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Managing client/server implementations: today's technology, yesterday's lessons

ASHOK SUBRAMANIAN and MARY C. LACITY
School of Business Administration, University of Missouri–St Louis, St Louis, MO 63121-4499, USA

Client/server computing is quickly becoming the computing architecture of choice in the 1990s. However, like many advances in information technology, public sources, such as trade journals and newspapers, portray client/server as a completely new paradigm which will transform our profession. But is it? We are conducting multiple case studies on organizations that have adopted client/server technology in order to extract managerial prescriptions for best practices in evaluating, developing and implementing effective client/server systems. Thus far, we have completed three case studies. Many of the lessons we are uncovering – the need for top management support, redesigning business processes before automation, user participation, phased implementation strategies and buying-in vendor skills to transfer learning – have been identified by previous researchers in other information technology contexts. Thus, although client/server is being touted as a radical change in information technology, practitioners need not discard the lessons from the past. Although there are some unique technical skills required to deploy client/server systems effectively, confirming project management lessons from the past is consoling to practitioners and academics alike. While the context of information technology changes rapidly, the organizational, administrative and policy practices are proving robust.

Introduction

Client/server computing is a phenomenon that is sweeping the information systems industry today.

(1) Seventy-one percent of all new applications are being developed for desktop or midrange computers as compared to 29% for mainframe computers (Allen, 1995; Interactive Information Services, 1996).
(2) Sixty-eight percent of the organizations use specialized servers in their computing architecture in contrast to 9% which use mainframes only (Allen, 1995; Interactive Information Services, 1996).
(3) Forty percent of information technology (IT) dollars are being spent on client/server development, deployment and support. If infrastructure costs such as hardware, systems software and networking rise, client server expenditure will rise to 60% (Gerber, 1995).

These statistics provide evidence of the rapid adoption, significance and wide spread diffusion of client/server systems in recent times.

However, like many new 'advances' in IT, public sources, such as trade journals and newspapers, often portray client/server as a quantum leap, a radical change or a dramatic paradigm shift. Customers are promised that client/server is finally the technology that offers a significant business advantage. Through enhanced data sharing, integrated services, cost reduction due to downsizing, interoperability and data interchangeability, location independence of data and processing and centralized management, client/server promises to transform data into knowledge, to empower users and to increase the quality and speed of decisions. And, given advances in technology, such as increases in input/output over networks, storage capacity and cost, graphical user interfaces, relational databases and the proliferation of local area networks, these business benefits can be affordably achieved. But are they?

Some recent studies have begun to question the hype of adopting client/server technology.

(1) The Gartner Group conducted a survey in 1995 of 100 companies that have implemented client/server. The study found that over half of the implementations were late and over budget, although the final implementation did produce business benefits (Lyons, 1995).
(2) A study by Sentry Market Research showed only a 3% increase in client/server adoption over the last year across 712 large enterprises in North America and Europe. The reasons cited include unexpected complexity of infrastructure demands (Pontin, 1995).

(3) An *InformationWeek* survey of 225 chief information officers (CIOs) found that 31% of client/server projects were abandoned, with 25% of respondents claiming, 'client/server has failed to live up to expectations' (Caldwell, 1996, p.36).
(4) Companies such as EDS are not delivering client/server solutions to meet their high standards of performance. 'We've got a big problem. Like most companies, we've got a kludge of standards and platforms that aren't as efficient as we'd like' (Todd Carlson, CIO at Plano, Texas site of EDS; quoted in Caldwell, 1996).
(5) 'There is all this hyperbole and melodrama about client/server computing' concluded Malcolm Frank, vice-president of marketing, Cambridge Technology Partners (reported in Wagner, 1995a, p. 87).

Our research investigates client/server implementations. We are conducting multiple case studies on organizations that have adopted client/server technology in order to extract managerial prescriptions for best practices in evaluating, developing and implementing effective client/server systems. Thus far, we have completed three cases studies and this paper documents our preliminary findings. Although we have identified some unique issues associated with client/server, such as grasping the total costs of the architecture, middleware issues and support of distributed systems, most of the best practices we are uncovering have been identified by previous researchers in other IT contexts. These best practices include top management support, redesigning business processes before automation, user participation, phased implementation strategies and buying-in vendor skills to transfer learning. Thus, although client/server is being touted as a radical change in IT, practitioners need not discard the project management lessons of the past. Confirming lessons from the past is consoling to practitioners and academics alike – although the context of IT changes rapidly, the organizational, administrative and policy practices are proving robust.

Research methodology

In order to develop an in-depth understanding of client/server implementations, we adopted a multiple case study approach. This approach was deemed most appropriate from an interpretivist perspective, which assumes that the most valid way to understand complex social phenomena is to enter into a dialogue with people directly (Van Maanen, 1979; Orlikowski and Baroudi,

Table 1 List of participants

Silicon	Baking	Insurance
The director of MIS inherited the project in 1991 when he became head of information systems	The vice-president of information systems initiated the client/server project. At the time of the interview, he only had 3 weeks left before he was terminated due to sale of the company	The manager of the Business Technology Department was responsible for justifying the project to senior management and assembling the project team
The manufacturing services support systems supervisor is a current business manager over the users of the system	The director of systems support was the IT member in charge of implementing the network part of the client/server implementation. He now has a 1 year contract with the new owner	The manager of systems development was responsible for supporting the project. He served as project sponsor who arbitrated disputes between IT and users as well as staffed the technical side of the project largely with contractors
The strategic manager of marketing was the lead user and project manager of the entire project	The director of data processing managed the outsourcing contract for mainframe operations for Baking prior to the sale. He now manages the outsourcing contract for the new owners, who plan to migrate off the mainframe within 2 years	Project manager of the client/server project The technical systems designer has been with Insurance for 18 years and is responsible for the technical design of the project
The manager of business information systems headed the business applications development, implementation and support		
The senior analyst worked on the project team		

1991; Walsham, 1995). Our aim was to interview different stakeholders within organizations who were likely to have different views on the client/server project, who could provide longitudinal accounts of the decision-making process and who could explain the contexts in which implementations were embedded.

Our aim is to conduct 15 case studies. Thus far, we have conducted three. At each case site, we conducted face-to-face interviews with individuals directly involved in the client/server project. Each interview lasted from 1 to 3 hours. The interviewees included project sponsors, project business managers, project technical managers and project team members (see Table 1 for a list of participants and their role in the client/server project). All interviews were conducted in person at the company site. All interviews were tape-recorded and transcribed, but the participants were assured of anonymity so as to promote open discussions. We also gathered a number of documents including acquisition requests, user and technical documentation of the client/server project, annual reports and organizational charts.

The interviews followed the same protocol, proceeding from an unstructured to a structured format. During the unstructured portion, the participants were asked to tell their client/server story. The unstructured format allowed the participants free rein to convey their interpretations. After the participants had completed their stories, they were asked semi-structured questions designed to solicit information on specific issues that may have been absent from their previous recollections.

