Tartaglione) a few years back. The plant manager wanted to increase the standard average output per worker on pint and quart cartons from seven to nine packages per hour. Ren now averages eleven packges per hour. From this example, it can be seen that Ren does not have an overall plan to control and realistically measure productivity. The project consultant remains amazed at the low rate of production being accepted. Employees at Ren have been allowed to leisurely produce Ren's products because of this lacking measurement of productivity.

2. Project consultant's measurements of productivity

Response - To determine productivity at Ren for all or a few of the operations would require the project consultant to figure out line speeds and downtimes. The line speeds and downtimes were impossible to calculate in the mixing, filling, and packaging operations. This is due to the fact that no two products and/or working situations were the same, thus leading to different mixing, filling, packaging, and related set-up and clean-up times for each. For example, during batch production at Ren,

there may be one person performing the mixing, filling, packaging, or related set-up and clean-up or it may change to six employees. This fluctuation occurs frequently so that the number of people involved in each batch is never constant. The viscosity of the product changes from very thick to very thin. This variety in consistency changes the filling and mixing times of the product. The different viscosity of the products and the fluctuations in the work force resulted in the project consultant not being able to measure line speeds and downtime in a four week period for the 250 different products packaged in six primary and three secondary packages. Therefore, conservative estimates were made by the project consultant to determine the hours and dollars spent on labeling Ren's products. The conservative estimates were based on the percent of total labor hours in 1982. The labor hours consisted of time spent on hand-affixing DOT labels to packages, imprinting variable information on standard labels with the off-line hot-stamp imprinter, hand-imprinting standard labels from the off-line hot-stamp imprinter with a rubber-mat-stamp, hand-affixing standard labels from the off-line hot-stamp imprinter, downtime on the pint and quart packaging line due to the label affixer and imprinter, and hand-imprinting gallon cartons with the product number. Total labor hours can be defined as the number of workers that are involved in mixing, filling, packaging, and their related set-up and clean-up times, multiplied by the amount of hours involved. At Ren, the number of people involved in production in 1982 were 12 employees, both shifts are included. Each worker spent 2,000 hours a year at Ren (40 hours a week times 50 weeks). Therefore, twelve workers would spend 24,000 hours (2,000 hours times 12 workers) a year mixing, filling, and packaging at Ren.

Ren employees earn $17 dollars an hour including benefits. The employees belong to the United Automobile Workers (UAW) union.

Hand-affixing 340,000 DOT labels on pint cartons, quart cartons, gallon cartons, two and five gallon pails, and drums represents 5 percent of the total labor hours in 1982. Collection of the needed amount of containers and/or cartons and the peeling of the backing of the pressure-sensitive DOT label and application of the DOT labels require numerous manhours.

Imprinting variable information on 160,000 standard labels on the off-line hot-stamp imprinter for gallon cans, two and five gallon pails, and drums represents 1.6 percent of the total labor house (384 hours divided by 24,000 hours) in 1982. It requires one Ren employee four days of continuous monitoring to do a month's supply of off-line imprinted labels. That person spends 48 days or 384 hours (4 days times 12 months equals 48 days times 8 hours a day) making off-line imprinted labels.

Hand-imprinting standard labels with a rubber-mat-stamp represents 3 percent of the total labor hours. The 160,000 gallon, pail, and drum standard labels have already been imprinted by the off-line imprinter with the product number, product name, mixing ratios, and weight. These labels also need the date and batch number imprinted by hand with the rubber-mat-stamp. If a product label does not have an imprint plate to put the product number, product name, mixing ratios, and weight, then that information must be imprinted by hand with a rubber-mat-stamp. It is common for Ren to be without an imprint plate for a particular product.

Hand-affixing the 160,000 standard labels to the appropriate gallon cans, two and five gallon pails, and drums represents 2 percent of the total labor hours. Collection of the right amount of containers and/or cartons and the peeling of the backing of the pressure-sensitive standard labels and applying the standard labels require many manhours.

