New machine or rebuild?

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By applying new technology to old paper machines, we can reduce the capital costs needed to keep a mill viable and competitive.

Several developments in papermaking equipment and technology in the past 30 years have made it practical to greatly increase production capacity and improve paper quality. Gains have come from

- More efficient dewatering capacity: twin-wire and top-wire formers, double-felted presses, large-diameter roll and shoe presses, fourth presses, and spoiler bars
- Higher machine speeds
- Improvements in auxiliary equipment including drives, process control computers, cross-machine profile controls, paper machine clothing, and sheet-handling equipment.

Papermaking capacity has increased both in tons per inch of machine trim and in tons per foot of machine-direction length. New technology is being implemented on rebuilds and on new machines. These changes have permitted production rate increases of as much as 100% without increasing machine-direction space requirements. The question of whether to increase capacity by installing a new machine or rebuilding existing machines is often difficult to answer.

Quality vs. costs

Two key parameters for success in papermaking are good product quality and low operating costs. Paper manufacturers should strive to be perceived in the top 25% of the industry in terms of quality, while keeping manufacturing costs in the bottom 25% of those mills producing similar grades. Obviously, all mills cannot have above-average quality and below-average operating costs. However, mills that are well positioned in both areas do well in both strong and weak markets.

The range of manufacturing costs per ton for some major grades produced in the United States are shown in **Table I**. Mills that have the lowest costs are commonly those that are integrated pulping and papermaking operations that operate efficiently. Mills with high costs must develop grades with a high profit margin or must upgrade their equipment to be more competitive.

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I. Range of manufacturing costs per ton, U.S. dollars

Grade	*Low*	*High*
Corrugating medium	170	300
Linerboard	180	300
Newsprint	280	400
Lightweight coated	400	600
Fine paper	400	800
Tissue	400	800

II. Fine paper machine performance indices

Parameter	*Observed range*	*Good performance*
Overall machine efficiency, %	67–93	88
Headbox consistency, %	0.2–0.8	0.4–0.6
Flatbox vacuum, ft³/min/in.	2–12	5
Couch vacuum, ft³/min/in.²	1.9–8.2	6–7
Consistency off couch, %	8–22	20
Consistency after last press, %	25–46	42
Moisture entering size press, %	1.0–4.2	3
Energy		
Btu/lb of paper	2500–10,000	2600
Btu/lb of H_2O evaporated	1250–1620	1270
Heat trans. coef., U factor	35–54	50
Oven-dried weight profile, % total variation	3–10.3	4
Moisture profile, % total variation	0.7–4.0	1% at 5% average
Water consumption, 1000 gal/ton	4–40	3

Feasibility study

In most cases, a comprehensive feasibility study should be conducted to compare the alternatives of rebuilding existing machines and installing a new one. The study should include a market study, product specification requirements, and be carefully estimated. Proposed technical solutions must be well analyzed, well understood, and fully accepted by the people involved in the project (*1*).

III. Economies of rebuilds

	News-print	*Fine paper*	*Light-weight coated*	*Tissue*	*Liner-board*	*Corru-gating medium*
Current capacity, tons/day	300	300	300	150	800	400
Capacity after rebuild, tons/day	375	375	375	188	1200	600
Downtime cost, $ million	2.4	3.6	4.0	2.5	5.0	3.2
Rebuild investment,* $ million	40	59	62	33	132	82
Investment per daily ton, $ thousand	535	790	830	875	330	330

*Justified at 15% return-on-investment.

IV. Cost estimates for a new paper machine

	News-print	*Fine paper*	*Light-weight coated*	*Tissue*	*Liner-board*	*Corru-gating medium*
Capacity, tons/day	600	600	600	300	1200	800
Reel trim, in.	280	285	300	280	265	260
Speed, ft/min	400	2700	3000	6000	2000	2100
Installed cost, $ million	135	150	215	90	175	140
Capital cost/daily ton, $1000	225	250	360	300	145	175
Return on investment, %	16	20	15	20	15	13

Existing machines should be carefully analyzed. Successful rebuilds require an excellent understanding of current equipment and process capabilities, a working knowledge of practical technology, and good follow-up to make sure that the projected goals are achieved. Mill improvement programs are often poorly focused because the rebuild plans are not sound (*2*).

