New Techniques in Engineering Evaluations for Improved Capital Effectiveness

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INTRODUCTION

The pulp and paper industry spends twice as much capital compared to other commodity indusrtries. However, the industry has not achieved preferential status in terms of increased shareholder's value from this increased spending (1). Effectiveness in capital spending is a growing concern in the pulp and paper industry for both short term and long range planning. Short term projects are usually maintenance related and/or based on small incremental production advantage. Long term capital projects are based on market analysis, long term forecast on profitability, production costs and competetiveness in the market.

In a typical capital project implementation, the project is generally divided into several phases including conceptual or study phase, preliminary engineering, detailed engineering, procurement, construction and start-up. The scope of the overall project is defined to a major extent in the conceptual or preliminary engineering phase. The portion of the approved capital allocation used to perform this task is relatively small as compared to the overall project cost, but the accuracy of the engineering, estimates and calculations have a greater bearing on the capital effectiveness and the success of the project.

Figure 1 shows a relationship between the different phases of the project and their ability to influence the final cost over the life of the project.

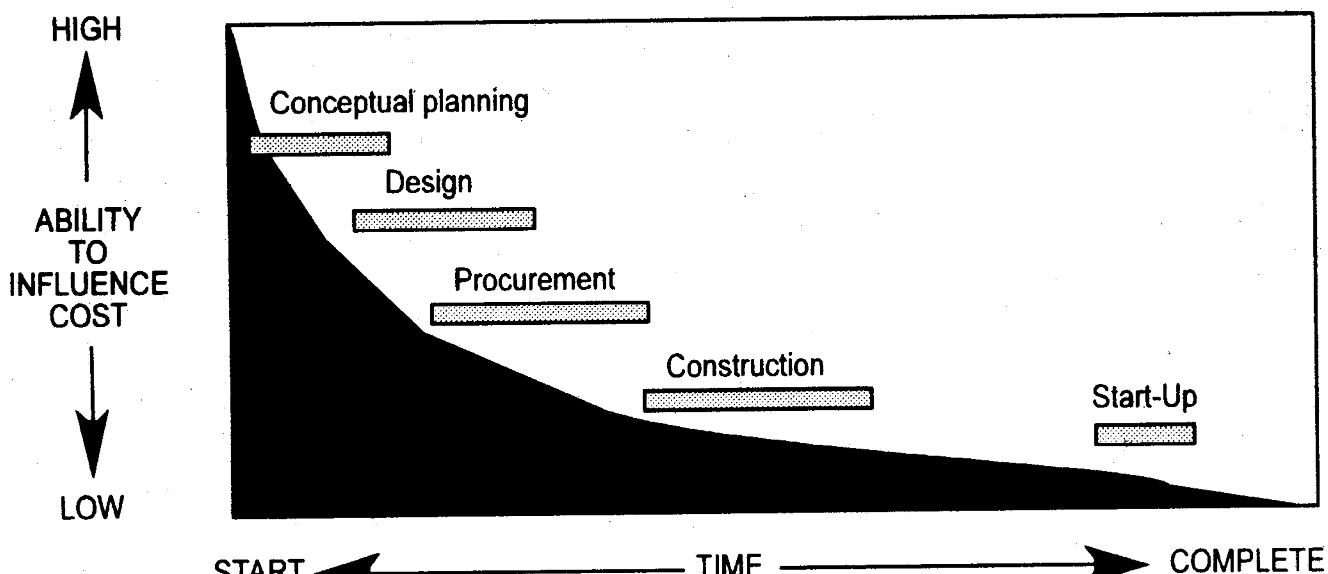

Figure 1 : Different Phases of the Project and Their Ability to Influence the Total Cost