We focused on four main issues. First, we asked the participants to discuss the purpose, justification and motivation behind the project. At each site, the participants reviewed the original acquisition request to explain the proposed tangible and intangible benefits. The participants also discussed how the proposed system was supposed to affect their competitive positioning, as well as providing the detailed cost–benefit analysis and opportunity costs. This served as our benchmark of client/server success – were the expected benefits actually achieved? Second, we focused on project management issues because it has been reported that the client/server system development has complexities that require unique development methods (Clarke *et al.*, 1996). The project management questions covered project sponsorship, project teams, development methodology, the role and use of outside vendors and major emerging project management challenges and their outcomes. Third, we explored the technical complexities of client/server systems because much has been written about the maturity or lack thereof of the technology. The technical issues included the functional description of the client/server system, the technical description of the architecture and applications and the major technical challenges and their outcomes. Finally, we focused on the perceptions of relevant individuals about the degree of success of the system. We asked the participants to compare their perceptions of the outcome with project objectives and justification.

Table 2 Company profiles

	Silicon	Baking	Insurance
Business	Manufacturer of silicon wafers	Manufacturer of food products, primarily breads, cookies and cakes	Insurance company that provides house, health, legal and emergency insurance
Headquarters	Midwest US with manufacturing plants worldwide	Midwest US with bakeries in several midwestern states	UK
1995 sales	$1 billion	$2 billion	£4600 million total in insurance premiums; £650 million approximately $1.1 billion) in Household Division we studied
Number of employees worldwide	5000	10 000	17 000, corporate wide
Annual IT budget	$8 million	$16 million, half spent on mainframe-based outsourcing contract	£15 million (approximately $24 million) in the Household Division
Number of IT employees	72 people	100 people	180 people in the division we studied

The participants were also asked specific questions about their industry, company and IT department. Pertaining to their industry, the participants described their competitive advantage, marketing position, critical events in the industry in the past 5 years, their company's response to those events and the role of IT (if any) to the company's competitive advantage. Pertaining to their company, the participants described the organizational structure, the major products and services produced and their financial situation, corporate goals and business successes and failures. Pertaining to IT, the participants described their IT activity in terms of headcount, budget, organization, chargeback system, user satisfaction, challenges, goals and reputation.

Description of the companies

We assigned our first three cases the pseudonyms of Silicon, Baking and Insurance. Table 2 describes these companies in terms of location of headquarters, sales, number of employees, annual IT budget and number of IT employees. The business context, development and outcome of the client/server implementations for each of these cases is described below.

Case 1: Silicon

Silicon is the second largest manufacturer of silicon wafers in the world, with manufacturing plants in the USA, Asia and Europe. Silicon's worldwide client/server implementation of customer ordering, manufacturing planning, plant scheduling and product specification system was prompted by a crisis in customer service. Silicon makes custom products exclusively, taking special orders from the world's largest electronics companies. Their customers' demands for custom wafers required as many as 200 parameters for product specification. Back in 1989, Silicon's customers were frustrated by Silicon's inability to commit to orders, fill orders on schedule or change orders in a timely fashion. The problem stemmed from a lack of shared information about each of the manufacturing plant's capabilities, capacities and schedules. When a customer called the centralized sales office to ask whether X product could be manufactured by Y date, Silicon took up to 3 weeks to call the customer back and confirm the order. The process was time-consuming because the headquarter's person taking the order would have to determine which plant had the capability to manufacture silicon with the requested properties. Once the targeted plant was notified, that plant would then determine what supply they needed to make that product. This often generated another internal order to another silicon plant. That second plant would then determine its ability to deliver the supply and call back the targeted plant, which would then be in a position to determine its ability to deliver the product. The targeted plant passed this information back to headquarters, which would then call back the customer to see if they still wanted the order. By this time, the customer may have found a silicon manufacturer that responded quicker, thus representing a lost sale to Silicon. The strategic manager of marketing described the situation as follows:

> It was a mess because you couldn't get accurate information. The cycle time to place an order after a customer calls in and says 'I want 2000 more of part number six for delivery in June', it would take us 6 or 7 days* to process that because we would have to first receive the order in, then they'd have to figure out where to source the slices, and then the slice people say, 'Oh we need crystal'. Now we have to submit an order for the crystal people. They would have to find out where they were going to make it. In the meanwhile, no one was talking to the people in specifications and the customer says, 'I'll take material from site A but not from site B.' And we were in a constant swirl there.

To rectify the problem, Silicon initiated the worldwide systems project in 1989 which eventually evolved into a client/server solution. The original acquisition request (AR) for the worldwide systems project stated a reduced cycle time to respond to customers as the primary justification. There was an attempt to quantify the costs and benefits, but the benefits, in particular, were extremely rough. On the cost side, the original AR requested $6 million for a 2 year project. The expected cost benefits were loosely stated as (1) $15 million a year for projected increased sales due to better customer service and (2) savings of approximately $500 000 a year to migrate off the mainframe and terminate an outsourcing contract which was perceived as expensive and non-responsive. The development of the system happened in three phases.

(1) In 1991, the internal project team – comprised of users and IT – implemented a packaged manufacturing planning system. The selection of this package, which ran on a client/server platform, as well as re-engineering of the business function drove the selection of the client/server platform. The client machines were at headquarters and

*This figure was confirmed by four other participants as a 3 week mean response time.

the servers were the mainframe data (which still captured customer orders) and individual plant data on capabilities, capacities and schedules. The system first standardized the customer's specifications (such as converting all units to metric). Then the system took these specifications and determined which plants had the capacity and capability to manufacture the product. Once a plant was selected, the system created a local recipe which described exactly how the plant should manufacture the product. Finally, the system determined a manufacturing schedule. This information was accessed and updated by local plants.

(2) In 1992, the project team migrated the 700 mainframe reports to the client/server platform. These reports are used to answer customer enquiries about scheduling, delivery, cost, etc. For this phase, a unique partnership was developed with the software vendor. Silicon debugged the vendor's software in exchange for free vendor consulting. This significantly reduced the cost of this phase.

(3) In 1994, the front-end order entry system was migrated off the mainframe to the client/server platform.

Silicon's client/server system has been recognized both internally and externally (in *Computerworld*) as a successful project. The 5-year project can best be characterized as a marrying of business processing reengineering (BPR) and client/server technology, although neither of these terms were part of Silicon's vocabulary at the time of development. The resulting client/server project reduced the amount of time to process a customer order from 3 weeks to less than 4 hours. The system also reduced the manufacturing cycle time from 27 days to 19 days and reduced inventory carrying costs. Although all of the participants cited these and other business benefits as evidence of success, enthusiasm varied as to the financial costs and benefits of the project. From the senior management's perspective, the project was 2 years late and cost over twice the budgeted amount. Although they are pleased with the improved customer service, they credit manufacturing not IT for business improvements. To senior management, IT was primarily credited with implementing the 'black box' technical side. To most users in the plants, the system was a non-event because their local recipes and scheduling interfaces and reports are the same. To the end customers, however, the system is a huge success. The customers are now pushing for an EDI interface to the system so they can send orders directly into the system as well as conduct their own queries.