The evaluation of the current machine performance is a key step. By comparing the results of a machine evaluation to performance standards for machines producing similar grades, areas of the machine that require improvement can be identified. Performance standards for bond, newsprint, corrugating medium, linerboard, and coating basestock have been developed (*3–5*). **Table II** shows the range of performances observed on several paper machines that produce fine grades. The values for good performance represent practical standards that are being achieved on the best machines.

The effect of each parameter on overall machine performance must be determined. Some parameters can be well below the values for good performance without restricting production rates. Areas of greatest impact must be identified so capital expenditures and improvement efforts can be concentrated in areas of highest return.

Alternatives for upgrading equipment should be carefully evaluated. Experimentation with new concepts often requires extra time to achieve the projected goals.

Assumptions for rebuilds

Some assumptions were made to aid in determining the relative attractiveness of rebuilding existing machines vs. installing new machines. These assumptions are:

1. Production increases of 25% can be achieved for newsprint, lightweight coating, fine paper, and tissue.
2. Linerboard and corrugating-medium machines can be rebuilt to increase production capacity by 50%. (These higher increases are projected because of the potential for using shoe-type presses.)
3. Manufacturing costs on existing machines is 20% above the lowest-cost producers.
4. A 10% reduction in manufacturing costs will be realized by rebuilding the machine.
5. A 45-day outage will be required to rebuild the machine.
6. Depreciation is on a 15-year straight-line basis.

Table III summarizes rebuild guidelines and projected economics. Paper machines of nominal size were selected. The rebuild investment is a hypothetical number that represents what can be justified with a 15% return on investment. The return would be higher than 15% if the same production increases can be achieved with lower capital expenditures. The return-on-investment calculations were based on current selling prices.

New paper machine cost estimates

Cost estimates for state-of-the-art new paper machines were developed to establish a basis of comparison. Parametric cost estimates based on several years of experience in engineering and constructing paper mills were used.

Baseline information and cost estimates are shown in **Table IV**. The installed cost includes stock preparation equipment, a new paper machine, a winder, auxiliary equipment, and the necessary buildings. The estimate for the machine for lightweight coated includes coaters and

supercalenders.

The information shown in Table IV is for the specific conditions listed. Capital costs per daily ton and return on investment vary with machine size. However, the calculations indicate that the 15% return-on-investment used for the rebuild calculations can be met or exceeded for all grades except corrugating medium.

Other considerations

There are several other factors to consider in addition to capital costs and economic return. The requirements for capital to upgrade existing machines vary widely. Machines on which all the components are operating near capacity require more capital to achieve increases in production rates. Conversely, a machine on which only one or two minor components are restricting speed can be upgraded at relatively low capital cost.

Some older mills are crowded and have little space for expansion. The practice of "shoe horning" papermaking equipment into small spaces often results in compromises that restrict the machine's performance.

Market impact is an important consideration. Rebuilding an existing machine will result in lost production during the period the machine is down. Existing machines can remain in operation and then be shut down when a new machine comes on line. If a new machine will add to existing capacity, it will provide a large jump in available capacity that must be marketed. It may be necessary to discount production from new machines until top quality can be achieved and additional capacity can be sold at market prices.

Reel trim is an important consideration. Some machines do not fit converting equipment and accordingly are not candidates for upgrade. For example, a 120-in. corrugating-medium machine does not trim well and would likely not be a good candidate for a rebuild. Trim is less of a problem on machines producing cut-size grades.

Current technology on machines producing similar grades must also be considered. For example, most modern newsprint machines have twin-wire or top-wire formers to minimize linting problems on offset presses. It may not be practical to rebuild the wet end or add a top-wire former on some existing newsprint machines. Because it is difficult to compensate for a two-sided sheet on coaters and printing presses, water should be removed from opposite sides of the sheet in the last two press nips on machines running lightweight-coated and fine paper grades. However, some paper machines cannot be easily adapted to modern press configuration.

Staffing is another important consideration. On most rebuilds, crews will be trained and updated to operate the rebuilt machines. This effort can be smooth or difficult, depending on whether or not a labor contract is in force and its limitations if one is in force. Depending on the location and other factors, it may be possible to hire experienced personnel from other paper companies in a nonunion environment on a new "greenfield" machine.□

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