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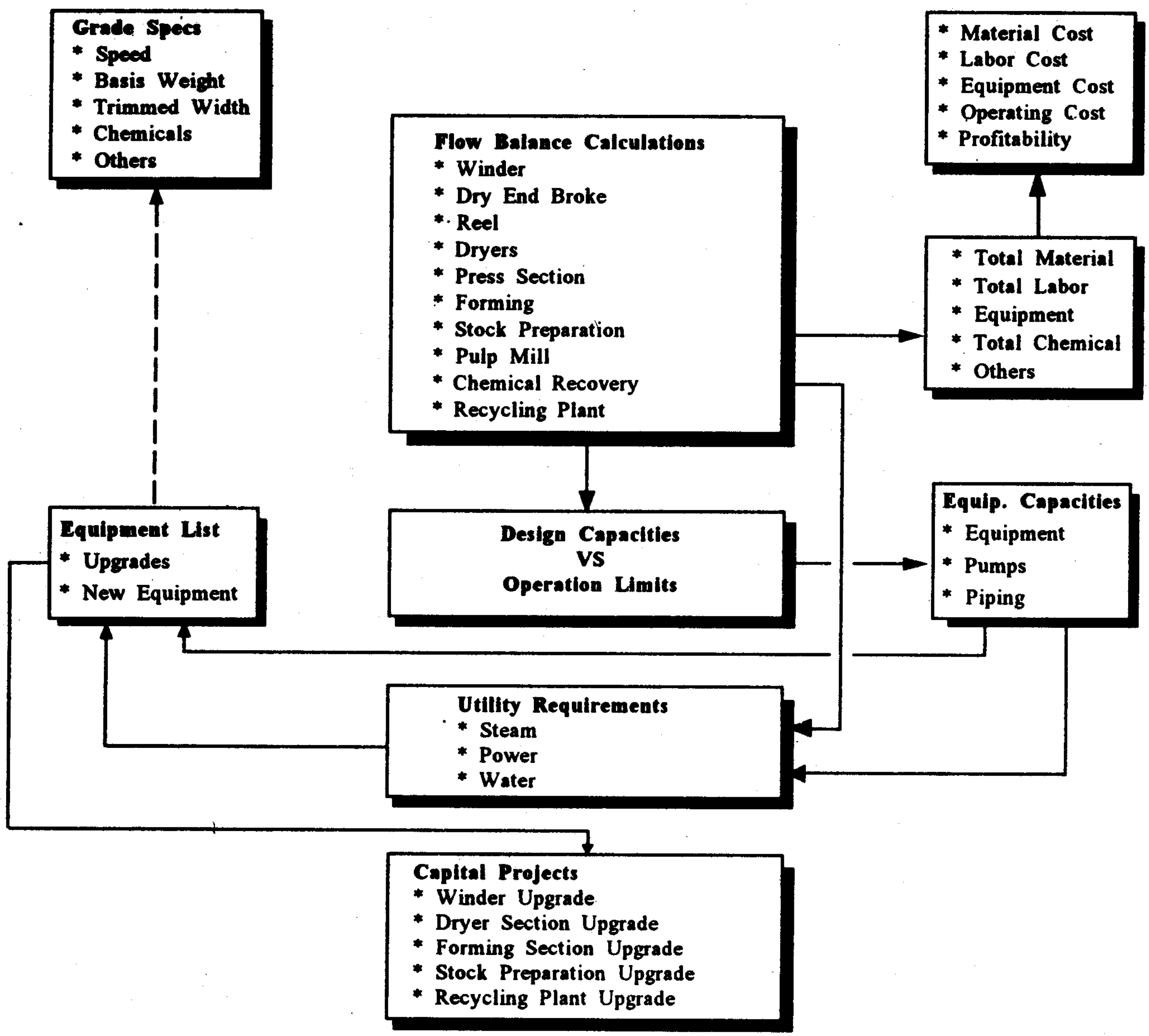


Figure 2 : Performance Evaluation and Data Analysis - Logic Diagram

As seen, the earlier stages to influence the overall project costs. Inaccuracies and incompleteness in capital estimates in the conceptual/preliminary engineering stage of the project result in higher over all capital costs, extended down time and inefficient project schedules. On the other hand, over-estimating the capital has the risk of lowering the attractiveness of the project for capital investment. For capital effectiveness in those projects the following criteria are essential.

1. The scope development and background information used for these estimates are to be as accurate as possible.

2. During the earlier phases of the project, constructibility issues are to be considered for any major changes including addition/replacement of equipment.

3. Overall outage time is to be estimated and the upgrades are to be carefully planned taking advantage of the regular maintenance outages for tiein's and other minor upgrades to minimize the overall shoutdown outage time for the upgrade.

To facilitate the flow of information during the conceptual/study phase and to achieve the above objectives, a new engineering approach has been identified. This approach has been successfully utilized for optimizing the capital requirement on facility upgrades and long range planning for such upgrades.