The downtime on the pint and quart packaging line due to the label affixer and imprinter represents 3.125 percent of the total labor hours (750 hours divided by 24,000 hours). Ren's present in-line label affixer and hot-stamp imprinter is down one hour a day. The downtime is represented by switching rolls of labels, switching rolls of imprint material, switching imprint plates, making the necessary adjustments to the imprinter to improve the quality of the imprint or the placement of the imprint, implementing adjustments in the label affixer so the label attaches properly to the pint or quart, and finally more people and time are needed to handle these predicaments. On the average, three people are involved in packaging pints and quarts on that line. So, if the label affixer or imprinter goes down, three people are left idle or are working at fixing a particular situation. There are 250 working days a year (50 weeks times 5 days) which means that 250 hours in 1982 are spent in downtime on the in-line label affixer and hot-stamp imprinter (250 working days times one hour of downtime a day). But on the average, three people are on the line which makes downtime 750 hours a year (3 people times 250 hours).

Hand-imprinting the product number on 100,000 gallon cartons represents 1 percent of the total labor hours. There are 100,000 gallon cans packaged into 100,000 gallon cartons. The gallon cartons have the product number hand-imprinted with a rubber-mat-stamp on the carton surface. The batch and date are already imprinted on the gallon label with the hot-stamp imprinter.

Table-IV The estimated percent of total labor hours spent on labeling at Ren in 1982

5 percent	Hand-affixing DOT labels to packages.
1.6 percent	Imprinting variable information on standard labels with the off-line hot-stamp imprinter.
3 percent	Hand-imprinting standard labels from the off-line hot-stamp imprinter with a rubber-mat-stamp.
2 percent	Hand-affixing standard labels from the off-line hot-stamp imprinter.
3.125 percent	Downtime on the pint and quart packaging line due to the label affixer and imprinter.
1 percent	Hand-imprinting gallon cartons with the product number.

15.725 percent of the total labor hours in 1982

Table-V The estimated total labor hours and dollars spent on labeling at Ren in 1982

1200 hours (24,000 hours times 5 percent) $20,400 dollars (1,200 hours times $17) are spent on hand-affixing DOT labels to packages.

384 hours (24,000 hours times 1.6 percent) $6,528 dollars (384 hours times $17) are spent in imprinting variable information on standard labels with the off-line hot-stamp imprinter.

720 hours (24,000 hours times 3 percent) $12,240 dollars (720 hours times $17) are spent hand-imprinting standard labels from the off-line hot-stamp imprinter with a rubber-mat-stamp.

480 hours (24,000 hours times 2 percent) $8,160 dollars (480 hours times $17) are spent hand-affixing standard labels from the off-line hot-stamp imprinter.

750 hours (24,000 hours times 3.125 percent) $12,750 dollars (750 hours times $17) are spent on downtime on the pint and quart packaging line due to the label affixer and imprinter.

240 hours (24,000 hours times 1 percent) $4,080 dollars (240 hours times $17) are spent hand-imprinting gallon cartons with the product number.

3774 hours in 1982 $64,158 dollars in 1982

Table-VI Cost of labeling at Ren in 1982

$ 76,866	Table-III totals
64,158	Table-V totals
$141,024*	

*This figure does not include label machinery costs, label machinery operating costs, the $25,000 dollars of inventoried imprint plates, the cost incurred due to standardization of packages that required $10,000 dollars worth of imprint plates being purchased, and the cost incurred due to Ren's moving to Dawn Avenue in East Lansing, Michigan from South Cedar Street in Lansing, Michigan which changed the address on the label print plates at a cost of $8,400 dollars.

