Beyond Y2K:

Information Technology and the Automotive System Integrator

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Office for the Study of
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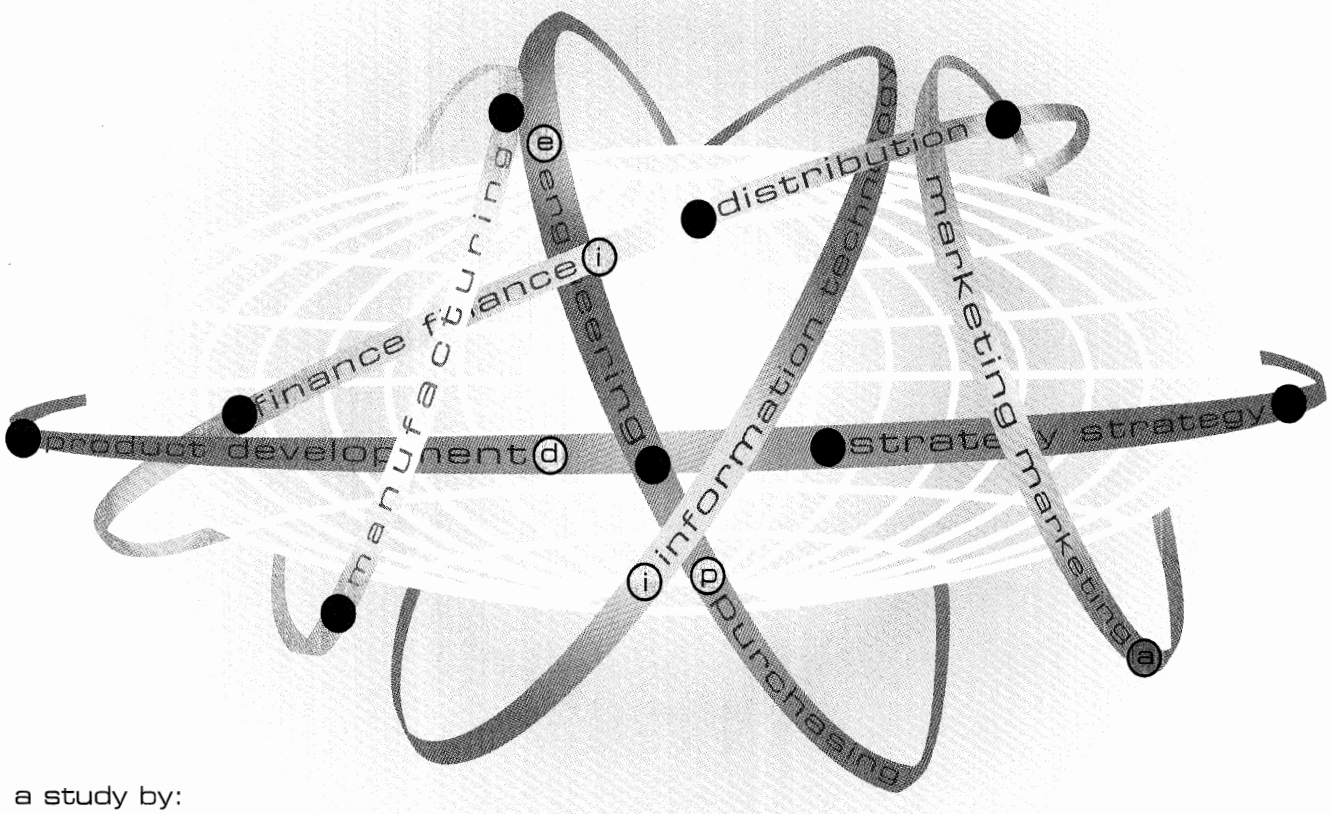

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Executive Summary

Automotive suppliers today face many challenges, including the restructuring of company roles and responsibilities, altering value-chain relationships between manufacturers and suppliers, improving internal performance, and the industry-wide deployment of information technology (IT). These are particularly critical for a key set of suppliers, often called system integrators, who are taking on major technical and managerial responsibilities from the vehicle manufacturers.

Information technology forms a set of linking technologies that can markedly accelerate achieving both internal company goals and the coordination of activities across the production chain. However, IT is complex because it consists of two crucial elements, the IT infrastructure (physical hardware, networks, etc.) and IT software applications (Enterprise Resource Planning, etc.). These must be coordinated and balanced for effective IT implementation.

This report explores the implementation and successful exploitation of IT technologies, building on both mail surveys and face-to-face interviews with system integrator CEOs, CFOs, and CIOs in the fall of 1997.

- These supplier executives rate implementing both IT applications and infrastructure as currently quite important in the strategic hierarchy, and they expect IT infrastructure to become even more important by 2001. The IT goals currently rank lower than some goals, such as improving customer relations, quality, and achieving time reductions across all processes, but ahead of others, such as achieving system integrator capabilities and globalization.

- They rate IT between moderately important and quite important as a means to other strategic goals, viewing applications as more important than infrastructure for a number of their goals. The interviewees emphasized the utility of IT in achieving some form of integration, whether internal or external, and this theme recurred throughout the interviews.

- The executives report a wide range of outcomes in their efforts to implement IT to address internal and supplier-related change efforts, seeing IT implementation as more important for internal than for external change efforts, and emphasizing applications over infrastructure.

- They report that they are electronically quite well linked to their customers, somewhat well linked internally, and not very well linked to their own suppliers. They stress the importance of using IT to achieve integration across tasks, functions, companies, and locations.

- In regard to their most recent substantial IT effort, respondents rate internal resources as a bit more important for success than external support. Effective internal leadership and support, along with vendors working together well, are most closely related to project success. Securing leadership and staff commitment is critical for success, while lack of training and allocation of insufficient learning time are major hindrances.

- For implementing IT, appropriately identifying the business processes for implementation is clearly the initial stage, and most important for overall cost and effectiveness. Hardware selection is seen as relatively less important for project cost and effectiveness.

- IT projects are evaluated much as other major investments are at most companies; however, a substantial minority do not rely on traditional financial measures. This reflects the difficulty of unambiguously measuring costs and benefits and sometimes simple recognition of the need to pursue implementation. Personnel costs for training and implementation are much more substantial than the hardware and software of the IT system, and the cost and ease of using IT becomes more a concern as IT is driven lower in the supply chain.

- CEOs generally are less confident than CFOs and CIOs in IT as a mechanism for achieving their strategic priorities. CEOs are also less confident than others in the relative value of IT infrastructure and applications, and the utility of IT for achieving current efforts to select and manage the supply base.

Introduction

Today's automotive supplier faces numerous strategic challenges in the face of rapidly multiplying and changing business threats and opportunities.[1] First, the industry's continuing globalization raises a particular set of challenges for suppliers. Most immediately, globalization is leading the suppliers' traditional automaker customers to demand support for their own entry into new and emerging markets, requiring suppliers to add production capacity and/or adapt to new logistics challenges. Less immediately, but of potentially equivalent importance, the continuing entry of new automakers and their suppliers into North America changes the competitive equation for the traditional supplier. It brings the traditional supplier new customer opportunities, but it poses new competitive threats for the traditional supplier as well, both in the form of direct competitors and indirectly through threats to its traditional customers.

Second, the industry is restructuring, and virtually all suppliers will experience continual change in their specific roles and responsibilities, as the locations for executing various technical and managerial functions shift along the value chain. For example, some suppliers will face increased requirements to engineer their own parts and components and even provide engineering support to their own suppliers. Almost all suppliers will experience heightened responsibility for the process engineering and manufacturing of their automotive products.