DATA ARRANGEMENT FOR ENGINEERING EVALUATION

To evaluate the present operation of different equipment, a performance survey is required. During this survey information will be collected on the operational requirement, design capacities, average and maximum operational capacity usages of the equipment. The survey would include information on utilities, such as steam capacities, electrical distribution systems, water usage and equipment capacities. Operational information such as minimum and maximum production on different grades, equipment performance, known operational bottlenecks, steam and water usage are also collected. The next step is to arrange these data in a usable form for performance evaluation and corporate planning.

Figure 2 shows the data aggangement established in an excel program for a mill producing different grades. All information related to production variation and grade changes are included as input variables in the mill information, data in the program. These include variations in the raw material furnish speed, trimmed width, basis weight, chemical consumption, etc.

A flowsheet or block diagram is developed for the mill area to reflect the process equipment arrangement. An overall material balance calculation is then performed for the different unit operations based on the diagram.

Operational data such as consistencies of stock, reject rates, retention in forming, dryness of sheet are specified as required. The program may cover different areas of the mill starting from winder or finishing back to pulp mill and chemical recovery areas. The program can be tailored to meet the required level of detail on the capacity evaluations of the different equipment or process areas.

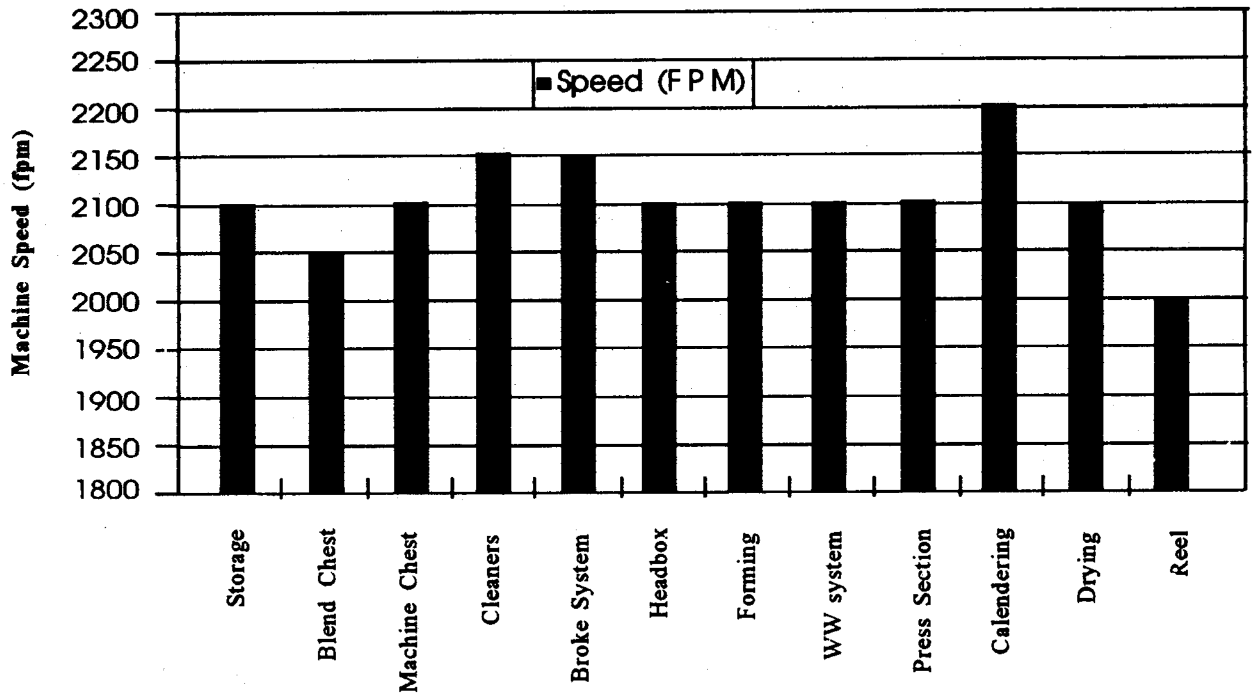
The equipment design information such as hydraulic capacity of equipment, maximum tonnage, and pump data are stored in a separate location in an excel spreadsheet as input data. A program logic is developed to compare the design information to the instantaneous operational capacity requirement at any given production speed and highlight the equipment to be upgraded. This is a preiminary equipment list for capital projects. The analysis can be repeated several times by changing the machine speed and also the grade specific information to find the operational limits of the major equipment for the different grades. For example, a particular speed increase on a light weight liner board grade may be hydraulically limited by a fan pump or a headbox, whereas on the same machine, at a heavier grade may not be hydraulically limited by the fan pump or the headbox, but may be dryer limited. Then the question is which grade is more important in terms of market demand, volume of production, profitability, etc., for finalizing the equipment to be upgraded.