III. Problems Facing Ren Plastics' Labeling System

Response - The standard labels are printed on expensive high gloss paper. Ren will be spending $26,920 dollars in 1982 on 412,000 standard labels shown in Table-III. The shiny surface of the high gloss label affects the quality of the variable information imprinted on the standard labels by the in-line and off-line hot-stamp imprinters. This effect is the result of the imprint material not always adhering properly. Therefore, the majority of the variable information imprinted on the standard high gloss labels have poor imprint quality due to poor adhesion to the slick surface of the label.

Ren is using an imprinting system that is very expensive due to the cost of the imprint plates and the cost of the imprint material which delivers poor quality imprints on the standard labels. Ren has $25,000 dollars invested in imprint plates. This does not include the 100 new imprint plates that will be ordered in 1982 or the imprint plates not used anymore. The 100 new imprint plates will cost Ren an additional $2,000 dollars in 1982 (100 new imprint plates times $20 dollars per imprint plate). As for the imprint plates not being used anymore, Ren ordered 500 new imprint plates due to the standardizing of their primary packages in 1980. This standardization changed 500 weights on 1,250 imprint plates currently being used. This then resulted in replacing imprint plates with the wrong weight with new imprint plates with the right weight. This cost Ren $10,000 dollars ($20 dollars per plate times 500 plates). Ren will also be spending $26,196 dollars in 1982 on imprint material ($4,356 dollars in small imprint material rolls plus $21,840 dollars in large imprint material rolls shown in Table-III).

The twenty-eight formatted standard labels create large inventories in each standard label, twenty-eight print plates owned by Ren, and switching charges of the print plates during the production of the standard labels. Ren has expensive inventory costs due to carrying large inventories of each formatted standard label. The high inventory is traced to the fact that Ren only receives price breaks on large quantity orders of one or groups of formatted labels. Ren's twenty-eight print plates cost $300 dollars each. Changing any of the information or the print plates becomes an expensive propsition. For example, Ren had to change the address recently on all their print plates because of Ren's moving from South Cedar Street in Lansing, Michigan to Dawn Avenue in East Lansing, Michigan. This cost Ren $8,400 dollars (28 formatted labels times $300 dollars a print plate). The switching from one formatted label to another by the label supplier during printing costs fifty dollars each time. Ren will have 60 switchings during 1982, at a total cost of $300 dollars (60 switchings times 50 dollars each switch). Therefore, the standard labels are locked into an expensive system of high gloss labels, imprint plates, imprint material, and many formatted labels that have poor imprint quality.

Specialty and DOT labels are also expensive. Ren will be ordering 15,000 specialty labels in 1982, but only 1,500 will be used on product packages. This means that 90 percent of the specialty labels will be wasted. Specialty labels cost Ren $2,250 dollars in 1982 shown in Table-III. Ren will also be ordering 340,000 DOT labels in 1982 that cost $17,000 dollars shown in Table-III.

The cost of the twenty-eight formatted standard labels and their imprint plates and material, as well as specialty and DOT labels, represents $77,366 dollars as shown in Table-III. Therefore, Ren spends $77,366 dollars (Table-III) on materials to label their products. Consequently, material and labor cost savings can be compiled for Ren in the future.

Ren's standard hours do not control nor realistically measure productivity. The source of this problem can be traced to the number of employees are not being kept track of during the production of Ren's products during mixing, filling, and packaging operations. Ren's employees then, are able to take advantage of the missing productivity measurements by deciding upon the rate of production. Thus, any activity at Ren requiring labor is very expensive due to the $17 dollars per hour employees receive for producing Ren's products. Consequently, the $64,158 dollars in Table-V represents 15.725 percent (Table-IV) of the estimated total labor hours spent on labeling in 1982. The insertion of a productivity measure by Ren Plastics' management will result in future savings.

IV. Recommendations

Response - The project consultant developed three groups of recommendations attempting to solve the problems facing Ren Plastics labeling system. The first group of recommendations could be implemented immediately. The second group of recommendations requires the purchase of a computer labeling system. The third group of recommendations involves the purchase of a jet-spray carton imprinter and label affixer for the gallon line.