The industry's increased globalization, combined with its altered responsibility structure, is driving a third important challenge, as suppliers and the manufacturers will inevitably develop quite different relationships as time passes. Some suppliers will find these relationships growing more balanced, as their increased responsibilities and the larger number of available customers makes them less dependent on any given manufacturer. Other suppliers will see their traditional relationships with the manufacturers essentially disappear, as system integrators or other suppliers replace their old manufacturer customers in the industry's more tiered structure.

These three change challenges all intensify competition, forcing companies to alter their standard business operations, processes, and strategies as they pursue higher levels of internal performance and external coordination of their value chain. Meeting the demands of today's industry will require most suppliers to make more and better use of information technology (IT), and the deployment of IT's constituent elements itself becomes a fourth fundamental and major challenge for the automotive supplier.

These challenges are especially severe for an emerging set of key suppliers, often called system integrators, those large first-tier or direct-to-manufacturer suppliers who are taking on major added responsibilities in the production chain. The vehicle assemblers want their key system integrators to serve them on a worldwide basis, so the pressures of globalization are particularly acute for these suppliers. Moreover, the assemblers are requiring these suppliers to execute more of the industry's engineering and technical work, including added design and engineering for complex vehicle modules or systems of parts and components. Finally, assemblers are also asking them to accept increased responsibility for selecting, coordinating, and managing the entire supply chain for those systems. In a sense, these system integrators are picking up activities and responsibilities *from* the manufacturers and *for* the indirect suppliers, in effect mediating the assembler's relationship to its total supply chain.

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[1] Flynn, Michael S., Bruce M. Belzowski, Bram Bluestein, Michael Ger, Manfred Tuerks, and John Waraniak, The 21st Century Supply Chain, "The Changing Roles, Responsibilities and Relationships In the Automotive Industry." A. T. Kearney, Inc., 1996.

Information technology forms a key set of linking technologies that can markedly accelerate the process of implementing the wide range of company strategies and of achieving the diverse company goals demanded by today's automotive climate. However, the continuing burden of effectively implementing and competitively exploiting IT itself constitutes a major and complex challenge on the broad industry's agenda. The challenge is quite complex because IT consists of two crucial elements: IT infrastructure (physical hardware, networks, etc.) and IT software applications (Enterprise Resource Planning or ERP, etc.) Moreover, the coordination and successful implementation of these two IT elements, both within a company and between it and its customers and suppliers, is essential for IT to be effective.

IT promises to be an effective resource for automotive system integrators as they wrestle with globalization, additional technical responsibilities, and new supply chain coordination requirements. Indeed, the internal and external changes demanded of these suppliers make the implementation of IT infrastructure and a range of IT applications a critical strategic issue for them as the industry moves into the next century.

A number of interests motivated and guided these research efforts.[2] These include fundamental questions about whether IT implementation is primarily a means or an end in the suppliers' strategic thinking, and its relative importance as a means to various strategic goals now and in the future. Another important consideration is how suppliers' might differentiate their views of the two major components of IT, its infrastructure and applications. We also explored how closely linked these companies are electronically, both internally and with their customers and suppliers, and their progress in meeting their internal change goals and in selecting/managing their supply base. Finally, we examined the role of outside vendors in the suppliers' most recent major IT installation, the major barriers and facilitators of that implementation, and key decisions in the IT implementation process, including how these suppliers evaluate the costs and benefits of IT.

Method

In fall 1997, we mail-surveyed chief executive officers [CEOs], chief financial officers [CFOs], or chief information officers [CIOs] from suppliers that already are, or soon will be system integrators. We also conducted supplementary face-to-face interviews with these types of executives at 12 additional system integrators.[3] This report presents selected highlights of our findings rather than a complete account of the interview and survey results. For the survey material, we examine whether or not the responding executives' current assignment (CEO, CFO, or CIO) is related to their views. We treat our statistical results as exploratory, and consequently report a few effects somewhat weaker ($p < .10$) than tradition demands.

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[2] The research reported here is funded by two IT companies, Hewlett-Packard, a major information technology (including infrastructure) supplier, and Baan, a major supplier of production applications to the automotive industry. Their business interest in better understanding the competitive situation and responses of a key group of their potential customers, the system integrators, nicely dove-tails with OSAT's broader research interest in understanding the change efforts of suppliers and the changing competitive topography they face as a result of globalization and industry restructuring.

[3] We appreciate the interview efforts of Morgan Edwards, Jeremy Myer, and Richard Senter.

IT implementation in the strategic map

Our survey asked executives to consider their investments of financial and human resources across an array of 13 challenges and then to rate the strategic importance of each challenge in 1997 and 2001, yielding a rough portrait of the strategic-change hierarchy for the North American system integrator. The executives rate all the challenges as important, with the lowest one rated mid-way between moderately (3.0) and quite (4.0) important on the five-point scale.

The ratings cover three types of challenges. First, the broad challenge of *change itself* is critical, since how well companies manage change and adapt to new circumstances is an important part of the competitive equation. Second, *external challenges* are those change imperatives which require changes in relationships or conditions beyond the company's boundaries, such as those associated with global competition or industry restructuring. Third, *internal challenges* largely require change within the company's boundaries, such as improving performance, even though they too are often rooted in the industry's competitive dynamics.

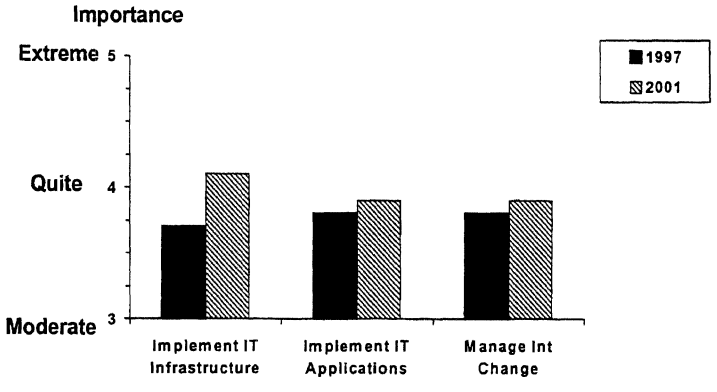

Figure 1: Priorities for General Change Are Stable

Figure 1 displays the importance ratings for three *general-change* challenges. All three are rated quite important, and two, managing internal change and implementing IT applications software, are also fairly stable over the 1997 through 2001 time frame. The third, implementing IT infrastructure, shows nearly a half-point increase in importance by 2001. We suspect that these executives view IT infrastructure investments as more episodic in nature than IT applications, which require ongoing investment. In a sense, they probably consider infrastructure investments to be big project, one-time efforts, while software applications may already be embedded in the company's routines, benefiting from fairly steady investments for maintenance and expansion.

In our interviews, executives volunteered those challenges most active in their own strategic thinking. Interestingly, they mention the problems of coping with and managing change only in the context of specific change efforts, and not once as a general challenge. This is more than a semantic distinction: while executives often mention profit as a specific criterion or goal of particular projects, they rarely fail to mention it as an overall concern and target of the company! The only two mentions of the importance of implementing IT as a general challenge are in regard to successful globalization and apprehensions about the Year 2000 problem.

Figure 2 exhibits those external challenges associated with industry restructuring, which often require coordination of activities beyond the company's own boundaries and are relatively diffuse throughout the company. These results are fairly straightforward. Improving customer relations and service is today's most important restructuring challenge, rated about half a scale point above improved supplier relations and supplier selection and management, and almost a full scale point above the broader imperatives of globalization and developing system-integrator capabilities. As we look ahead to 2001, these priorities converge, and the ratings of these five strategic challenges narrow to a range of just about one-third of a scale point, with improving customer relations still the most important.

