

**The Reaction of Financial Analysts to
Enterprise Resource Planning (ERP) Implementation Plans**

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The Reaction of Financial Analysts to Enterprise Resource Planning (ERP) Implementation Plans

This study investigates the extent to which investors believe that enterprise resource planning (ERP) systems enhance firm value by examining changes in financial analysts' earnings predictions before and after they receive an announcement that a firm plans to implement an ERP system. A total of 63 analysts participated in a two (firm size: small and large) by two (firm health: unhealthy and healthy) randomized between-subjects design. The ERP announcement represented a within-subjects manipulation. The analysts' overall reaction to ERP implementation plans was positive, as mean post-announcement earnings forecasts were significantly higher than mean pre-announcement forecasts. Additionally, as expected, mean earnings forecast revisions in the small/healthy and large/unhealthy firm conditions were significantly greater than mean forecast revisions in the small/unhealthy firm condition.

Experimental results from the current study support archival findings reported by Hayes et al. (2001), who explored the same research questions, among others, by examining cumulative abnormal returns surrounding ERP announcements. Triangulation studies of this nature using multi-methods (e.g., behavioral versus archival) and complementary criterion variables (e.g., earnings forecasts versus cumulative abnormal returns) are important to social scientists, as they provide insight into the reliability, consistency and validity (both internal and ecological) of proposed theoretical relationships (Boyd et al. 1993; Flick 1992; Libby et al. 2001).

Key words: Enterprise Resource Planning, ERP, Investors, Financial Analysts, and Triangulation.

Data Availability: Data will be made available upon written request and justification.

I. INTRODUCTION

Enterprise resource planning (ERP) systems promise to integrate business processes within and across functional areas in organizations. Early ERP systems primarily included inventory control software, material requirements applications and manufacturing planning modules. The continual evolution of ERP systems has subsequently encapsulated the full spectrum of business processes such as selling, marketing, purchasing, warehousing, accounting, and human resource planning into tightly integrated enterprise-wide information databases. The latest generation of ERP systems extends beyond the organization by capturing inter-organizational processes such as customer and vendor relationship management (Kumar and Van Hillegersberg, 2000).

The pervasive organizational effects of ERP systems have been widely addressed in the popular literature. However, there is a paucity of empirical research examining the impact of ERP system implementations on firm performance, which is surprising considering that ERP systems inextricably intertwine a vast array of intra- and inter-organizational business processes with the accounting information system. Recently, calls for empirical studies into the effects of ERP system implementations on firm value have appeared in the literature (Lee, 2000).

In response to such calls, a recent accounting archival study investigated the market reaction to ERP implementation announcements (Hayes et al., 2001). Overall, they found that the market reacted favorably to ERP announcements, as cumulative abnormal returns surrounding the announcement date were significantly positive. Additionally, they hypothesized that market reactions to small/healthy and large/unhealthy firms would be more positive than the reaction to small/unhealthy firms. However, this effect was realized only for the small/healthy firms. They suggested that the non-significant effect for large/unhealthy firms could have been

due to low power, as the mean reaction was in the anticipated direction, but sample sizes were somewhat small.

In the current study, we examine the same questions set forth by Hayes et al. (2001): do investors (1) believe that ERP systems add value to organizations and (b) react differently to ERP system announcements contingent on the firms' relative size and financial health? However, we use a different research approach (experimental) and examine a different, yet complementary, criterion variable (earnings forecasts). As compared to Hayes et al. (2001), our experimental design allows us to draw causal inferences, which could only be implied through correlation in the archival study, and yield greater statistical power to determine if the lack of significance between large/unhealthy and small/unhealthy firms in the archival study was a power problem or a theoretical issue.

As suggested by Boyd et al. (1993), Flick (1992), and Libby et al. (2001), the use of multi-methods (e.g., behavioral versus archival) and complementary dependent variables (e.g., earnings forecasts versus cumulative abnormal returns) to investigate underlying phenomena are very important to social science research, as convergence of perceptual (e.g., financial analysts' beliefs) and objective (e.g., stock investors' reactions) measures of the environment can increase the internal and ecological validity of theoretical relationships pertaining to phenomena of interest. In the next section, we present relevant theory and offer study hypotheses. In the following sections, we describe the research method, analyze the experimental data, and discuss the study findings.