Case 2: Baking

In 1992, Baking was a wholly owned subsidiary of one of the largest food manufacturers in the USA. Baking operated 35 bakeries, which produced hundreds of products that were delivered daily by 7000 drivers to 250 000 end customers. Because the margins in this industry are very low, senior management focused on low costs, which were obtained through economies of scale of centralized processing and decision making. Headquarters determined all business practices such as prices, baking schedules, promotions, driver instructions and accounting for all bakeries.

The computer support for these bakeries involved gathering data from the drivers and bakeries, then uploading this data onto a headquarters mainframe to generate the next day's instructions. Specifically, the 7000 drivers input daily customer deliveries, returns and orders into hand-held computers. This information was uploaded to and processed on a centralized mainframe computer which was operated by an outsourcing vendor. In the morning, the instructions were downloaded to local area networks at each of the bakeries.

The computer support was considered adequate, but senior management pressured the IT director to reduce his $16 million annual IT budget, half of which was spent on the mainframe outsourcing contract. The IT director pushed for downsizing off the mainframe to client/server to reduce IT costs by $3 million a year:

> You can buy a $100 000 processor that if you want to use MIPS or throughput, so you can get a pretty sophisticated piece of equipment for $100 000. To get the equivalent in IBM, older generation, you are talking $700 000 to $1 000 000. So what I presented to management was, 'Here we are on this path with this investment base and it's dropping at this rate. Here's a new technology base, a lower entry fee, but its cost is dropping. How do we get from this curve to that curve without killing ourselves and without making a zillion dollar investment?' (vice-president of information systems).

Thus, the client/server platform was strictly justified as a less expensive technical platform, as no changes to user software or business processes would occur.

The pilot project was implemented in 1994. It was considered a technical success by IT and a non-event for end users in the pilot bakery. Senior management approved a roll out for the other 34 bakeries. However, Baking was bought by another company in June 1995. This new company decided not to implement the client/server system. The new management treats all bakeries as profit centres and it is up to each bakery to decide what technology to implement, thus the project was terminated.

Although the project was not implemented, different stakeholders have strong opinions about the success of the pilot. The IT managers perceived the project as a success, arguing that the technology worked and that they would have reduced costs significantly if fully implemented. The outsourcing vendor, however, argues that the financial case for the project was fraudulent. First, the IT managers did not include the cost of maintenance, training and support. Second, the IT managers did not consider that the outsourcing vendor had already reduced their contract from $8 million to $5 million between 1992 and 1994 – so where were the savings? In our lessons section, we point to research that suggests that client/server actually costs more than mainframes when the costs of training, support and maintenance are considered.

Case 3: Insurance

Insurance provides household, health, legal and emergency insurance in the UK. The company paid too much for claims because of undetected fraud, exaggerated claims and excess payments due to poor processing. These problems prompted a business process re-engineering project in 1992. The business process redesign suggested two remedies. First, instead of a supervisor assigning claims to claim handlers, a consistent set of business rules would assign work flow. This would ensure that the appropriate expertise and authority would investigate the claim. Second, the encouragement of having customers use the phone rather than paper would reduce exaggerated claims. The manager of the Business Technology Department explained:

> It is more likely the customer will paint an accurate picture of the claim on the telephone. If they are filling out a claim form, they can start dreaming up what they want to claim. The reason we want to do this is good customer service. We want to handle a claim promptly and swiftly. The second reason: If they do it on the phone, it is more accurate, easier to determine what is actual.

The client/server project for claims processing started in 1992 with a prototype project of a 'mock office', budgeted at £200 000. There were ten people who worked on the prototype. Once the prototype was completed, the project sponsor decided to move forward with full development of the system.

The design of the system comprised 200 client machines manned by the claims handlers, as well as servers for claims processing, image processing and printing. From the claims handler perspective, customers call them on the phone to make a claim. The claims handler downloads all customer information off the mainframe (which is used a server). The claims handler guides the customer through the claims process. After the phone call, the claims handler prints the form and sends it to the customer for a signature and additional information if needed. The claim form is also stored as a 'work product' on a server. The customer sends back the signed form and it is scanned into the system – the image is stored on the image server and the structured data is input into the mainframe. The mainframe software processes the claim and assigns a complexity rating ranging from 0 to 20, with 20 being the highest priority. The results of this mainframe analysis are passed to the work flow software on the image server. The work flow software tracks five work queues – A, B, C, D and E. E requires the highest skill set of claims handler to work on. At this point, the claims handler can make a decision, such as calling an inspector, denying the claim or granting the claim. If the end customer is awarded a check, the claims handler sends a message to the mainframe check-cutting program. The work flow is directed to a supervisor for authorization. If all goes well, the claim is tagged closed and removed from the work queue.

The AR for the expansion of the prototype to a full-blown system requested £4.5 million to develop and implement the system by April 1995. The project was started in late 1994, thus there were only 6 months allotted for development. The project ran into two problems. First, the business project manager kept changing the user requirements. Second, there was a technical incompatibility between Windows on the client side and OS/2 on the server side which prevented data from being passed between the client and servers. These problems caused the system to be over a year late and £1.5 million over budget.

The major expectations and outcomes as well as stakeholder perceptions of the client/server projects at our three case companies are summarized in Tables 3 and 4.

Lessons from the three case studies

Although the three cases represent three different contexts and outcomes, the participants identified similar critical success factors across the cases. In some instances, these critical success factors were recognized early and, thus, managed throughout the client/server project. In other cases, these critical success factors were recognized after the fact – failure to manage these factors led to project delays and budget over-runs. We have summarized these factors in Table 5.

Table 3 Assessment of client/server expectations and outcomes

	Silicon	Baking	Insurance
Client/Server application	Worldwide implementation of integrated customer ordering, manufacturing planning, plant scheduling and product specification system primarily to improve customer service	Migration of transaction processing systems for 35 bakeries off the mainframe to client/server environment primarily to reduce computing costs.	Claims processing system designed to increase detection of fraudulent claims, faster and better customer service and improved productivity of 200 claims handlers
Project approval date	1989	1992	1992
Expected cost savings of project	$15 million per year for projected increases in sales and savings of $500 000 to migrate off the mainframe	$3 million a year cost savings by terminating mainframe outsourcing contract	£4 million per year on reduced payments for fraudulent claims
Actual cost savings	Cannot be determined. Sales have increased, but they cannot be attributed to the client/server project	None; the system was not implemented due to the sale of the company in 1995	Too early to determine
Expected implementation date	1992	1995	1995
Actual implementation date	First phase 1991; Last phase 1994	Pilot system implemented 1994 in one bakery; the pilot system has been removed	June 1996
Expected project cost	$6 million	$7 million	£4.5 million
Actual project cost	$12 million	$1.5 million for the pilot; project cancelled after the pilot due to take-over	£6 million
Expected intangible business benefits	Reduced customer response time Better manufacturing scheduling Reduced inventory carrying costs	None	Increased claims processing productivity Increased customer satisfaction due to faster claims processing and improved procedure for filing claims
Actual intangible business benefits	Reduce customer response time from 3 weeks to a few hours Reduced manufacturing cycle time from 27 days to 19 days due to better planning Reduced inventory from 60 000 wafers a day to 20 000 which reduces inventory carrying costs	None	Too early to determine

Secure the support of top management

IT research has found that top management 'support' is one of the most vital critical success factors in the successful implementation of IT. IT researchers have distinguished between four theoretical constructs comprising senior management's attitudes and behaviours towards IT.