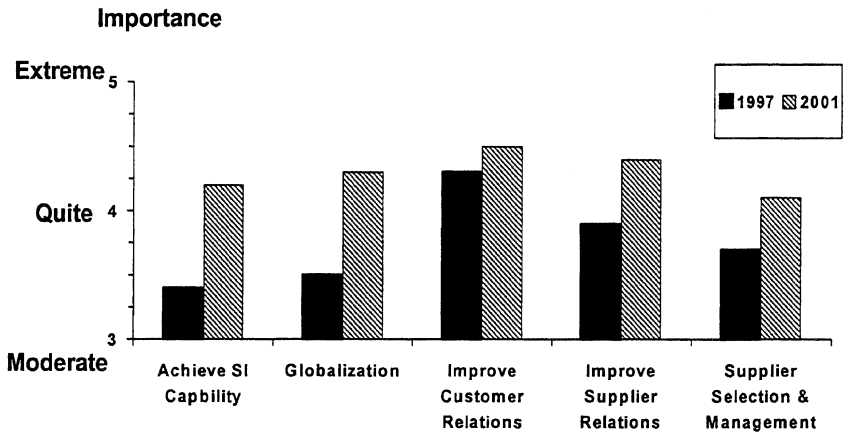

Figure 2: Restructuring Priorities Converge

It is interesting that these system-integrator executives report that improving relations with customers is substantially more important than improving relationships with their own suppliers. We suspect that there is still some tendency for first-tier supplier executives to consider the value chain as primarily extending forward from their company to the assemblers, and to view their own supply base in much the same fashion that the assemblers view them. This pattern is somewhat ironic, since these system integrators themselves strenuously object to any suggestion that the assemblers view them as a replaceable and less important part of the production chain.

It is rather surprising that globalization and developing system-integrator capabilities rank so low. To be sure, suppliers rate them midway between moderately and quite important, but this is a comparatively low priority. Still, these are the two challenges respondents think will grow the most in importance by 2001, and these substantial increases over their 1997 ratings may reflect a slower, more cautious pace suppliers are taking today to meet these challenges.

Our interviewees view these priorities somewhat differently than do our survey respondents. Perhaps this is because the interview may elicit and identify the current "hot-button" issues, while the survey describes and compares a more considered appraisal of the full range of issues. In any case, interviewees emphasize globalization, accounting for over 40 percent of all restructuring responses (31 total). Meanwhile, the responses identifying customer and supplier issues tie at 4 each, combining to account for 8, or just over a quarter of the total. However, developing capabilities as a system integrator receives scant mention, consistent with its relatively low ratings in the survey results.

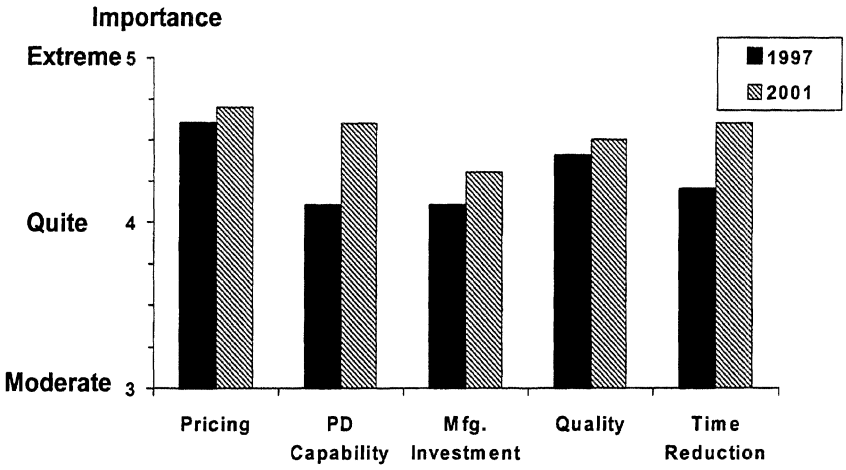

Figure 3: Internal Priorities Converge

Figure 3 displays the importance ratings for change efforts directed to improving internal performance on a number of competitively critical dimensions. For 1997, supplier executives reported that competitive and profitable pricing, along with improving quality, are the most important strategic priorities, rating them midway between quite and extremely important. Time reduction for all processes, product-development capabilities, and investing in world-class manufacturing facilities are all rated as quite important. For 2001, the respondents again reveal a pattern of converging importance for investments across these targets. Enhanced product-development capability and time reduction show the greatest gain in importance, about half a scale point, between 1997 and 2001.

The interview results on the importance of investing in internal performance improvement are consistent with the survey. Interviewees most often mention quality and some general performance improvement programs, such as lean enterprise (4 mentions), just under 20 percent each of the 22 total mentions of internal improvements, while they note pricing and concerns about human resources 3 times apiece, or just under 15 percent each. Only investments in world-class manufacturing facilities failed to receive a specific mention.

In our survey results, CEOs frequently rate a particular challenge as less important than do CFOs and CIOs for 1997, but then rank it the same as, or even more important than they do for 2001. Among restructuring imperatives, CEO respondents rate globalization as a less important 1997 imperative than do either CFOs or CIOs, but for 2001 rate it more important than do the other executives. The seriousness of the current Asian crisis may have tarnished what had earlier seemed to be CEO enthusiasm for globalization. The pattern also holds for developing system-integrator capabilities and two internal performance dimensions, enhancing product development and investing in world-class manufacturing facilities. The lower priorities that CEOs assign system-integrator and product-development capabilities suggest that the transfer of these responsibilities from the manufacturers could be somewhat slower than many observers expect—or that suppliers already believe they are more capable in these areas than is generally recognized.

Figure 4 displays the summary comparison of all three types of strategic priorities. For 1997, internal efforts are rated as more important than external and broad change areas. However, when we look ahead to 2001, the breakpoint shifts, and internal and restructuring efforts are more similar in importance, and more important than the broader change efforts. This pattern suggests that restructuring challenges are seen more as future than as current concerns.

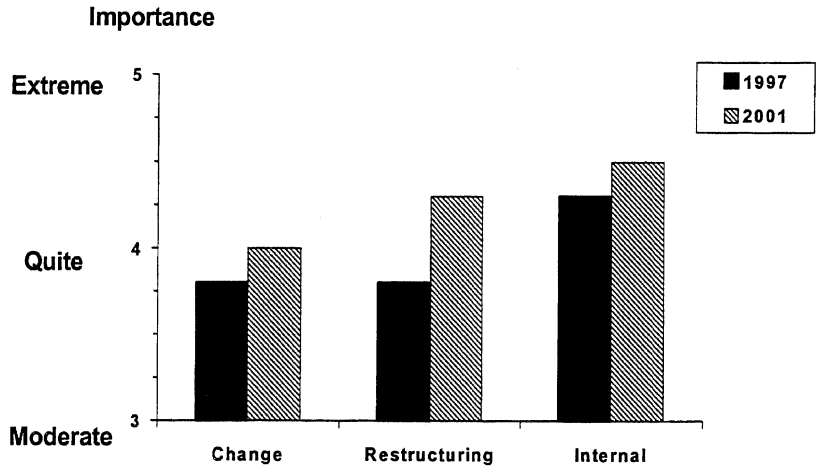

Figure 4: Pattern of Strategic Priorities' Importance Reconfigures Over Time

Beneficial uses of IT

As information technology expands throughout the industry, a central question is how important IT infrastructure and applications will be in achieving company strategic and performance goals. The implementation of IT is itself strategically important only to the extent that it represents a broad, effective, albeit a variable solution to a wide array of disparate challenges. If IT is simply a limited, problem-focused series of tools, it is of little strategic interest, no matter how powerful it may be: the world's most powerful press is still a tool, not a strategy. We do see IT as such an overall strategic approach, paralleling broader efforts such as Total Quality Management or the Toyota Production System in its power to improve performance across a wide front.