II. THEORY AND HYPOTHESES

The purpose of this study is to experimentally test theoretical relationships developed by Hayes et al. (2001), who examined the market reaction to ERP implementation announcements

via cumulative abnormal returns surrounding announcement dates. While Hayes et al. (2001) attributed positive, significant, cumulative abnormal returns to ERP announcements, they warned readers to be cautious about drawing causal inferences from event studies of this nature. Another limitation of the Hayes et al. (2001) study is that one of their hypotheses did not obtain statistical significance (large/unhealthy firms > small/unhealthy firms). While they attributed the lack of significance to low power, it is also possible that the underlying theory leading to their hypothesis needs refinement.

We examine the same issues as Hayes et al. (2001) using a different research method (experimental versus archival) and complementary criterion variable (earnings forecasts of financial analysts versus cumulative abnormal stock returns). Using multiple methods and different dependent variables can provide deeper insight into underlying phenomena, particularly when the initial method leaves significant questions unanswered (e.g., cause-and-effect relationships and unsupported predictions). Whether an issue is investigated using objective or perceptual data, each method brings its own strengths and weaknesses to the questions addressed (Boyd et al. 1993).

For example, investigating hypothesized relationships using archival methods allows researchers to determine if expected relationships hold in the complex environment of the real world. However, archival studies can only imply causality through theoretical expectations and statistical associations. Experiments, on the other hand, introduce randomization, and measurement and control elements that allow researchers to test causal relationships. However, the weakness of experiments is their inability to capture the ecologies of real world complexities. Hence, by comparing objective and perceptual study results, researchers can better understand the extent to which theoretically derived causal relationships hold in a macro environmental setting

(Flick, 1992). Thus, while both the current study and Hayes et al. (2001) investigate the impact of ERP implementation on firm value, the archival study (Hayes et al. 2001) focused on standardized cumulative abnormal returns (an objective measure), whereas this study examines financial analysts' earnings forecasts (a perceptual measure).

We refer readers to the Hayes et al. (2001) study for a complete explanation of the theoretical basis for the upcoming hypotheses. However, in the next section we briefly review the reasoning behind the hypotheses, as our predictions parallel the first two hypotheses offered by Hayes et al. (2001).

Overall Reaction to ERP Implementation Plans

Hayes et al. (2001) argued that by disclosing ERP implementation plans, firm managers signal to the market that the firm intends to incur transitory costs associated with the implementation. At the same time, due to strategic benefits associated with ERP systems such as reduced internal and external transaction costs, decreased information asymmetry among information consumers, and lower cost of capital, managers also signal expected improvements in productivity and profitability that should positively impact future discounted cash flows. If the market recognizes these offsetting signals and determines that the long-term benefits exceed the short-term outlays, the overall market reaction should be positive.

However, Hayes et al. (2001) also acknowledged that the market reaction could be negative, as ERP implementations are known to be costly and risky. Thus, it is possible that the reaction to ERP implementation plans will be pessimistic, particularly if investors believe that the discounted value of long-term benefits associated with the implementation will not offset the short-term costs. Based on the preceding arguments, Hayes et al. (2001) offered a non-

directional hypothesis regarding the overall effect of ERP implementation plans on the market value of the announcing firms.

Statistical testing of standardized cumulative abnormal returns (SCAR) revealed an overall positive reaction (two-sided p -value = .07) to ERP implementation announcements (Hayes et al., 2001). Thus, the market appeared to assess the discounted value of future cash flows associated with the use of ERP systems as greater than the short-term implementation costs.

While the Hayes et al. (2001) study used SCAR as a dependent variable, we solicited analysts' earnings forecasts as our criterion variable for two main reasons that surfaced during pilot testing with a pilot sample of financial analysts. First, the two metrics should move in the same direction, which provides for convergent validity of objective (e.g., SCARs) *and* judgmental (e.g., earnings forecasts) indicators of the perceived value associated with ERP implementations. Second, while we considered asking for stock price predictions rather than future earnings estimates, the analysts informed us that predicting pre- and post-announcement stock prices in an artificial setting would result in higher variability than earnings estimates due to a host of exogenous factors that would necessarily remain uncontrolled and unmeasured in the experiment. Their primary reasoning for suggesting that earnings forecasts would be less variable than stock price predictions was that earnings are but one of many complex factors affecting stock prices; hence, earnings forecasts should be more stable than stock price predictions. Accordingly, we chose earnings forecasts as the dependent variable. Based on the theoretical arguments and empirical results of Hayes et al. (2001), we offer the following directional hypothesis:

H1: The announcement of an ERP implementation will have a significant positive effect on financial analysts' earnings forecasts.