(1) Project champion: 'Champions are managers who actively and vigorously promote their personal vision for using IT, pushing the project over or around approval and implementation hurdles. They often risk their reputations in order to ensure the innovation's success' (Beath, 1991, p. 355).
(2) Project sponsor: 'Sponsors have the funds and authority to accomplish their goals' (Beath, 1991, p. 355). (A less active and enthusiastic role compared to a champion.)
(3) Senior management participation: 'activities or substantive personal interventions in the management of IT; (Jarvenpaa and Ives, 1991, p. 206) (active behaviours).
(4) Senior management involvement: 'the psychological state reflecting the degree of importance placed on IT' (Jarvenpaa and Ives, 1991, p. 206) (moral support).

The participants in all three of our case studies certainly pointed to the support of business managers as a key to success. Using the previous definitions, all three companies had a project sponsor (usually a very high level of business user). Two of our companies – Silicon and Baking – also had a project champion who traversed through political obstacles. In these two companies, senior management did not directly participate nor were they involved in most IT projects, thus the project champion was very critical to success in each case. At Insurance, no discernible project champion was identified, but the senior management at Insurance regularly participated and was involved in IT. Thus, Insurance may not need a project champion because the organization views IT as a business enabler. Senior management support for each of our cases is described below.

(1) At Silicon, the participants credited the political savvy of the high-level business champion for the success of the project. The manager of business information systems explained how Michael, the manufacturing manager, competently traversed through Silicon's organizational politics:

"The credit really goes to (Michael) in my mind and the CFO. They drove it. They made it work. (Manufacturing) group were on the sidelines, dragged in kicking and screaming. What made a difference – our organization is like this, a mess, and it still is. . . it's democratic. Getting consensus can be difficult. We didn't always get consensus throughout the project. But what allowed us to be successful was the fact that [Michael] knew how to navigate the matrix organization. He pulled in the right people at the right time to get decisions made. This matrix organization made it possible to get access to the right people to get things done. Because so many people work for so many other people, you have to build the right strategic alliances to the right parts of the matrix. You have to pull the matrix however you want to pull it. But that's something that helped. Manufacturing had dotted lines into marketing, marketing had dotted lines into planning, etc. But high level user involvement was a key to success. But it was also who was involved."

(2) At Baking, the vice-president of information systems was convinced that building systems is easy, but changing the corporate culture to accept these new systems is difficult. Therefore, IT capital projects – including the client/server project – requires a full-time senior level business manager. This manager is assigned to the project as the co-project director along with a senior IT person. That individual's performance rating and bonus is based upon the success of the IT project. The vice-present of information systems explained how this ensured the pilot project's success.

"We found we were able to do a couple of things. We overcame some cultural resistance because this was one of their people coming in the department saying, 'We are not going to do this and this and this the way we used to because of these reasons. We are going to do this and this and this.' They would all jump up and scream at him, 'It's stupid and dumb', but it was all interdepartmental. It was them against them. They could either resolve those cultural differences or say, sorry this is how it is going to be. And our mutual boss says he wants it done that way. So we cloned one of my directors and one of the Sales VP. They walked around in the same suit for 6 months. They were both very enthusiastic and the sales department was enthusiastic because he was able to communicate with salesmen who have been with this company for 25 years why this technology made sense. He was able to communicate that to them in terms they could understand."

Table 4 Stakeholder perceptions of client/server project

	Silicon	Baking	Insurance
Senior management's perceptions of project	Senior management is pleased that the project was a success, but the project did not receive much attention because they viewed it as technical wizardry and attribute growth in sales to other business projects, such as new plants rather than new client/server system "Senior management is glad it is over. They were glad that we didn't kill the business. By and large, they are pleased" (strategic manager of marketing) "From management's perspective, it looks like a duck, it quacks like a duck" (manager of business information systems)	Senior management was pleased with the project proposal because of the favourable ROI. "There is very little support for intangible benefits. Soft benefits don't get you very far" (vice-president of information systems) However, the sale of the company terminated the project early and the new company decided not to implement the system because it does not fit in with their management philosophy	Senior management is highly supportive of this IT project. Since the 1990s, senior management has actively participated in IT projects, including the client/server project "In the late 1980s, senior management saw the IT as a cost and not a value to the business. That's changed over the last 5–6 years and now it is seen as a major enabler and business transformation for enabling our business goals and that's quite solidly secured within the business thinking of the senior management" (manager of Business Technology department)
User perception of project	To users in the plants, the system was a non-event because their interface is the same To manufacturing scheduling users, the project is a huge success because of the new GUI interface	To users, the pilot project was a non-event because they had the same software and same user interface They (the users at the pilot site) began using this processor and they could not tell the difference (vice president of information systems)	The end users are the 200 claims handlers. They are extremely excited about the system because of the GUI software that will support the claims process. When a customer calls them, they can immediately retrieve all documents pertaining to the customer, eliminating paper files and waiting for mainframe reports
IT managers perception of project outcome	The project is perceived as a huge business and technical success. IT managers believe the system has contributed to growth in sales, higher customer satisfaction and reduced costs. However, morale has suffered somewhat because of lack of senior management recognition "When you try to explain exactly what technology went into this and what we really accomplished as compared to anybody else or compared to another way of doing it, it's hard to get that across" (to management) (director of MIS)	The IT managers perceive the pilot project as a technical and financial success "We discovered a couple of things (from the pilot). One, it was cost beneficial. We improved throughput between two and three times at about 60% of the cost. Our numbers were holding up which makes management feel good. The second thing was reliability. If there had been blips, the users don't know about it" (vice-president of information systems)	The IT managers were upset about the two problems which increased the cost and delivery date of the project. The two problems were a user project manager who caused major delays due to changing requirements and technical incompatibilities between WINDOWS on the client machines and UNIX on the servers
Other stakeholders	**Customers** perceive the project as a huge success because of the rapid response to customer orders, changes to existing orders and queries "Many of our customers come back and say, 'It's almost phenomenal the change, (strategic manager of marketing) If success is measured by customer acceptance they will speak highly of it" (director of MIS)	**The mainframe outsourcing vendor** claims that the ROI of the client/server budget was highly flawed. It does not consider that the vendor had already reduced the $8 million annual cost to $5 million due to passing on price/performance improvements to the Baking company. In addition, the ROI does not include important costs such as maintenance and support	**Customers** who participated in the pilot were very pleased with the system. Rather than filling out a lengthy paper form, a claims processor guides the customer through the process over the phone. Rather than waiting weeks for a decision on a claim, the customer is given an immediate response as to whether the damage is covered under the policy. The customer still waits for a claims inspector to verify the claim, but the customer has better knowledge of where their claim is in the claims process.