Group One - Ren should switch the expensive high gloss paper on their standard labels and go with a cheaper label material. The high gloss paper causes the imprint quality of the variable information to have poor quality because the imprint material can not adhere properly to the glossy surface. By switching to a cheaper label material, Ren could save 30 percent on the cost of the labels (vendor quotation) and improve the imprint quality because the imprint material can adhere properly to a coarser surface.

Table-VII The cost savings generated by switching to a cheaper standard label material

$1,350	Small standard label cost savings ($4,500 dollars Table-III times 30 percent)
6,510	Large standard label cost savings ($21,700 dollars Table-III times 30 percent)
216	Wasted label cost savings ($720 dollars Table-III times 30 percent)
$8,076	dollars

Ren should look for alternatives in materials or vendors to replace the expensive imprint material. The imprint material costs $26,196 dollars (smaller imprint roll $4,356 dollars plus large imprint roll $21,840 dollars shown in Table-III). After reviewing the 1982 cost of the imprint material, Lee Hill negotiated the price of the imprint material with the present vendor down 50 percent. The new price is $24 dollars for the large roll and $18 dollars for the small roll. This lead to a savings of $13,098 dollars ($26,196 dollars times 50 percent).

Ren should consider the possibility of printing the DOT information on the pint, quart, and gallon cartons instead of hand-affixing them to the carton. The project consultant estimated that Ren spends 11 cents in labor and materials each time a DOT label is affixed on a package ($17,000 dollars in material shown in Table-III plus $20,400 dollars in labor shown in Table-V equals $36,900 dollars divided by 340,000 DOT labels shown in Table-II equals 11 cents).

DOT labels are hand-affixed on pint cartons, quart cartons, gallon cartons, two gallon pails, five gallon pails, and drums. In Table-II, 240,000 DOT labels out of the 340,000 DOT labels are hand-affixed on pint cartons, quart cartons, and gallon cartons. Printing the DOT information on cartons through a carton supplier would cost Ren 1.2 cents per carton (quotation from a carton supplier). Out of the 240,000 DOT labels affixed to the pint, quart, and gallon cartons, the project consultant estimates 120,000 of the DOT information can be printed on the carton. Ren would save $11,760 dollars (120,000 DOT labels times 11 cents minus 120,000 cartons times 1.2 cents). The $11,760 dollars should be cut to a $10,000 dollars savings since there will be an added inventory cost and an increase in carton costs due to the added number of different cartons and the lower volumes of purchases of each carton.

The final recommendation in group one is to standardize the twenty-eight label formats similar to the standardization of packages in 1980. Several vendors have looked at the formats and suggest a reduction in label formats to four. This would reduce the number of formatted labels by seven times (28 divided by 4). It cost Ren Ren $26,920 dollars in 1982 for the standard labels ($4,500 dollars for the small label plus $21,700 dollars for the large label plus $720 dollars for the wasted labels shown in Table-III). Therefore, it cost Ren $961.42 dollars in 1982 for each of the twenty-eight formatted labels ($26,920 divided by 28). Thus, by standardizing the label formats the amount of savings would be $6,730 dollars ($961.42 dollars times 7).

Table-VIII Group one potential cost savings

$ 8,076	Using cheaper label material at a savings of 30 percent Table-VII
13,098	50 percent price reduction in imprint material ($26,920 times 50 percent)
10,000	Printing DOT information on cartons instead of putting DOT labels on pint, quart, and gallon cartons by hand
6,730	Standardizing the label format
$37,904	dollars

Group Two - A switch from the two hot-stamp imprinters to a computer labeling system would eliminate the need for imprint plates, imprint material, hand-imprinting with rubber-mat-stamp, downtime caused by in-line imprinter specialty labels while increasing the labor hours spent on off-line imprinting.