Hayes et al. (2001) further indicated that the market reaction to ERP implementation plans could differ, depending on the interaction of firm size and financial health. We next offer an overview of their reasoning.

Firm Size and Financial Health

The nature and extent of market reactions to firm announcements depend on a host of contextual factors. With respect to major capital outlays as reflected by ERP implementations, firm size and financial health reflect two of the more salient factors (Hayes et al. 2001).

The market reaction to smaller firm announcements is often stronger than larger firm announcements because fewer analysts and media outlets follow smaller firms; hence, less is known about smaller firms in the marketplace. As a result, smaller firm announcements frequently contain more incremental information content than larger firm announcements (e.g., Atiase 1985; Feroz and Wilson 1992; Grant 1980; Hayes et al. 2000, Hayes et al. 2001). However, predicting a size effect related to firm announcements is complicated by another salient contextual factor—financial health (Hayn 1995; Khurana and Lippincott 2000).

Completion of ERP implementations can require between six months and several years (Cooke and Peterson 1998). In addition, ERP implementations often experience significant cost over-runs (Koch 1996) and short-term declines in firm performance (Wah 2000). For these reasons, significant positive returns on ERP investments may not obtain for two to five years (Davenport 2000; Stedman 1999; Wah 2000). Thus, firms must have sufficient levels of resources to withstand the financial strain of ERP implementations. Accordingly, financial analysts may be particularly cognizant of the effects of ERP implementations on smaller firms, especially those that might not be able to acquire the resources needed to complete ERP implementation projects.

Smaller firms are riskier than larger firms, in general, because smaller firms have more frequent losses (Hayn 1995) and display greater heterogeneity with respect to liquidity and solvency (Huff et al. 1999). Such market risk is amplified considerably for smaller firms who are financially unhealthy, as they often do not have and cannot acquire sufficient financial resources. While the risk of large/unhealthy firms is also a concern in this regard, such risk is mitigated because large/unhealthy are better able to withstand the financial strain of ERP implementations than small/unhealthy firms for two primary reasons. First, it is more likely that larger firms either have or can obtain financial resources sufficient to withstand the economic demands of ERP implementations, and second, the proportion of overall costs consumed by ERP implementations is less for larger firms, as compared to smaller firms.

Based on the reasoning presented above, Hayes et al. (2001) predicted a joint effect of firm size and financial health. Specifically, they expected the market to react most positively to small/healthy and large/unhealthy firm announcements because investors would perceive that (a) both firm categories could withstand the financial strain of ERP implementations, (b) small/healthy firms might become larger and stronger via ERP systems, and (c) large/unhealthy firms could become more competitive, thus healthier, if they adopt ERP systems. On the other hand, Hayes et al. (2001) predicted that the market would respond least favorably to small/unhealthy firm announcements, as their ability to struggle through the financial strain of the implementation period would be in question. Finally, Hayes et al. (2001) made no prediction with respect to large/healthy firms, as the authors were unsure how ERP systems would improve the efficiency or effectiveness of firms that were already deemed to be strong and healthy.

Their results indicated a moderately significant interaction term ($F = 3.25, p = 0.075$). Further analysis revealed that the SCAR for small/unhealthy firms (-0.270) was significantly

lower than small/healthy firms (+0.283). However, the SCAR for large/unhealthy firms (+0.272) was not significantly different from small/unhealthy firms, although the direction was as anticipated. The authors attributed the lack of significance for the latter comparison to low statistical power due to a relatively small sample size.

We further test the interaction hypothesis articulated by Hayes et al. (2001) using an experimental method to determine if the lack of significance between large/unhealthy and small/unhealthy firms was a statistical power problem or theoretical issue. Accordingly, we offer the following hypothesis:

H2: Firm size and health will interact such that earnings forecast revisions due to the announcement of an ERP system implementation will be significantly more positive for small/healthy and large/unhealthy firms than small/unhealthy firms.