(3) At Insurance, senior management support of IT development in general was very high. Every major IT project had a senior management sponsor, including the client/server project. When asked about the history of this support of IT, the participants explained that the president of the division was previously the IT director.

"Peter who heads up Insurance used to head up management services who was responsible for IT. So he has, if you like, come across from a services one to actually running a front line business" (manager of the Business Technology Department).

Because of this general support by the president, a specific IT champion may not be needed for IT capital projects.

Table 6 summarizes the types of senior management support in the companies.

Redesign business process before selecting client/server

Ever since Hammer and Champy's (1993) seminal book, *Re-engineering the Corporation: A Manifesto for Business Revolution*, practitioners have been told 'do not automate, obliterate'. Their message is simple: improve the business process before implementing IT solutions. However, their methods call for radical change: 'It is about beginning again with a clean sheet of paper... marginal improvement is no improvement at all but a detriment' (Hammer and Champy, 1993, p. 32). Although these authors argue for radical change, research has suggested that practitioners often opt for a more moderate approach to BPR, one of gradual process improvements, rather than obliterating the past (Willcocks, 1995; Willcocks and Currie, 1995).

The participants from two of the cases stated that business process re-engineering should drive the selection of client/server; the technology should merely be viewed as an enabler that fits a business solution. At Silicon and Insurance, a business process re-engineering project drove a client/server solution. However, these BPR projects can be better characterized as process improvements rather than radical redesign. Silicon still went through the same process of order entry–central specification–central planning–local specification–local planning. The process improvements comprised integrating information for a faster customer response. Insurance changed some business processes, such as taking customer claims by phone rather than through the mail, but many of the processes have remained the same, they are merely automated. There is much double entry of data between the image server and mainframe server; thus they have not achieved the streamline IT defined by Hammer and Champy (1993). Thus, although the participants used the rhetoric of 'BPR driving technology', a better description is 'process improvement before automation'.

Table 5 Perceptions of critical success factors to client/server

Critical success factor	Silicon	Baking	Insurance
Secure the support of top management	✘	✘	✘
Redesign business process before technology selection	✘	–	✘
Do not under-estimate the costs of training, support and maintenance	✓	✓	✓
Insource the development, but buy in vendor expertise to facilitate organizational learning	✘	✘	✓
Implement incrementally	✘	✘	✘
Include users on the development team	✘	✘	✘

✘: the company recognized this as a critical success factor early on and made this an integral part of the project.

✓: the company recognized this critical success factor only after the fact; failure to recognize this early caused project delays and budget overruns.

–: the company did not cite this as a critical success factor.

Table 6 Senior management support

Type of support	Silicon	Baking	Insurance
Project champion	✘	✘	–
Project sponsor	✘	✘	✘
Senior executive participation	–	–	✘
Senior executive involvement	–	–	✘

(1) "It's a business problem that we solved using this technology as opposed to the other way around. (The MIS director) thinks, from what he has seen, if you are installing client/server just to install client/server, you are crazy, because there is a high learning curve to get over" (strategic manager of marketing, Silicon).
(2) "The mentality that Silicon has right now that is pretty strong right now, we understand that there are processes to doing everything. And we always look to fix the process before we automate it. That is key. That is true of a lot of our IS projects. We've got to look at the process first then try to write a program around it because the process is usually what the problem is, as opposed to the software. Some companies go out and buy new software like SAP and they use it – they say they are putting new software in – but they are really putting it in to re-engineer the company to be more like what this software says you should be. That's where the benefit comes. Quite frankly, I don't think it's the software as much as they get the organizational processes redone in a more streamlined way" (director of MIS, Silicon).
(3) "We are re-engineering the business process. It takes a large number of business functions, so for example, process work flow handling. It has business rules in it for processing claims. You take it immediately into a PC arena. Also because we are processing rules, it takes us into the client/server arena. We are actually holding some data locally to assign work flow" (manager of the Business Technology Department, Insurance).

In Baking, however, the client/server project was selected solely to migrate off the mainframe to save costs – there were no planned changes to business processes. The vice-president of information systems rejected the validity of BPR based on a prior experience.

> We had one re-engineering project in our shipping area and it was a bust. If I name names, don't publish them. But we engaged (a consulting firm) for a re-engineering project of our shipping process. We had a 20 step shipping process, very manually intensive. They helped us redesign that shipping process to half a dozen steps. We were going to use scanning technology and sensors and transmitters and that was a complete wash out. The design was poorly done. The concept was a good concept but inattention to detail (caused the failure). The technology vendor recommended by them couldn't develop the application. It ended up being a complete bust. Our operations department took a lot of heat for that. This was sold as a nice re-engineering project. If we hadn't been sold we'd be suing (the consulting firm). It was a disaster looming from day 1, because there was no cultural buy-in.

Do not underestimate the training, maintenance and support costs of client/server

When client/server technology was first sold by vendors, it was largely paraded as a cost saver; companies could invest in the technology for approximately $100 000 compared to a multimillion dollar mainframe. The price–performance curves are approximately 30% improvement per year compared with 20% for mainframe improvement. These arguments were used to rationalize the investment in client/server in two of our companies.

(1) At Silicon, the most concrete financial justification for the project was moving off the mainframe. In terms of operating costs, the mainframe environment was costing $100 000 a month. Now Silicon, Inc. operates 15 RISC machines for only $50 000 a month.
(2) At Baking, the client/server project was justified strictly on lower costs. The IT manager decided that migrating off the mainframe to client/server technology would reduce costs by $3 million annually because his mainframe unit costs were only dropping 10–15% per year, whereas client/server unit costs were dropping 25–35% with a much smaller initial investment.

These numbers, however, include only the hardware and software investment and neglect the costs of learning the technology, maintenance and support. International Data Corporation estimated that companies spent more than $800 million on client/server training out of a total training market of $6.6 billion. Another study by Forrester Research estimated that 'for a little over $500,000 over a period of one to two years, an organization can get 20 developers 100% trained in client/server technologies' (Lipp, 1995, p. 58.) This figure is based on training IT professionals proficient in older technologies (COBOL, CICS, MVS, DB2/IMS and SNA) to becoming proficient in client/server technologies such as client/server power tools, operating languages, local area networks, relational databases, graphical user interfaces, object-oriented development, C++ programming language, structured query language, high-level design and business issues.

The support and maintenance costs are high because of the distributed environment. In two of our compa-

nies, Baking and Silicon, the project teams had originally decided on local servers. The expense, however, caused them to move the servers to headquarters. This increased the complexity of the network to ensure response time, but the overall cost was perceived as less than distributed servers.