We therefore asked survey respondents to rate how important each type of IT investment will be from now through 2001 in reaching the other strategic goals discussed above. In general, they think both IT infrastructure and IT applications are important means to these other goals. These suppliers rate infrastructure investments on average halfway between moderately and quite important, and applications another quarter of a scale point towards quite important.

The survey executives rate the contribution of IT applications to successful management of internal change as 4.1, just above quite important and about half a scale point higher than the contribution of IT infrastructure. It seems likely that the executives are thinking here of the ways in which applications can change and shape specific behavior within the company. Some software applications permit the development of new organizational routines, while others require compliance to a set standard. For example, ERP software may permit new routines for part procurement and production scheduling, but new accounting software may require payments and notifications in particular formats and at specified times. These kinds of changes are both important. CIOs report that IT applications and infrastructure make roughly similar contributions

to managing internal change, while CEOs report more benefits from applications and CFOs report more benefits from infrastructure investments.

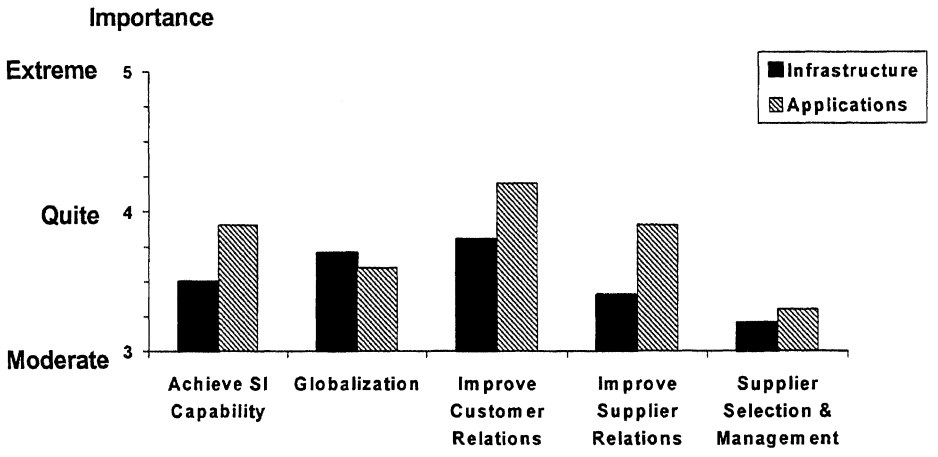

Figure 5: IT Applications More Important For Restructuring Priorities

Figure 5 displays the ratings for IT's contribution to achieving external strategic goals. These executives view the two IT elements as equivalent for achieving successful globalization and selecting/managing their own supply base, although both are more important for globalization. However, they see applications as roughly one-half scale point more important than infrastructure for three critical challenges: developing system-integrator capabilities, and improving customer and supplier relationships. This is surprising, since communication, coordination of effort, and imposition of some common frame is critical to achieving these three strategic challenges. Indeed, here we might expect hardware and networking of the infrastructure to be comparable in importance to applications.

Conventional wisdom in the industry certainly suggests that IT infrastructure and applications will be important as both assemblers and system integrators begin to select suppliers with the IT capability to integrate into new, "virtual" enterprises. Yet these survey respondents attribute the lowest IT efficacy across all these strategic imperatives to supplier selection/management, and CEOs again attribute less importance than other executives. Perhaps CEOs address supplier issues in more non-routine, one-on-one situations, at the policy, rather than the operational, level.

Our interviewees made numerous comments on the role of IT, effectively covering almost the entire list of strategic challenges from the survey, but at a high level of generality seldom distinguishing the relative importance of IT infrastructure and IT applications. Thus, interviewees provided 15 comments on the utility of IT industry restructuring and 12 of these simply referenced IT generally. Still, 8 of the 15 comments identified supplier coordination issues as a key arena of IT benefit, as the interviewees' views again differ from the survey respondents'.

Figure 6 displays the survey respondents' ratings of how important the IT elements are for improving internal performance. Both IT elements are again at least moderately important, but applications reportedly have more to contribute on three dimensions: achieving competitive pricing, product-development capability, and time reduction. For improving quality and investing in world-class manufacturing facilities, IT infrastructure and applications are about equally

important. CEOs report both forms of IT are less important for investing in world-class manufacturing facilities and for reducing the time of all processes than do CFOs and CIOs.

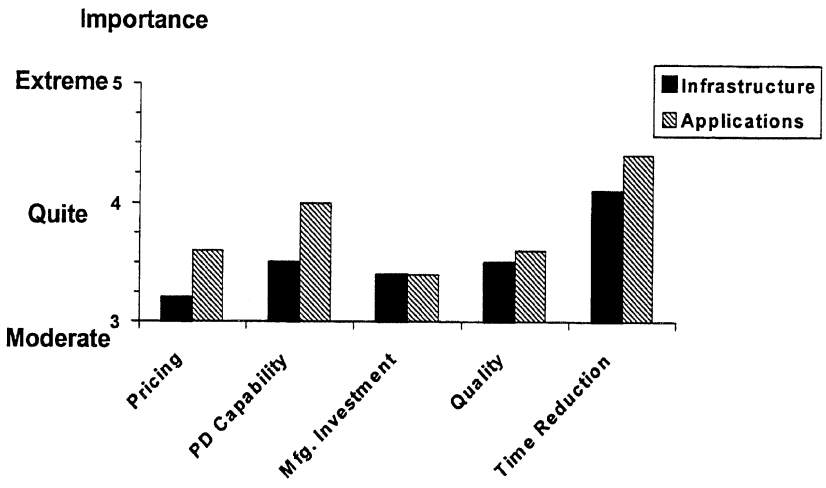

Figure 6: IT Applications More Important For Internal Challenges

Interviewees made 17 comments about the relationship of IT to internal performance improvements, but 15 simply refer to the undifferentiated benefits of IT. While they see the importance of IT for reaching their overall restructuring and internal goals as roughly equivalent, they do differentiate the utility of IT across the priorities within each set. Moreover, they even distinguish between the value of the two IT elements for a number of these specific priorities. Yet they seem to draw at most a weak link between the broader, more relational challenges and the IT infrastructure on the one hand, and the more targeted efforts and the range of specific IT applications on the other. Indeed, they seem to view applications as more tightly linked to all priorities than infrastructure. Perhaps the distinctions we draw between IT infrastructure and applications are less sharp and critical to these executives. After all, there are extremely broad and versatile software applications, such as ERP programs, as well as ones meant to integrate activities, such as CAD/CAM. [4]

We asked interviewees what role IT would play in addressing future challenges. Nearly all identified integration as an important theme. Of the 32 responses, 56 percent identified business-integration issues (including both internal and external integration of processes, information, etc.), while another 31 percent identified global integration issues (again including both internal and external dimensions). The balance of 13 percent evenly split between technical issues (capability, etc.) and those focused on issues involving training and the corporation's maintenance of knowledge as employees retire or leave the company.

Integration is indeed an important theme throughout these interviews, recurring numerous times and in a variety of guises. As companies implement IT hardware and software successfully, they are seeing returns on their investment, and they are also beginning to identify opportunities to integrate processes not only within the business and technical units, but across them as well. At

[4] Our survey instructions used ERP as an example of software applications, and that may have blurred, rather than sharpened, the distinction between infrastructure and applications we wished to explore.

the same time, they are beginning to pursue integrated activity with customers and suppliers, and to seek to expand this coordinated effort on a global scale. This is an area where IT infrastructure might be more important because of the desirability of common standards, formats, and networks.