The computer labeling system does not require imprint plates because a dot matrix printer uses hammers to create images, unlike the letters and numbers produced by Ren's hot-stamp imprint plates. The

matrix printer consists of a number of dots, arranged in a grid. The hammers deposit ink from the ribbon in an array of dots to form a given letter, number, or bar code. If this process was implemented, Ren would forego their order for 100 new imprint plates in 1982. The amount saved through imprint plate purchase avoidance will total $2,000 dollars (100 plates times $20 dollars). Consequently, Ren will not be locked into a system containing $25,000 dollars worth of inventoried imprint plates.

The computer labeling system uses ribbon cartridges instead of rolls of imprint material. Due to negotiations brought forth by Lee Hill, Ren will be spending $13,098 dollars a year on imprint material. There are 121 small rolls and 455 large rolls for a total of 576 rolls of imprint material. The price of a computer ribbon cartridge, given by a computer labeling vendor, is $10 dollars. This cartridge is claimed to last longer than one roll of imprint material. For the purposes of comparison then, 576 cartridges would cost Ren $5,760 dollars ($10 dollars a ribbon times 576 ribbons). Therefore, Ren's savings by implementing a computer labeling system could be $7,338 dollars ($13,098 dollars spent on the present imprint material minus $5,760 dollars for computer ribbon).

Hand-stamping off-line imprinting standard labels with a rubber-mat-stamp would be eliminated by the computer labeling system. This elimination will allow a savings of $12,240 dollars in labor (Table-V). The computer labeling system would then be able to print variable information automatically instead of hand rubber-mat-stamping.

Insertion of a computer labeling system will reduce the downtime by 50 percent if the imprinted label from the in-line pint and quart imprinter is converted off-line to the computer labeling system. The label affixer and imprinter are combined together in one unit so if the imprinter is eliminated, 50 percent of the downtime is stopped. Ren would save $6,375 dollars ($12,750 dollars in downtime shown in Table-V times 50 percent) in labor downtime resulting from the in-line imprinter being eliminated and all imprinting will be processed off-line by the computer labeling system.

Specialty labels will be completed by a computer labeling system which would save Ren $2,250 dollars (Table-III).

The computer labeling system will require every label to be imprinted off-line. The computer labeling system will increase the 384 hours or $6,528 dollars (Table-V) spent on labor in the present off-line imprinting system. The quart and pint imprinting of labels will now be performed off-line which represents 240,000 labels out of the 400,000 (60 percent) labels excluding wasted labels. Therefore, $3,917 dollars in labor will be added to accomplish the pint and quart imprinting of labels ($6,528 dollars times 60 percent). But the computer labeling system is not as fast as the present off-line

system. The computer labeling system is 5 times slower than the hot-stamp imprinter (30 imprinters per minute with the hot-stamp imprinter divided by 6 imprints per minute with the computer labeling system). However, the computer labeling system can change label formats automatically, as well as change ribbon cartridges. The computer labeling system requires no monitoring and prints label after label with guaranteed accuracy without anyone monitoring it the whole time. The hot-stamp imprinter requires constant supervision, switching of imprint plates and imprint material, and has poor imprint quality. Even though the computer labeling system is five times slower than the present system, the labels can be printed immediately when needed. Ren's batch type production allows plenty of time during set-up times to produce the necessary amounts of labels. For these reasons, the project consultant feels the computer labeling system would add the $3,917 dollars calculated earlier to accomplish the pint and quart imprinting of labels.

Table-IX Group two potential cost savings by buying a computer labeling system

$2,000	No need for new imprint plates (100 new plates times $20 dollars each)
7,338	Switching from hot-stamp material to computer ribbon cartridges
12,240	Eliminating hand-imprinting with rubber-mat-stamp (Table-V)
6,375	Eliminating downtime by 50 percent in the in-line imprinter for the pint and quart packaging line ($12,750 dollars shown in Table-V times 50 percent)
2,250	No need for specialty labels (Table-III)
(3,917)	Increased cost caused by imprinting pint and quart labels off-line
$26,286	dollars

A computer labeling system will cost Ren between $20,000 to $30,000 dollars. The payback period will be approximately a year, since the potential cost savings of buying a computer labeling system will be $26,286 dollars.