III. RESEARCH PROCEDURE

Professional financial analysts completed a computerized case study. We based the case on an existing company in the electronics industry. Analysts provided initial earnings forecasts and revised forecasts, as summarized below:

Step 1: The fictitious case firm, HMW Corporation, is a large (small), financially healthy (unhealthy) producer of electronic circuits and other technical components. All analysts received seven icons representing: 1) business background, 2) cash flow analyses, 3) key ratios, 4) accounting policies, 5) income statements, 6) balance sheets, and 7) quarterly summaries. All financial information reflected five years (1995 through 1999). The icons were randomized per individual to preclude an order effect. After reviewing the company information, the analysts provided initial forecasts of earnings (1st quarter 2000, FY ending December 31st 2000, and FY ending December 31st 2001).

Step 2: After the initial forecast, the participants read that the case firm had committed approximately 12% of free cash flows to implement an ERP system beginning with the 2nd quarter of 2000. Analysts were asked to revise their initial earnings forecasts at this point (1st quarter 2000, FY 2000, and FY 2001).

With respect to the second hypothesis (H2), we manipulated relative financial health by varying industry average ratios, which were provided as comparative standards. That is, while the ratio values were identical for all conditions, participants in the financially healthy (unhealthy) condition were given different standards, or average industry ratios, and told that HMW Corporation's key ratios fell in the upper (lower) quartile of firms in the industry. We operationalized the size manipulation by expressing financial information in thousands of dollars for small firms and millions of dollars for large firms. The ERP announcement read by analysts in the large firm condition, which closely resembles the actual wording of several ERP press announcements, is shown in appendix A. The small firm announcement was identical, except that the dollars were in thousands rather than millions.¹ The remainder of the experiment solicited responses to manipulation check items (which were randomized to preclude an order effect) and demographic questions.

Experimental Design

We employed a 2 X 2 randomized, between-subjects design, with financial health (healthy and unhealthy) and firm size (large and small) as independent variables. The ERP announcement was a within-subjects manipulation. We compared the overall mean earnings forecasts before and after the ERP implementation announcement to test the first hypothesis (H1). The mean earnings forecast revision (post-announcement minus pre-announcement) served as the dependent variable in an ANOVA model when testing the second hypothesis (H2).

Participants

A total of 63 sell-side analysts working for a large regional financial services and investment brokerage firm participated in the experiment. The analysts were attending firm-sponsored training at company headquarters. We conducted experimental sessions over five

contiguous days (one session per day) during the first week of March 2000. We randomized participating analysts into four treatment conditions. Table 1 displays sample demographics. Results of statistical testing indicated no significant differences ($p > .10$) among treatment conditions or across experimental sessions on any of the measured demographic variables.

[Insert Table 1 about here]

Manipulation Checks

We used three manipulation check questions. The first two questions tested the success of experimental treatments with respect to firm size and financial health. The third question tested whether participants attended to the timing of the ERP implementation provided in the announcement. The manipulation check question pertaining to firm size read as follows: “In your estimation, how large is HMW Corporation?” (7 = Very Large Size, 6 = Somewhat Large Size, 5 = Slightly Large Size, 4 = Medium Size, 3 = Slightly Small Size, 2 = Somewhat Small Size, 1 = Very Small Size). Mean responses in the large (5.84) and small (2.39) conditions were significantly different from each other ($t = 15.87, p < .01$). The firm health manipulation check question read as follows: “How would you rate the financial health of HMW Corporation, relative to its industry?” (7 = Very Healthy, 6 = Somewhat Healthy 5 = Slightly Healthy 4 = Neither Healthy nor Unhealthy 3 = Slightly Unhealthy 2 = Somewhat Unhealthy 1 = Very Unhealthy). Mean responses in the healthy (5.63) and unhealthy (2.15) conditions were also significantly different from each other ($t = 16.40, p < .01$).

A final manipulation check tested the attentiveness of participants to the experimental materials. We expected no significant difference between the pre- and post-announcement earnings estimates for the 1st quarter of 2000. We based this expectation on two factors: (1) the announcement stated that the implementation would take place during the 2nd quarter of 2001 and

(2) the announcement was made only 3 weeks prior to the end of the 1st quarter. Consequently, an attentive analyst should realize that the announcement would have no impact on cash flows for the 1st quarter. As anticipated, the mean earnings forecasts between the pre- and post-announcement periods for the 1st quarter were not significantly different from each other ($p > .90$). Based on the manipulation check results, we deemed that the experimental manipulations were successful.