Relevant comments from the case participants as to the actual costs of client/server are described below.

(1) At Silicon, the cost savings for migrating off the mainframe did not include the full costs of training, support or implementation. When the strategic manager of marketing was asked about these other costs, he responded:

"Yeah, but the biggest problem we had, we had gone into a mode that we knew we were going to discontinue support of the old software and old methodologies. So, yes, it's true we had to add bodies in to support the new applications, but had we decided to continue on with the old applications, we would have had to have as many bodies, if not more, to continue to support it on the old platforms using the old methodologies. We made a conscious decision early on, that if it wasn't true, that's what we were going to state to everybody. And by and large, everybody bought it. . . So, yeah, it's true you have to support it, you have to have facilities, people dedicated to it, but it's not going to run itself. You can't walk away from it, no matter what. So you are going to pay that burden."

(2) At Baking, the outsourcing vendor noted that the IT manager failed to include the costs of training, maintenance, and support: 'The implementation plan that I saw and he was real cagey about showing it to me, it didn't seem to address training costs and roll-out costs, and on-going support' (vendor manager).

(3) At Insurance, the costs of maintenance, disaster recovery and support were considered in the numbers – they are estimated at £416 000 per year, approximately one-tenth of the cost of the initial hardware investment. These numbers still do not include the cost of training the staff to learn client/server.

The case study finding that the total costs for client/server may exceed the total costs of an equivalent system on a mainframe is supported by research conducted by the Gartner Group: 'The total cost of owning a client/server system is in general a staggering three to six times greater than it is for a comparable mainframe system' (Bill Keyworth, research director for network and systems management at Gartner Group, quoted in Caldwell, 1996) and 'We've been saying for three or four years that client/server computing will cost more than host-terminal computing because client/server is a labour intensive model' (Ken Dec, vice-president of marketing research at Gartner Group, quoted in Cox, 1995).

We conclude that client/server 'success' should be based on the business value to the customer (which typically cannot be quantified) rather than traditional financial measures. A recent study by the Technology Managers Forum of 207 companies supports this finding: 'Another interesting conclusion in the study is that these corporations are no longer looking to client/server as a cost cutting mechanism. Systems are going to cost as much as they always have, if not more. Client/server now is being viewed as the most strategic way to build systems' (Myers, 1995, p. 34).

Insource the development, but buy in vendor expertise to facilitate organizational learning

The sourcing strategy for client/server implementations was seen as a critical success factor by the participants – how could they acquire the skills necessary to build and support this new technology? Many companies are opting to outsource the development of client/server applications rather than build in-house capabilities. For example, the First National Bank of Chicago has signed a 7 year, multimillion dollar contract with CSC to install SAP on a client/server platform. Holiday Inn announced a partnership with IBM to build and install client/server-based reservation systems in 1900 hotels by mid-1997 (Wagner, 1995b).

All three of our case companies insourced the project, although they wished to access vendors' technical expertise. Therefore, they decided to buy in vendor expertise to supplement in-house skills, but they managed the external talent internally. Previous research has shown that this strategy is most successful for the development of technically immature areas because the vendors help the in-house staff learn new skills (Lacity *et al.*, 1995).

(1) At Silicon, the participants perceived that outsourcing vendors do not have the same motivation as internal IT employees to service users or to keep IT costs down. By insourcing, Silicon's IT staff was more responsive to the users because they understood the business consequences of their requests. The director of MIS explained that:

"It's (manufacturing) a very difficult job. Anyone who hasn't been there, can't appreciate that. That 24 hour-a-day, 7 day-a-week demand to have the place produce. No matter what happens. I don't care if the power fails or it snows or we are running out of supplies. It's all the responsibility of manu-

facturing to get that done... At Silicon we determined that by bringing the application in-house and integrating it to the scheduling systems, we would reduce lead times and improve customer service".

> Although Silicon insourced the development, implementation and support of the client/server system, that did not preclude Silicon from accessing needed talent from an external vendor. However, this vendor engaged in a unique partnering situation with Silicon which resulted in complementary goals. Silicon offered to debug the vendor's client/server software in exchange for free consulting and help with migration off the mainframe.

"We actually helped them debug it and make it a viable product. That was a partnership unlike any I had really seen in the past years I've been in IS. They gave us support to make it happen. But of course, we were checking their product out which needed a lot of checking. So it goes two ways" (director of MIS).

(2) At Baking, the vice-president of information systems felt that insourcing allowed his staff to actually surpass the technical skills of the consultants he hired:

"I got some help from an outside consultant during an implementation phase, but I got the sense that they were only one chapter ahead of us in the book. By the time the project was over, I think our people were at least at the same level. And a month after they left, our people were ahead of them. All of the significant performance improvements in the system were implemented by Baking's people. But we had a group of bright young people, enthusiastic, intelligent".

(3) At Insurance, the project manager initially hired several independent contractors to serve as application developers on the project team. However, this expertise was not enough:

"The reliability problems had to do with the interfacing and the large amount of memory needed to run the applications, partly due to poor application design, but also lack of knowledge of the technology. We underestimated the technical skills we needed to be proficient in to really ensure successful delivery" (manager of the Business Technology Department).

Subsequently, Insurance hired external consultants to help with the technical plan. This proved successful, as the plan passed both internal and external audits.

Implement incrementally

Benchmarking companies have found that small IT development projects are more productive than large IT projects because there are less resources spent on administration, paperwork and meetings. When developing large IT projects, one strategy to improve efficiency is to implement incrementally. Incremental implementation is the practice of dividing large IT projects into multiple, smaller IT projects. There are three types of incremental implementations: prototyping, phasing and piloting. With prototyping, the system is developed in an artificial environment so that users can test and validate the proposed system. With phasing, the large IT project is divided into phases, with each phase being implemented at different stages. With piloting, one site at the organization is used as the test site and the system is rolled out to other sites when complete. In addition to efficiency gains, the benefits of incremental implementation include verifying user requirements, verifying system design, demonstrating value to secure management approval for full-scale implementation and gaining user acceptance of the system (Naumann and Jenkins, 1982; Janson and Smith, 1985).

In all three of our cases, the companies chose an incremental implementation strategy. Because these companies were inexperienced with client/server, project managers felt a need to divide these large projects into manageable phases. In this way, the project teams minimized the costs of mistakes and rectified design flaws early. Incremental implementations also served to bolster management confidence in the project because they had something to show the organization early in the development process.

Silicon pursued a phasing strategy by implementing each subphase worldwide. They implemented scheduling, central specifications and central planning in 1991, migrated 700 reports in 1992 and migrated order entry in 1994. Baking developed a full-blown system at one pilot site, then received permission for a roll-out to other sites. Insurance developed a prototype in a mock office, then received permission for full-scale development. The participants discussed the major political and technical benefits of incremental implementation.

(1) Silicon participants stressed that phased implementation served to keep management's confidence during the 5-year project.