We also asked interviewees about their companies' current and future uses of IT. Currently, they report more specific and targeted applications in manufacturing (33 percent), business practices (33 percent), engineering (19 percent), and others. For the future, they see more integration of business, purchasing, and supply-chain systems (68 percent), with the balance in the integration of product, process, and manufacturing systems. There is a substantial shift in focus to business, purchasing, and supply-chain integration. The particular need to select and manage the supply chain is addressed in the next section of this report.

Progress in meeting change goals

Change has become a virtual constant in the industry, and the management of change is now a critical challenge. We asked our survey respondents to focus on their progress in achieving internal change goals and their external, supplier-related change goals. Figure 7 displays the overall comparisons. The executives report similar levels of meeting or beating timelines and providing targeted resources for the two efforts, including having a coherent strategic plan, clearly prioritizing the critical areas, and having a team to manage implementing the change efforts. On the other hand, they report some important differences between the internal and external efforts. Thus both IT infrastructure and IT applications are more critical to the internal change efforts, as are broader reorganization and personnel development attempts.

Even though here we ask respondents to rate how critical each element of IT is to their current internal and supplier-related change efforts, the pattern is similar to our earlier question. Respondents view IT as more important or critical to internal efforts, and, to the extent that they distinguish infrastructure and applications, have some tendency to view applications as a bit more important than infrastructure.

Their current assignment markedly affects our respondents' views regarding internal and supplier-related change efforts. CEOs view both IT applications and infrastructure as distinctly less critical to both efforts than do CFOs and CIOs, whose views are virtually identical. In each case, CEOs rated the relevant IT element about one scale point below the CFOs and CIOs.[5]

[5] CEOs also rate developing and training the company's people as less critical for managing the supply base than do CFOs and CIOs, again just about a full scale point lower.

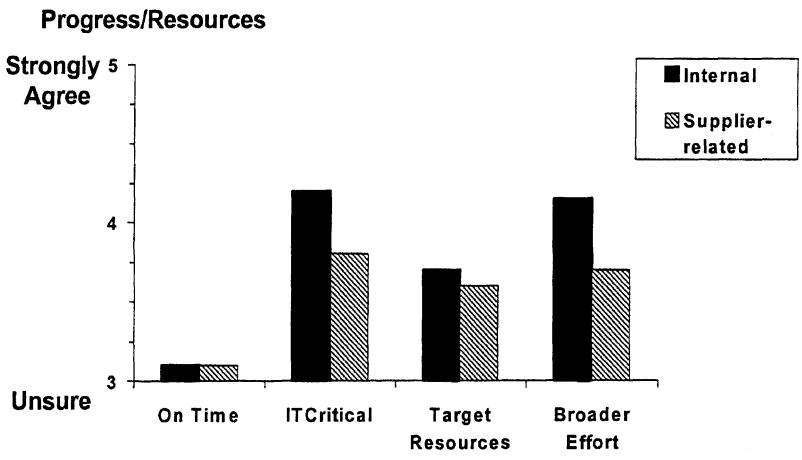

Figure 7: Progress and Resource Allocation for Internal and Supplier-Related Change Efforts

We asked the interview respondents a parallel question. Instead of asking them how important or critical IT might be in achieving a specific strategic imperative, we asked them to identify the most important uses of IT in their company today and in 2001. These results are displayed in figure 8. The current emphasis on using IT for internal changes and goals is extremely strong here, as almost 90 percent of 1997 responses fall into that category. However, the respondents clearly expect this to change, and just over half of the important 2001 IT uses are internal.

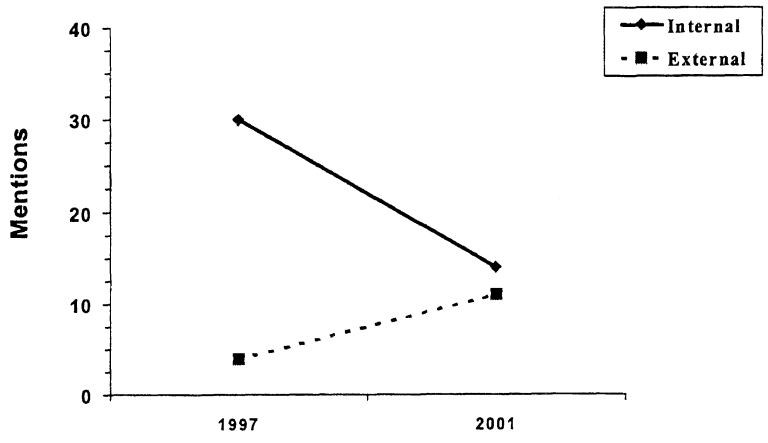

Figure 8: Most Important IT Uses Today and in 2001

These respondents mentioned a wide range of internal change efforts as the most important IT uses today. These efforts cross functional boundaries to include engineering and design, as well as numerous business processes and shop floor manufacturing activities, but are still on balance fairly narrowly targeted. The increased mentions of external efforts for 2001 are largely centered in globalization efforts and initiatives to improve supplier relations.

Interviewees also described the role of IT in their supply-chain management strategy. Most of the responses noted the cost and time reductions IT promises as key elements of its role, attributes that will only make it more important as the industry globalizes. At the same time, a few respondents noted the affordability challenge it raises for small companies: will they be able to increase their resources to purchase what is available, or will applications they can afford to purchase become available? System integrators are increasingly recognizing the need to drive down IT costs so that the entire supply chain can participate in its deployment and use.

The emphasis on IT as a method for linking and communicating, both within companies and externally to both customers and suppliers, is an important theme in these interviews. We asked our interviewees how well linked they are electronically within their company, but also with their customers and suppliers. Not surprisingly, interviewees report very different levels of linkage depending on the specific relationship under consideration. Within their own companies, some interviewees think they are very well linked (25 percent), while the majority think they are somewhat linked (58 percent), and others feel they are not at all well linked (17 percent). These suppliers are better connected with their customers, as 50 percent comment that they are very well linked, and the other 50 percent that they are somewhat linked. But linkages with their own suppliers lag: 50 percent of the interviewees think they are somewhat well linked with their suppliers, while the other 50 percent think they are not at all well linked.

If we convert these codes to numeric scores of 5 for very well linked, 3 for somewhat linked, and 1 for not well linked, then the resulting linkage scores are 4.0 for customer, 3.2 for internal, and 2.0 for suppliers. These are substantial differences, and it is somewhat surprising that external linkage with customers is better than internal linkages within their own companies. Perhaps this better linkage with customers reflects the fact that the assemblers have for some time been requiring their direct suppliers, including these system integrators, to establish such linkages.

We also asked interviewees what improvements need to be made at each of these links. These executives see needed internal improvements focused on the integration of programs and processes (50 percent), while another 25 percent call for improved communications. In terms of customer links, they identify better integration with their customers (53 percent), including the manufacturers' product-development, material-planning, order-release, and billing systems, as well as better technical communications, including consistent and accurate data transfer through EDI (Electronic Data Interchange) for all companies in the worldwide supply chain (24 percent). In communicating with their suppliers, interviewees seek better IT integration, such as improving basic network connectivity through improved e-mail and EDI (42 percent). The pattern of these suggested improvements certainly are consistent with their overall ratings of how well-linked they are with different communication targets.

Within these broad categories, a number of respondents made specific comments that merit mention. Some respondents particularly highlighted the need to develop industry-wide standards, and easy to use, inexpensive (possibly Web-based) applications that lower-tier suppliers can afford. Some see personnel training as critical, so that people can make use of the technical improvements that loom ahead. These system integrators also see the need to educate their own suppliers in much the same way the manufacturers have been educating them about the need to implement and use IT-based communication and processes.