IV. RESULTS

Hypothesis Testing

Recall that the analysts provided earnings forecasts for the case firm for FY ending December 31st 2000, and FY ending December 31st 2001.² They provided forecasts before (pre-announcement) and after (post-announcement) the ERP announcement. Table 2 provides the cell means and standard deviations for the earnings forecasts and revisions for FY 2000 and FY 2001.

[Insert Table 2 about here]

In summary, the first hypothesis (H1) posited that overall mean earnings forecasts would be revised upward after the announcement of an ERP system implementation. The overall FY 2000 mean (standard deviation) forecasts for the pre- and post-announcement trials were \$1.07 (0.12) and \$1.16 (0.16), respectively. The means were significantly different from each other ($t = 3.75, p < .01$). The overall FY 2001 mean (standard deviation) forecasts for the pre- and post-announcement trials were \$1.12 (0.13) and \$1.21 (0.16), respectively. Again, the FY 2001 means were significantly different from each other ($t = 3.30, p < .01$). Consequently, the first hypothesis was supported.

Recall that the second hypothesis (H2) predicted that forecast revisions for small/healthy and large/unhealthy firms would be significantly larger than forecast revisions for

small/unhealthy firms. The ANOVA models shown in Table 3 used the signed difference between post-announcement and pre-announcement earnings forecasts as the dependent variable.³ Table 3, panel A (panel B) provides the results for FY 2000 (FY 2001).⁴ Regarding FY 2000 (panel A), the interaction term is moderately significant ($p = .06$), while the interaction term for FY 2001 (panel B) is highly significant ($p < .01$).

[Insert Table 3 about here]

The bottom portions of panels A and B (labeled “Planned Comparisons”) show test results pertaining to the second hypothesis (H2). Regarding FY 2000 (panel A), the mean forecast revision for small/healthy firms is marginally greater ($p = .09$) than the mean revision for small/unhealthy firms, whereas the mean forecast revision for large/unhealthy firms is significantly larger ($p = .05$) than the mean revision for small/unhealthy firms. The pattern of mean forecast revisions is similar for FY 2001, except that the significance of statistical testing ($p = .05$ and $p = .01$, respectively) is stronger than FY 2000. Based on these findings, the second hypothesis was supported.

Supplemental Testing

Given the within-subjects nature of the ERP announcement, concerns arise with respect to possible demand effects. We conducted a supplemental between-subjects experiment ($n = 29$) to test the validity of this concern. Using the same case materials as in the main experiment, we ran a separate between-subjects (no ERP announcement versus ERP announcement) experiment using different analysts to determine the extent to which within-subject demand effects might be impacting significant findings obtained in the main experiment. The case firm was characterized as relatively small and healthy (using the same size/health manipulations from the main experiment).

To make the ERP implementation announcement as non-obvious as possible, it was not treated as a separate event in this study. Rather, the ERP announcement was entitled ‘committed capital projects’ and it was presented along with the firm’s business background, cash flow analyses, key ratios, accounting policies, income statements, balance sheets, and quarterly summaries. The eight information items just mentioned were randomized per individual to preclude an order effect. After reviewing the items, we asked the analysts to predict FY 2000 earnings for the case firm.

There were 15 analysts in the control condition and 14 in the ERP announcement condition. Earnings forecasts for FY 2000 in the control (\$1.09) and treatment conditions (\$1.13) were significantly different from each other ($t = 2.39, p = .02$). Hence, although the magnitude of earnings forecast differences among treatment conditions in the main experiment might be amplified due to demand effects, findings from the between-subjects supplemental experiment nevertheless indicate that the direction of change is positive in light of ERP adoption plans.

V. DISCUSSION

The current study investigates the extent to which professional financial analysts believe that the implementation of an enterprise resource planning (ERP) system is a value-added endeavor for business firms. To investigate this issue, we designed a two (firm size: small or large) by two (financial health: unhealthy or healthy) between-subjects experiment, wherein the manipulation of an ERP announcement represented a within-subjects treatment. Sixty-three financial analysts participated in the study.