"Being able to have successes along the route and not necessarily everything is installed at once. It can't be a sit-back-and-wait a year and a half and all of a sudden, boom, here it is. It has to be something that comes in pieces of discernible enough

sizes that people can see it's there and working and doing what we want it to do" (strategic manager of marketing).

"At least this wasn't a thing that waited until the third year before it was turned on. Along the way, benefits were starting to come out. And that helped the situation. It wasn't like they waited 3 years with a totally manual system. Several steps, every 6 months, new features were being added. That's one of the advantages of client/server approach. You keep adding new features, we added new servers. We kept this very fluid mix of boxes out there. We kept changing the arrangement because we kept seeing a benefit each time as we learned, we found better ways to do things. So I think the project allows you that kind of advantage. You turn things on gradually. You see benefits gradually. The customer likes that. They feel good right away" (director of MIS).

(2) At Baking, the vice-president of information systems was concerned about the new client/server technology and felt that a pilot project was the best strategy to gain knowledge as well as management confidence.

"My concern was managing a distributed operation – not that we couldn't, it was a matter of climbing the learning curve. This to me seemed like a good interim step where we could learn how to manage a UNIX environment within one location, we could learn the best way to do back-up and recovery".

By using a pilot project for the first client/server application, the vice-president of information systems was able to accomplish four things. First, he gradually built in-house experience with the new technologies. This allowed Baking's IT staff to avoid depending solely on consultants and vendors after implementation. Second, he could easily shift strategies as more was learned. And he could change plans without losing credibility because few users were affected. For example, the decision not to buy servers at every bakery (as originally planned) but to buy three servers and maintain them at headquarters did not affect the bakeries. Third, he gained confidence in the selection of technologies because they worked and were cost effective. Fourth, he solicited senior management's confidence through early successes – he did not wait 3 years before having visible results.

(3) At Insurance, a prototype was built primarily to test the validity of the business process re-engineering. The claims investigators on the project started taking claim information via telephone instead of a claim form, assisted by a work flow product which ran under Windows. The manager of the Business Technology department explains some of the lessons learned from this exercise.

"What was proven was: basic concept of work flow, image and business rules handling. What we learned from that pilot was the business sense of when to ask questions and the type of questions to ask: to match up customer service, to provide a good level of customer service. But also deriving the right sort of information. And make sure we don't upset customers with the types of questions we ask. For example, the first question you do not ask a customer is whether they had any previous convictions. That's not a sensitive way of handling the claim. But you do need to find that information at some point. So we learned the ways to ask questions better".

They also learned that rigid scripts served to frustrate and annoy the customer. Thus, the system is designed to facilitate extracting claim information in a random format over the phone:

"Actually, we ask for information in a random format. There isn't a pre-set script. So a claimant may be distressed or worried at the time, you don't want to force a set script. You want to pick up whatever information you can get as they say it. So, a range of information is collected, but not in a logical order. Our system can accommodate that. We can put whatever information is coming in, the system drives the claim handler to ask the right questions, for example, if you still don't have the name, it prompts that you still need to get this information. Rather than a script driven process, this is a random approach. Information is collected in a random manner. Not asking the claims person to ask a set number of questions in a set format" (manager of the Business Technology Division).

However, the pilot project focused on the new work flow software that ran in a WINDOWS client/server platform, but failed to test the technical links to the UNIX mainframe. Instead, they relied on the vendors who assured them that the linkages were no problem. This neglect later served to delay the project significantly.

Include business users on the development team

IT research has demonstrated that close user–IT partnering is a critical success factor. Mumford (1981) described three types of user roles on project development teams.

(1) Consultative: users are consulted about what they want, but decision making is done by another group, typically IT.
(2) Representative: a group of users is elected to represent the needs of their co-workers in the design process.
(3) Consensus: users not only make decisions, but assume full responsibility for the success of the project.

In all three of our case studies, a subgroup of users was devoted full-time to the client/server project, thus falling under the category of representative. At Insurance, however, the users at first assumed a consensus role, with a user serving as project leader, but this delayed the project due to constant changes to requirements. (Consensus participation has previously been found to delay projects in Hirschheim (1985)). Eventually, Insurance's management diminished the users' consensus role to the representative role.

(1) At Silicon, user participation was seen as critical.

> "I come back to teamwork a lot. This company is not built on isolated units. We are very much working together as teams. There is no IS project that doesn't have users right on the project team" (director of MIS).

"In my opinion, we could not have pulled this project off by having MIS sit in one area and have the users sit in another area. Physically we were only 20 or 30 feet apart. Literally, the programmers were sitting by the schedulers, next to the people who write the plan orders, the people who deal with the commercial issues. If there hadn't been that close coupling, that would have led to frustration. It would have led to more false starts. We have a pretty active users group. Basically, the way we try to structure it, as we start tackling different segments, there was involvement from people who did the work, who were going to do the work in the future. One of the people who now maintains part of the system was a plant operator. She's been taught how to use SQL rules, how to use expert systems, things of that nature. There has been real imparting of knowledge to the users and soaking up of that knowledge. I think if it had been done in a vacuum, it would have never happened. There would have been too many frustration/fights/battles and the users would not have been able to see that progress was being made. Having them be able to report back to their supervisors and saying, 'Yeah, it's moving forward, it's getting there.' I think that was a critical factor" (strategic manager of marketing).

(2) At Baking, the project was primarily a technical one, but a full-time business user was assigned to the project. As stated in the section on top management support, the role of this user was to primarily gain support within the organization for the project.
(3) At Insurance, the project team initially consisted of a dual management structure with two project leaders: an IT manager and a business manager. The business project manager was responsible for meeting business requirements. She had a staff of ten people which included business process analysers and claims handlers. There was also a technical project manager in charge of developing the software on a client/server platform. He had a staff of ten people, including system developers from within the department as well as contractors. The project adopted the rapid applications development methodology which encourages users to articulate their business requirements quickly. However, soon into the project it was apparent that they would not meet the 6 month deadline because once the requirements were extracted, a stronger management style was needed to freeze user specifications and focus on the deliverables.

"We initially started in an entrepreneurial style which was very enabling. That was continued far too long. We should have switched into a stronger driver style with a clear focus on the deliverables. So we found that rapid application development techniques in terms of business requirements were useful, but we needed a more aggressive style later to ensure delivery. We also needed a high level of expertise in managing these projects. But the technical project manager had no experience in the scale of this project. Therefore he wasn't used to the type of problems with a large project. There are a lot of business functions, which we tried to scale down, but the users couldn't run the new process without all the systems" (manager of the Business Technology Department).

Because the technical project manager could not convince the business project manager to freeze specifications, management removed the business project manager and the technical manager became the sole project manager. Users still participate on the project team full-time but they now report to the technical project manager.

Conclusion

We note that many of these lessons on managing client/server technology are no different from the managerial lessons for other IT projects. Certainly, a plethora of IT research has demonstrated the need for top management support, redesigning business processes before implementing IT, user participation on development teams, incremental implementation strategies to improve productivity and reduce risk and buying in of vendor resources to transfer skills to in-house IT staff. We also see the same problems surfacing, such as IT projects which are late and over budget, primarily caused by the same problems: failing to freeze user specifications and underestimating the skills needed.