Barriers to, and facilitators of successful IT implementation

As part of the process of learning about the IT experiences of the industry, we asked respondents to the questionnaire and interviewees about their experience with a recent IT infrastructure or application implementation with substantial cost. Forty-six percent of the respondents to the survey were currently implementing such a new IT initiative, while 30 percent had implemented new systems within the prior year, and 22 percent had done so over a year ago.[6]

It is useful to know the common experiences of companies with these projects, if only to begin sorting out the more promising implementation strategies for future efforts. In a sense, they indirectly shed light on the barriers and facilitators of IT implementation. While we cannot tell exactly what implementations the survey respondents considered, the interviews provide some guidance as to the likely candidates. The most frequent projects were ERP systems, described by 8 of the 12 interviewees, while others include integrating product development as well as integrating processes on a global basis. Some of the interviewees commented that the Year 2000 problem was one motive for changing the corporate IT system, because of the extensive overhaul of their systems it requires in any case.

The survey asked 12 questions about this most recent project with substantial cost. We tapped the respondents' overall view of the success of the effort (3 items), the quality of the internal effort and resource allocation that supported the project (4 items), and the effectiveness of external resources, specifically IT vendors and consultants (5 items). By and large, respondents averaged right around neutral on the scale for all three categories, rating their satisfaction at 3.2, their internal efforts at 3.3, and the outside support at 3.1, where 1 represents strong disagreement and 5 indicates strong agreement.

A few general results merit comment. First, overall satisfaction is strongly correlated with both satisfaction with process implementation and also with intention to reuse the same process, and these two process-related items are even more strongly correlated with each other. Second, in regard to internal resources, respondents agreed that effective internal leadership and support was a major resource (3.9) and that information supplied by internal sources was better than that from external sources (3.4). Third, they rated IT vendors a bit better than might be expected, agreeing they are somewhat valuable to project success (3.4) and work together very effectively (3.3).

Figure 9 displays the items bearing on the relationship of the internal resources devoted to the project and the project's success. The respondents' views of the effectiveness of internal leadership has the strongest relationships with the success measures, a bit stronger for the process outcome items than for the system satisfaction item. The same pattern of stronger correlation for the process measures holds as well for the information support from internal people being better than that from vendors or consultants: it is more strongly related to process satisfaction than to the satisfaction with the system. Finally, the more the project lacked a good, knowledgeable source of advice across all stages of the implementation effort, the lower the success. If we rephrase this, having such a source of advice is positively correlated with project success.[7]

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[6] Surprisingly, one of the survey respondents reported the company had never implemented a new IT infrastructure or application project with substantial cost.

[7] For convenience, figure 9 inverts the actual wording on the availability of advice across stages, and shows this as a positive relationship. A correlation of .22 or above is reliable at $p < .10$, one-tailed, and one of .28 $p < .05$, one-tailed. Correlations that are not reliable are shown for completeness.

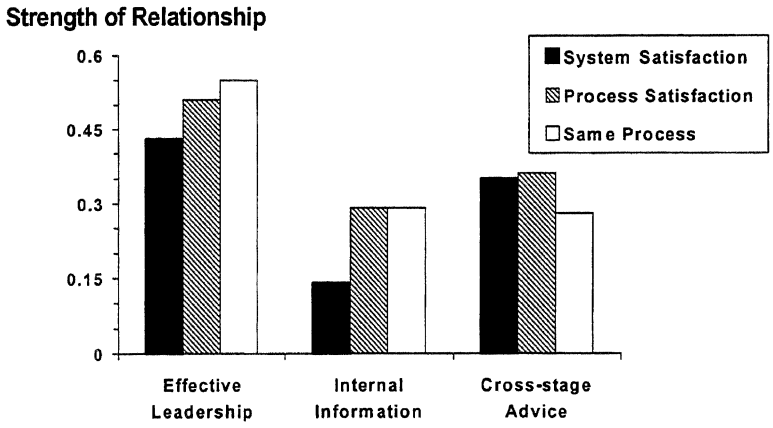

Figure 9: Relationships of Internal Resources To IT Project Success: Pearson's *r*

Thus three of the four internal resources are moderately to strongly related to the outcome measures.[8] Effective internal leadership and reliance on better internal information are more closely related to the effectiveness of the process of implementation than they are to satisfaction with the IT system, consistent with the more internal focus of the implementation effort. On the other hand, good advice across all stages presumably supports system selection as well, leading to more equivalent levels of satisfaction across product and process dimensions.

Figure 10 presents the relationships between the executives' opinions of the effectiveness of external resources, specifically IT vendors and consultants, and their views of their project's success, again measured by our three measures of satisfaction. Interestingly, one of the stronger rated items (at 3.4), the value of the vendor teams in making the implementation a success, is not related to these three outcome measures. However, the other four items are moderately related to the outcome measures, if generally a bit more weakly than are the internal resources.

How well the vendors worked together is more related to implementation-process outcomes than it is to satisfaction with the system, not surprising in view of its process orientation. On the other hand, the better the quality of information from vendors as opposed to consultants, the more successful the project, but this is especially the case in regard to satisfaction with the system itself. Better product vendor information makes for better product selection, but is less strongly related to better implementation. The better the communication effectiveness among outside vendors and/or consultants, the more likely the executives report that they are satisfied with the process and especially are likely to use it again. The views of the respondents as to whether the IT vendors overpromised and underdelivered are strongly related to all three measures, although a bit more strongly to the two measures of process satisfaction.[9]

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[8] The fourth internal resource, a dedicated project team to oversee complete implementation, is not related to any of the three measures of success.

[9] Again for convenience, figure 10 also inverts the actual wording on the questions to permit the graph to show the relationship as positive. The wording and values for vendor overpromising and ineffective communication are altered. A correlation of .22 or above is reliable at $p < .10$, one-tailed, and one of .28 $p < .05$, one-tailed. Correlations that are not reliable are shown for completeness.

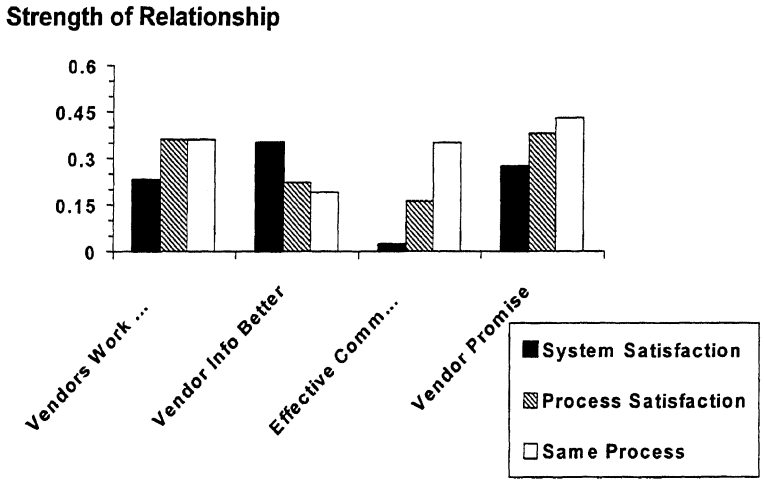

Figure 10: Relationships of External Resources To IT Project Success: Pearson's *r*

We also directly asked both survey respondents and interviewees to identify the most significant barriers or facilitators to implementing their most recent IT system. In most cases, the groups agree as to what constitutes the general barriers and facilitators. Fifty percent of the interviewee mentions and 44 percent of the survey responses identify the failure to secure commitment and support from both management and staff about the need for change and the value to be gained from the implementation as a barrier to successful implementation. Hardware and software problems represent 14 percent of the interview responses and 16 percent of the survey responses. Training issues, including misjudging the time required to learn a new system, the lack of training for staff, and lack of staff awareness of the underlying business practices, constitute 14 percent of the interviewee and 12 percent of the survey responses.