Group Three - The third group of recommendations involve improving the gallon packaging line. There are 100,000 gallon cans, 40,000 two and five gallon pails, and 10,000 drums that have standard labels hand-affixed. Since the drums are labeled twice, there are 160,000 standard labels hand-affixed to gallon cans, pails, and drums. The labor costs involved in hand-affixing the standard labels to gallon

cans, pails, and drums represents $8,160 labor dollars shown in Table-V. The affixing of standard labels to gallon cans denotes 62.5 percent (100,000 gallon cans divided by 160,000 total hand-affixed standard labels) or $5,100 labor dollars ($8,160 dollars times 62.5 percent). The purchase of a $5,000 label-affixer for the gallon line will have a payback period of less than a year.

The labor cost of $4,080 dollars in 1982 is attributed to the product number being hand-imprinted on gallon cartons with a rubber-mat-stamp (Table-V). The possibility exists for Ren to acquire a jet-spray imprinter similar to the one on the quart and pint packaging line for the gallon line. The Marsh jet-spray imprinter is comparable in cost to the labor dollars spent in 1982 on hand-imprinting gallon cartons with product numbers.

Table-X Group three potential labor cost savings by buying a gallon label affixer and gallon carton imprinter

$5,100	Labor dollars saved by buying a gallon affixer
4,080	Labor dollars saved by buying a gallon carton imprinter
$9,180 dollars	

Group one recommendations have a cost savings potential of $37,904 dollars shown in Table-VIII. The recommendations of group one do not require a capital investment in labeling equipment. This creates an instant cost savings when the recommendations are implemented. For example, Lee Hill reduced the price of the imprint material by $13,098 dollars (Table-VIII) which had immediate cost saving results. Group two and three recommendations require the capital investment in labeling equipment. The recommendations of group two requires the purchase of a computer labeling system. The potential cost savings of $26,286 dollars (Table-IX) and the cost of a computer labeling system of $20,000 to $30,000 dollars creates a payback period of roughly one year. Group three recommendations require the purchase of a label affixer and jet-spray carton imprinter for the gallon packaging line. Both the label affixer and jet-spray carton imprinter have a payback period of approximately one year. Therefore, all three group recommendations suggest solutions to the problems facing Ren Plastics' labeling system.

REN
PLASTICS

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a CIBA-GEIGY Company

FIRST AID: IN CASE OF CONTACT
EYES: Immediately flush eyes with plenty of water for a least 15 minutes. Call a physician.
SKIN: Flush skin with plenty of water.
CLOTHING: Wash clothing before reuse.

SPI Classification 2

B FOR INDUSTRIAL USE ONLY

CAUTION—FLAMMABLE!

Work in a well-ventilated area and use clean, dry tools for mixing and applying. Combine the resin and hardener according to mixing ratio shown above. Mix together thoroughly and use immediately after mixing. Material temperature should not be below 65° F (18° C) when mixing. For fast, gentle cleaning of hands, use REN RP-70-S Cleaner before washing.

IMPORTANT NOTE
Ren Plastics warrants that this product is free of defects due to materials or workmanship. NO OTHER WARRANTIES, WHETHER EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE SHALL APPLY TO THIS PRODUCT. No statements or recommendations contained herein are to be construed as inducements to infringe any relevant patent, now or hereafter in existence. Ren Plastics neither assumes nor authorizes any representative or other person to assume for it any obligation or liability other than such as is expressly set forth herein. UNDER NO CIRCUMSTANCES SHALL REN PLASTICS BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL OR OTHER DAMAGES ARISING OUT OF A CLAIM FROM ALLEGED NEGLIGENCE, BREACH OF WARRANTY, STRICT LIABILITY OR ANY OTHER LEGAL THEORY, THROUGH THE USE OR HANDLING OF THIS PRODUCT.