CAPITAL SPENDING PLAN OPTIMIZATION

Based on the various speeds and the upgrade requirements as dictated from the program for the different grades, an equipment list can be developed. This equipment list will include equipment upgrades necessary for increased production on any particular grade and new equipment based on the combined limitations identified for the different grades to achieve the desired production level. The forecasted grade distribution after the upgrade will be used to determine the average and maximum production possible after the upgrade. The forecasted increase in production and the associated profitability data will then be used to determine the feasibility of the upgrade. If the Return On Investment calculated at this point is lower than what is desired, the analysis can be repeated with a different speed increase and production level targets.

Figure 3 shows the equipment limitations as a function of machine speed. The target production and the machine speed can be visualized as a function of capital requirement. The machine speed can be chosen based on the major equipment upgrades needed and the estimates on capital effectiveness interpreted as capital dollars per year per ton of incremental production. If more than one particular grade produced on the machine, similar charts should be established for all the major paper grades and the combined equipment limitations are to be identified. The net incremental tonnage produced in the machine will be calculated based on the incremental speeds projected for the different grades based on the equipment upgrades and the grade mix for the future operations.

Advantages of the proposed method include the following:



Area Equipment Capacities

Figure 3: Speed limitations based on the equipment capacities

1. Establishes a reliable basis for the facility upgrade.

2. Identifies major milstones for the project in terms of capital requirement, outage time required, layout issues and construction costs.

3. Serves as an effective tool to evaluate alternate disigns and production levels.

ANALYSIS ON GRADE STRUCTURE AND PROFITABILITY

For evaluation of different grade structure, the input data for the different grades such as speed, basis weight, chemicals, refining and drying rates, are defined in the program. Impact of the different grades and their production levels on the direct and indirect costs are computed. Profitability for the different grades are calculated based on the average selling prices listed and the direct and indirect costs. A spreadsheet macro was developed to use the input data for the different grade structures and forecast the profitability of the different grades based on the changes in direct and indirect costs that were calculated. The advantages of the above analysis are listed below:

1. Enables to compare the profitability of the different grades for the corresponding limiting machine speeds and the upgrade requirements for achieving those machine speeds.

2. Comparison of the relative profitability of the grades helps to choose a specific upgrade plan.

3. Information obtained from the analysis on the equipment upgrade requirements help to quantify the production increase and hence the profitability on various paper grades. This would enable the mill to focus on the long term capital requirements to eliminate particular grades and produce new grades.

4. Comparison of the grade profitability between different facilities enables to identifiy inefficiencies in operation in one facility as compared to another facility.

CONSTRUCTIBILITY ISSUES

One of the factors very often not addressed early in the project is the constructibility. Issues associated with the constructibility can significantly alter the capital involved and has to be addressed early in the process of project development. In rebuilds involving major equipment upgrades, the machine outage time is a major contributor to the overall costs. Items to be upgraded during pre-shut down and shut down are to be clearly identified to minimize the overall machine downtime. Options on having the outages in phases or combining the upgrades and different phases of the project are to be investigated to minimize the outage time . Estimations of steam, power and water requirement and effluent treatment plant capacities are to be made during the conceptual phase of the project.

Considerations are to be given early in the project for the constructibility issues such as relocations, material take-off, etc., while choosing a particular machine speed for upgrades. Break points in the targeted speed are to be identified in terms of equipment upgrades. A good example is an increase in electrical load with the increase in paper machine speed can be accommodated in the capacity available with the existing transformer, whereas speed increase beyond that point requires a new transformer, switchgear and MCC Room. The layout issues associated with this and the capital cost are to be considered in the feasibility stage.

CONCLUSION

Capital effectiveness on any project gererally depends on how throughly the options were investigated in the feasibility stage and completeness of the estimate. The estimated Return On Investment (ROI) will be significantly incomplete data or is based on inaccurate project estimates. The methods outlined in this paper helps the corporate or mill engineering personnel to identify the feasible capital projects and hleps to optimize the incremental capital requirments for facility upgrades.

REFERENCES

1. Phillips, R.B., "Impact of Capital Spending on Paper Machine Profitability", Tappi Engineering Conference Proceedings, Sep 16-19, Chicago, 1996, Tappi Press, Atlanta.