One or the other group of executives mentioned two other barriers. First, 12 percent of survey mentions cover problems with integration, including the tendency to integrate all applications without regard to cost/benefit. Second, interviewees report more concern with vendor problems, with 14 percent of their responses targeting general conflicts between vendors and slow implementation processes that drain enthusiasm. Survey respondents mention cost as a major barrier to implementation, while interviewees did not, although they discuss their concerns for their own suppliers' cost in other parts of the interviews.

It is also important to identify the factors or circumstances that facilitate IT systems implementation. To be sure, facilitators are often just the flip side of the barrier coin: the presence or absence of a factor constitutes a barrier, while the obverse acts as a facilitator. Indeed, 40 percent of the interview mentions identify the ability to secure buy-in by communicating the personal advantage of the new system, as well as obtaining strong top management support (36 percent) as the key facilitators. The survey respondents assign 23 percent of all responses to top management support as key, but 47 percent of all their responses focus on the leaders and teams that implement the system, including dedicating a full-time core team with a strong project manager to IT implementation. This is interesting, because in fact the presence of such teams

was not related to project success in the survey analysis, as mentioned in footnote 7 above. Survey respondents also put emphasis on training and support, financial resources, and vendors.

When we asked interviewees how they evaluate the overall benefits of their IT strategy, 57 percent of the mentions cited specific metrics such as inventory reduction, reduced product-development time, reduced cost, and increased sales and revenue. The other 43 percent report that they do not use metrics, although there appear to be two distinct reasons for this. The most interesting responses (29 percent) indicate no need for specific measures. This group has no doubt about the value of IT, viewing it as the basis for doing business in terms of communications, reducing cycle times, and improving quality and productivity. Another 14 percent note that some things you just do, sometimes to respond to customer requirements, sometimes to find out what the competition is doing. The interviewees report the greatest costs accrue in formal and informal training of employees to use the systems, followed by consulting and reengineering. Both of these typically exceed the costs of hardware and software.

These system integrators reveal a rather wide range of outsourcing levels for their IT needs, from 70 percent to near zero, and averaging 37 percent. Half of the respondents' companies outsource 50 percent or more of their IT needs. In the future, 75 percent expect IT outsourcing to grow, because of the complexity of the systems, the need for continual upgrades, and the shortage of skilled IT people. Some of the interviewees think they will outsource to large global players who are financially sound and have a significant research and development capability.

IT implementation stages

We hypothesized that the implementation of a new IT system involves four key elements or stages, which we collectively call the IDEA model: *identifying* the relevant business processes, *developing* the database where all information will reside, *electing* or developing appropriate system and application software, and *acquiring* and deploying the system hardware and associated technologies. We asked survey respondents to provide a variety of information about the stages of implementation in the context of this model.

In terms of the actual order of implementation, almost all the survey respondents, 95 percent, agree that the first task is to identify the relevant processes that will be the IT implementation target. After this first stage, order becomes a bit murky, as displayed in figure 11. Electing software is considered the next priority by 73 percent of respondents, although 22 percent of respondents think that developing the database should be the second step. Acquiring the hardware for the implementation is considered the third stage by 46 percent of the respondents, with the balance dividing between developing the database and electing software. Developing the database is nominated as the fourth stage by 49 percent of the respondents, but another 46 percent think acquiring the hardware is. The disagreement of respondents regarding the last two tasks reflects some uncertainty in the minds of system integrators about how a new implementation should proceed. Moreover, based on the interview results, there may be other categories, such as training and selecting outside assistance, that may be useful additions to the model.

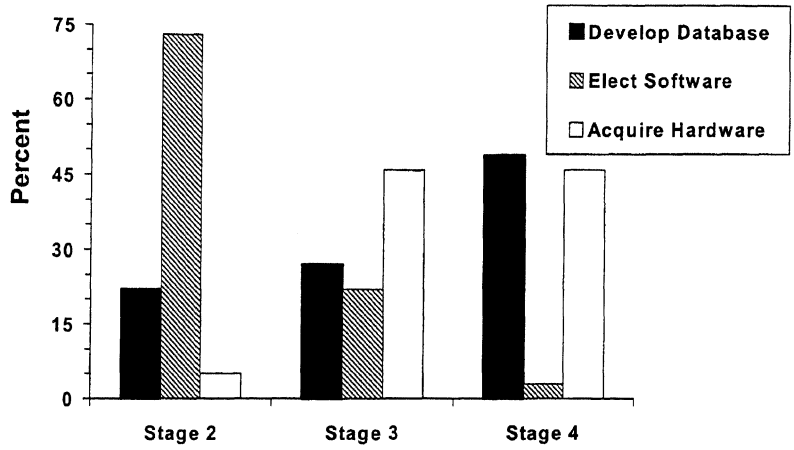

Figure 11: Respondent Identification of Stage Sequence for IT Implementation

There are some interesting differences in the respondents' ratings of how critical are the decisions at each stage of the model for total project cost and effectiveness, as displayed in figure 12. For project cost, they see identifying the relevant business processes and selecting the appropriate software as quite critical, while developing the database and acquiring the hardware are rated moderately critical.

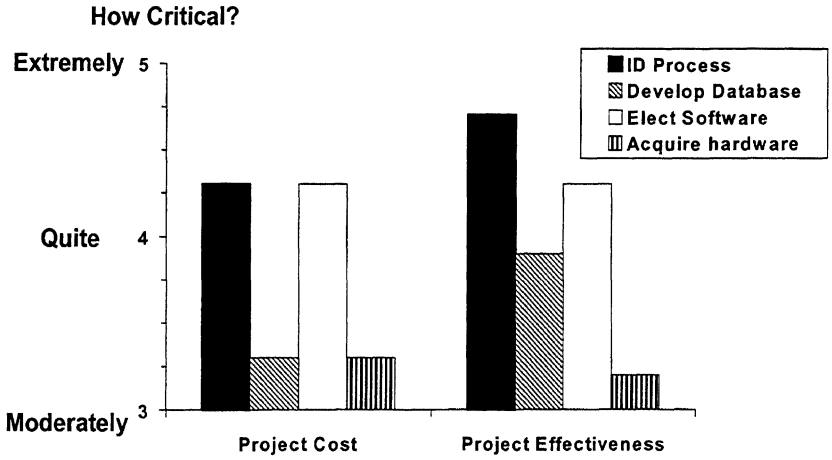

Figure 12: Effect of Decisions Across IT Implementation Stages

Survey respondents differentiate the stages more when considering total project effectiveness, rating identifying business processes as extremely critical (4.7), electing software (4.3) and developing the database system (3.9) as critical, and acquiring hardware (3.2) as moderately critical. CEOs, CFOs, and CIOs essentially agree about the critical importance of identifying relevant business processes and the less critical nature of decisions about acquiring hardware.

However, CEOs tend to see decisions about developing the database and electing software as less critical to total project effectiveness than do other executives.

The roles company officials play in this model vary depending on the stage of implementation. We asked respondents to identify the highest-ranking official involved in the decision, and who had the most influence in the decision. For identifying the business processes, companies vary as to who has the final decision and who has the most influence. Some respondents report that a vice president (25 percent) is the highest-ranking official involved in the final decision, while the CIO (22 percent) has the most influence on that decision. The views of other respondents are fairly evenly distributed, and that most likely accurately reflects how these decisions are being made today. Identifying the business processes targeted by new IT implementations demands crossing numerous functional boundaries, and getting support requires many company officials.