As predicted in the first hypothesis, we found a significant overall difference in mean earnings forecasts between the pre- and post-announcement trials. Specifically, post-

announcement forecasts were significantly larger than pre-announcement forecasts for fiscal years 2000 and 2001. Additionally, in the second hypothesis, we expected that the mean earnings forecast revision for small/unhealthy firms would be significantly smaller than mean forecast revisions for either large/unhealthy or small/healthy firms. The second hypothesis was also supported.

With respect to the overall reaction to ERP implementation announcements, experimental results from the current study are congruent with archival findings from Hayes et al. (2001). Such convergence offers compelling evidence that capital market participants perceive that positive firm benefits will arise from the use of ERP systems, as we employed a different research method (experimental versus archival) and examined a complementary criterion variable (earnings forecasts versus cumulative abnormal returns) than Hayes et al. (2001). We use the term ‘perceived’ benefits because objective (cumulative abnormal returns) and judgmental (analyst forecasts) evidence from these two studies suggest that investors believe that ERP systems will increase firm value in the future. However, upon such an announcement, the true longitudinal impact of ERP adoption on firm value is yet unknown.

A cross-study comparison of the ‘firm size’ by ‘financial health’ interaction also yields congruent findings. That is, both studies reported at least marginally significant interaction terms ($p < .10$), which suggest that the combined effect of these two contextual factors appear to moderate the influence of ERP announcements on stock prices and earnings forecasts. More specifically, Hayes et al. (2001) reported a significant difference between small/unhealthy and small/healthy firms, as the mean cumulative abnormal returns (standardized) was higher for the latter firm category. The current study also noted a significant difference in this regard. However, while predicted by Hayes et al. (2001), they found no significant difference in mean

cumulative abnormal returns between large/unhealthy and small/unhealthy firms, although the means moved in the anticipated direction. The authors suggested that the lack of significance was likely due to low power. In the current study, we found a significant difference in mean forecast revisions between large/unhealthy and small/unhealthy firms. Accordingly, the ‘low power’ issue noted by Hayes et al. (2001) appears to be a plausible explanation for their non-significant finding.

This study is limited by external validity concerns normally accompanying laboratory experiments of this nature. However, the use of professional financial analysts as participants mitigates the external validity threat to some extent. Another limitation is that the use of 12% of cash flows as the initial cost of the ERP might be interpreted as having a larger impact on small firms relative to larger firms. Finally, while within-subjects manipulations always raise concerns with respect to demand effects, the supplemental experiment described above suggests that the within-subjects treatment of the ERP announcement in the main experiment did not alter the directional nature of the analysts’ reactions.

Overall, results of the current study indicate that a key group of information consumers, financial analysts, reacted positively to the announcement of ERP implementation plans. However, as expected, their responses were moderated by firm size and firm health. Our results are consistent with an archival study conducted by Hayes et al. (2001). Triangulation studies of this nature using multiple methods (e.g., behavioral versus archival) and different yet complementary criterion variables (e.g., forecast predictions versus market reactions) demonstrate the value of testing similar issues from more than one research perspective to determine the reliability, stability and validity of proposed theoretical relationships of interest.

Future studies in this area should investigate the extent to which ERP systems impact firm value over time. One way to examine this issue is to track and compare firm performance (e.g., return on investment, return on assets, and firm profitability) over a multi-year time horizon via a matched-pairs study of ERP and non-ERP adopting firms. Another approach would be to analyze other salient value indicators such as quality improvements with respect to products, services, employee morale and customer relations, via pre- and post-implementation comparisons within and across firms.

APPENDIX A

ERP Announcement – Large Firm

Committed Capital Projects:

HMW Corporation has committed up to \$200 million (approximately 12% of free cash flows for 1999) to implement a rollout of an Enterprise Resource System (ERP), including consulting and support services. Management intends to implement the ERP during the second quarter of 2000. HMW's objective is to become the lowest-cost, best-in-class producer in its industry. According to HMW, the proposed system will give the company the considerable strategic benefit of having more timely and accurate information about its business. The system will allow for the distribution of information to thousands of users while maintaining critical information, such as information on vendors and materials at the enterprise level.

Like many organizations, HMW currently has legacy systems that cannot provide the flexibility and fast response required to stay competitive in today's markets. HMW's current systems for inventory control and collections of receivables, internally developed in the 1960s, are no longer able to keep up with the company's growing requirements. "This is a very ambitious project for us, ultimately linking users worldwide in a complex client/server network," said James E. Dunne, project manager for HMW.