FIRST AID: IN CASE OF CONTACT
EYES: Immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.
SKIN: Flush skin with plenty of water.
CLOTHING: Wash clothing before reuse.

SPI Classification 3

C FOR INDUSTRIAL USE ONLY

REN
PLASTICS

WARNING!

Work in a well-ventilated area and use clean, dry tools for mixing and applying. Combine the resin and hardener according to mixing ratio shown above. Mix together thoroughly and use immediately after mixing. Material temperature should not be below 65° F (18° C) when mixing. For fast, gentle cleaning of hands, use REN RP-70-S Cleaner before washing.

FIGURE I.--Samples of the Standard Labels (reduced in size).

FIGURE II.--Samples of the DOT Labels.

RP-870 REN:C:O-THANE PRIMER BASE

Mixing Ratio: 100 parts RP-870 Base to 25 parts RP-870 Diluent (by weight and volume).

Net Wt. 1.75 lbs. (794g)

REN PLASTICS

4917 Dawn Avenue
East Lansing, MI 48823
Telephone 517 351-5900
CIBA-GEIGY Corp.

WARNING! FLAMMABLE! Keep away from heat, sparks and open flame. USE ADEQUATE VENTILATION. Avoid prolonged contact with skin and breathing of vapor and spray mist. Close container after using and keep out of the reach of children.

REN PLASTICS

RP-1774

FOAMING ADDITIVE

Mixing Ratio:
1g Additive to
100g of Mixture

Net Wt.: 2 ozs. (55g)

REN Plastics
CIBA-GEIGY CORP.
4917 Dawn Avenue
East Lansing, MI 48823

REN-LEASE™ 11-B

Release Agent

SHAKE WELL

Keep Container Closed
When Not Using

USE IN WELL VENTILATED AREA

AVOID BREATHING VAPORS

Non-Flammable

Net Wt. 45 lbs. (20.25 kg)

ren

REN Plastics
a CIBA-GEIGY company
5656 South Cedar
Lansing, Michigan 48909
Telephone: 517 393-1500

FIGURE III.--Samples of the Specialty Labels.

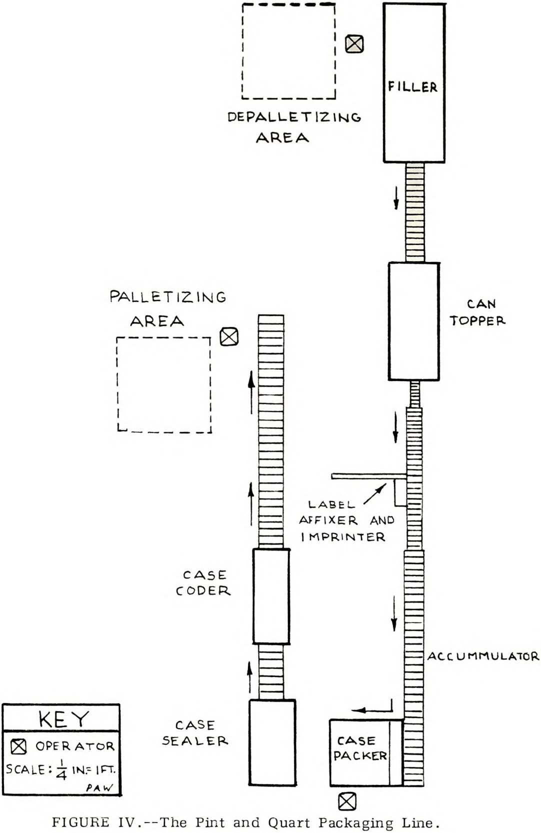

FIGURE IV.--The Pint and Quart Packaging Line.

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