For selecting software, 59 percent of respondents see the combination of the CIO and the CFO as the highest-ranking officials involved in the final decision, but with the CIO (50 percent) clearly having the most influence on that decision. Respondents describe the CIO (47 percent) as the highest-ranking official involved in developing the database, and 53 percent also rate the CIO as having the most influence on that decision. The same pattern holds for acquiring hardware, with 44 percent describing the CIO as the highest-ranking participant, and 58 percent describing the CIO as having the most influence.

When asked how their organization makes final decisions about strategic investments in new information technology, interviewees focus primarily on IT specialists, the CIOs, other IT professionals, or an IT steering committee. These individuals or groups develop proposals based on a business model and then submit them to management. Specific investments such as hardware and software purchases follow a slightly different path. Some interviewees note that these purchases must still fit into the overall strategic business plan (30 percent), while others report small investments are decided on by the CIO or the plant involved, and large investments go to a steering committee (20 percent). Some indicate that product divisions take the lead in proposing what is needed in the area of hardware and software (20 percent), and finally, another group reports that the strategic plan for the information-system sets standards for hardware and software (20 percent). These results are generally consistent with the survey respondents' views of the CIO as the decision-maker who has the most influence overall across all four elements of IT implementation.

Internal personnel such as the CIO or the IT steering committee are the people companies primarily rely on for decisions at each stage of implementation, although some companies rely on cross-stage vendor teams for software and hardware decisions. These cross-stage vendor teams are relied on more than specific vendors or consultants at all stages except developing the database; there they are relied on with the same frequency as specific vendors. It is interesting to note that 14 percent of the survey respondents report that cross-stage vendor teams are the primary decision source in the important area of identifying the relevant business processes targeted by a new IT implementation. To be sure, 83 percent of the respondents rely primarily on internal personnel at this identification stage.

The staging of decisions, as well as who participates in them, are critical to the success of an IT implementation. In particular, the coordination of purchase decisions across a complete system plan is necessary to avoid underinvesting at later stages because of overinvestment at earlier stages. So, too, securing proper and sound advice, whether from internal staff, external consultants, or IT vendors, is crucial. The difficulty is exactly in determining which advice to follow, and how to construct an overall plan.

It is clear that there is no one simple answer, or cookbook formula to follow in selecting and implementing IT systems, just as is the case with other changes. But that is the very nature of introducing new technology, and learning by trial and error becomes an important competitive resource: faster-learning companies will pull ahead of the pack.

IT's future

We asked interviewees what one aspect of IT, successfully implemented, will have the most impact on their business over the next decade; their responses describe many of the hopes for the future of IT. Almost 60 percent of the interviewees see IT implementations that tie business processes together throughout the company and around the world as a primary goal. Supply-chain management programs (25 percent) that allow easy communication between members of the chain with MRP (Material Resource Planning) and ERP programs using Internet technology are another area of great hope. Technical processes make the wish list for some 16 percent, including global and simultaneous virtual engineering, and EDI that is transparent (transferable, scalable, and intuitive).

This wish list suggests some of the promise IT may offer the auto industry, but the heavy reliance on IT also brings with it challenges. These challenges can be broad, such as balancing IT investments against other broad strategies for improvement, while other challenges are more specific, such as the Year 2000 problem. Though a number of interviewees noted that the cost of fixing this problem led them to examine all their processes and to begin overhauling all their systems, the Year 2000 problem offers an example of the kinds of problems companies will face in the future as they rely more on IT.

The promise of IT can also be a threat. If IT enables the information flow into the company, it can also enable the inappropriate flow of information out of the company. Security concerns already make some companies restrict the number of their personnel with access to sources of information such as the Internet, while other companies have such tight firewalls that employees have e-mail sent to their home accounts to ensure delivery. Of course, this may be part of an evolutionary migration to a more open system, but these limitations currently are strong impediments to the flow of information between companies. The industry still must achieve a balance between openness for IT to work well and security to protect proprietary information.

If IT implementation simply involves replacing one set of activities and personnel with another, then its ultimate promise of efficiency and effectiveness will also be undercut. It is also the case that if IT implementation simply "automates" current processes and activities, much of its potential will go unrealized. Unfortunately, IT implementation is not straightforward, and investments of time, personnel, and supporting resources are critical to its success.

Summary

How does IT implementation rank in the suppliers' strategic hierarchy? Overall, suppliers rate internally focused performance priorities as more important than external goals rooted in industry restructuring and relationships, and as more important than general change goals, including IT implementation. But these supplier executives rate implementing both IT applications and IT infrastructure as currently quite important, and they expect IT infrastructure to become even more important by 2001. The IT goals currently rank lower than some goals, such as improving

customer relations, quality, and achieving time reductions across all processes, but ahead of others, such as achieving system-integrator capabilities and globalization.

These executives rate IT as between moderately and quite important as a means to other strategic goals, rating applications as the more important IT element for a number of their goals. The interviewees emphasized the utility of IT in achieving some form of integration, whether internal or external, and this theme recurred throughout the interviews. In particular, looking to the future, they see a clear shifting from the more narrow applications focus on manufacturing, business processes, etc., to an emphasis on integrating systems, even across company boundaries.

These executives report a wide range of success in their efforts to implement IT to address internal and supplier-related change efforts. They again see IT implementation as more important for internal than for external efforts, and exhibit a tendency to view applications as more critical than infrastructure. They stress the importance of applications, but suggest that infrastructure will become closer in importance in the future, as integration and globalization become more pressing. They report that they are electronically quite well linked to their customers, somewhat well linked internally, and not very well linked to their own suppliers, which may partially account for their emphasis on internal efforts over relationship issues. These suppliers stress the growing importance of using IT to achieve integration across tasks, functions, companies, and locations.

We queried respondents regarding their satisfaction with their most recent, substantial cost IT effort, exploring how various factors influenced the success of the system and the process for implementing it. Respondents rated internal resources as only a bit more important than external support. Effective internal leadership and support along with vendors working together bear the strongest relationship to project success, and both are more strongly related to process outcomes than to product satisfaction. Interviewees and survey respondents endorse the crucial importance of securing leadership and staff commitment for making these projects successful, and they regard lack of training and allocation of insufficient learning time as major hindrances to success.

These respondents report some disagreement regarding the best sequencing of the major decisions for implementing IT. Appropriately identifying the business processes for implementation is clearly the initial stage and the most important for overall cost and effectiveness. Selecting software is seen by many, but not all, as the next stage, and this too is quite important for cost and effectiveness. Acquiring hardware and database development are seen as third and fourth stages, with no clear ordering priority. Hardware selection is seen as relatively less important for project cost and effectiveness. Overall, the CIO is reported to be typically the highest-ranking decision-maker, having the most influence over the last three stages. These companies show great variance across the first, critical stage in regard to who participates and who influences the decisions.

Interviewees report that IT projects are evaluated much as other major investments are at most companies; however, a substantial minority report that they do not apply traditional financial measures because of the difficulty in unambiguously measuring IT costs and benefits. Nevertheless, they expect the evaluation to become more financially based in the future. There is a strong consensus that personnel costs for training and implementation are much more substantial than the hardware and software of the IT system. They also express concern about the cost and ease of using IT as it is driven lower in the supply chain, and around the world.

These supplier executives' views vary as a function of their own current assignment, with CEOs at some variance with the CFOs and CIOs. These include their views of IT as a mechanism for achieving their strategic priorities, the relative value of IT infrastructure and applications, and the utility of IT for achieving current efforts to select and manage the supply base.