Another critical success factor for client/server that has been identified in the trade press is the continued need for disciplined development methodologies (Strehlo, 1995; Shelton, 1996). While many organizations use the system development life cycle (SDLC) for mainframe-based systems, the development of client/server systems often lacks the formal discipline of structured development methodologies. Project teams are busy coping and experimenting with business objects, application objects and technical objects – skills uncommon to many information systems professionals from the mainframe world. Subsequently, many organizations revert to an *ad hoc* and experimental approach. However, this *ad hoc* approach to development has been identified as one of the major causes of the failure of client/server systems. The participants from a conference on client/server development called for a return to disciplined development methodologies we fostered in the past (Lyons, 1995).

In contrast to this reported abandonment of a disciplined approach to client/server development, our case companies used structured development methods. Although they viewed these first time client/server projects as unique in some aspects, they believed that all IT projects should follow a structured method. For example, Insurance adopted rapid applications development, while Silicon applied manufacturing project management precepts to their IT project.

> I've also done a lot of project management over the years, run large projects, I headed up the maintenance organization here and the plant engineering organization. So I know how to run an organization and how to centre or get a view of where we want to go. Those are some of the skills I think I brought to the position from my engineering background. I basically applied a lot of that engineering approach to the IS organization. And guess what, it worked pretty good. I believe in planning, and a structured approach is how we do that. I believe in results, measuring performance against those results. And I don't believe an IS project by its nature is any different than a construction project. They have different pieces and tools and outcomes, but you still have the same methods and requirements and discipline on how to get there. You have to plan, track your process, communicate, clearly define your expected result, which is why a lot of projects fail (director of MIS, SILICON),

Although we identified many traditional practices that are relevant to client/server projects, it does not mean that client/server projects are exactly like other IT projects. We uncovered three client/server-specific challenges:

> (1) total costing of the client/server architecture, (2) the technical complexities of middleware and application software and (3) technical design.

On the issue of costing, practitioners often assume that client/server is less expensive than other platforms because initial investments in hardware are lower. In two of our case studies, the organizations justified the adoption of client/server computing as a lower-cost computing model. Silicon and Baking wanted to terminate their mainframe outsourcing contracts and they believed that client/server was a cost-effective way to build their own computer operations. What they did not realize was that distributed servers cost more to maintain than centralized computing. Decentralized servers are more expensive because of site software licenses, client software distribution, client software version control, expensive middleware required to integrate servers and local back-up and recovery (Hadburg, 1995; Caldwell, 1996). Eventually, both Silicon and Baking abandoned their decentralized architecture and planned to maintain all servers at headquarters.

In the trade press, similar experiences are being reported. The failure of client/server to achieve cost savings has triggered another phenomenon: the advent of intranets (Sarna and Febish, 1996). With intranets, the client machine contains only a Web browser which serves as an interface to a centralized server which houses the application logic. Web-based intranets, therefore, represent an evolution of client/server computing from 'fat' clients to 'thin' clients. Ironically, the cost savings occur from centralization, which echoes the arguments of mainframe computing over a decade ago.

The second unique challenge of client/server is the evaluation, development and management of middleware (the software that integrates diverse client and server machines) and application software. Because of the complexities of application partitioning, applica-

tion software and middleware in the client/server world is usually purchased off the shelf (Simpson, 1995). However, most organizations do not have the required experience to evaluate and test such large packages; instead they rely on vendor salespeople for technical assistance (Ball, 1996; Tristam, 1996). This was very evident in the case of Insurance where incompatibilities between OS2 and Windows were not identified prior to development. This caused the project to be delayed until the organization decided to adopt a uniform operating system.

Even in the case of a successful implementation at Silicon, numerous technical glitches were encountered with middleware.

> . . . There's a lot of complicated things we had to learn. We ran into problems like we had two network cards on one machine that were two separate networks that were not bridged together or routed together. DCE (their middleware product) would randomly pick one card or the other when routing messages (manager of business information systems).

The third unique challenge with client/server computing is the technical design of the distributed applications, including on-line updates, security and checkpoint–restart design. For instance, on-line transaction processing on client/server systems is very difficult because the data is physically distributed. At Silicon, they had to completely redesign on-line transaction processing when the following problem surfaced: 'We would put in a transaction that we would do 20 000 I/O per logical unit of work and hit the rollback button. . . and 2 days later the system would come back!' (manager of business information systems).

These technical issues surprise IT staff the first time they develop client/server because technical functions are mature and stable in the mainframe environment.

This research concludes that, although IT technology changes, we as IT researchers and practitioners have identified sound management practices which transcend technology. This may have profound implications on the research questions we investigate. Rather than ask, how is this new technology different (such as object-oriented paradigms, CASE technology, the World Wide Web, GUI interfaces, client/server), we may ask, 'How are they similar to what we already know? What lessons and practices, which we have already mastered, apply?'. Certainly, the vendor hype surrounding new IT technology 'breakthrough' always seems to promise vast improvements, with an implication to forget the past, forget the old way of doing things. However, increasingly, practitioners are seeing through the hype and delivering these new technologies within the context of previous organizational learning.

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Biographical notes

Ashok Subramanian is an associate professor of MIS at the University of Missouri–St Louis. Dr Subramanian has a PhD in MIS from the University of Houston. His research interests include telecommunication technologies, applications and policies, distributed computing technologies such as client/server computing, object-oriented systems development, diffusion of innovations and computer personnel issues such as productivity. He has published in journals such as *Omega, Information & Management, Journal of Information Technology Management* and the *Journal of Engineering & Technology Management*. He has worked as a consultant in the areas of open systems architecture development, the development of standards, policies and procedures for managing corporate computer networks and in IT-based business process re-engineering.

Mary Cecelia Lacity is an assistant professor of MIS at the University of Missouri–St Louis. Her research focuses on best IT management practices in the areas of sourcing, benchmarking and project management. She has published two books (with Rudy Hirschheim) on IT sourcing: *Information Systems Outsourcing: Myths, Metaphors, and Realities* (Wiley, 1993) and *Beyond the Information Systems Outsourcing Bandwagon: The Insourcing Response* (Wiley, 1995). A third book is forthcoming: *Strategic Information Systems Sourcing: Theory and Practice* (Leslie Willcocks and Mary Lacity (eds), Wiley, 1997. Her articles have appeared in the *Harvard Business Review, Sloan Management Review, Journal of Management Information Systems, Journal of Strategic Information Systems, European Journal of Information Systems, Information Systems Journal, Journal of Information Systems, Database, Journal of Information Systems Management* and others. She has worked as a systems analyst for Exxon, a consultant for Technology Partners and as an independent consultant on several public sector IT sourcing decisions.

Address for correspondence: School of Business Administration, University of Missouri–St Louis, 8001 Natural Bridge Road, St Louis, MO 63121-4499, USA.