CASE STUDY I-1

IMT Custom Machine Company, Inc.: Selection of an Information Technology Platform

June Page watched an October rainstorm coming out of the west from her second-story executive office. Turning to a growing stack of paperwork, she also thought of the dark cloud hanging over her information systems (IS) area.

Something had to be done. Committee after committee had analyzed urgent systems problems and proposed incremental solutions. And Page's faith in her staff usually led her to approve the recommendations. But soon another "glitch" always seemed to develop, and another committee would have to be appointed. "Something fundamental was missing," she thought to herself. "We don't have a strategic direction for IS—we don't know where we want to be or how to get there. We have to get our arms around where we want to go with our information systems once and for all."

Page was a vice president and the division manager of a subsidiary within the International Machine and Tool—USA (IMT-USA) Company. The IMT Customer Machine Company built multimillion-dollar, large custom-made production machines. These machines were used in the manufacturing of various parts for large items such as automobiles. As division head, Page was responsible for two factories, which built about 150 machines per year, and a third factory that made smaller machined parts for the two factories. A service and spare parts group within the division supported the repair and maintenance business for any custom machine, including those built by IMT's competition. The Fort Wayne, Indiana, plant, where Page worked, was the largest custom machine factory in North America. (See the organization chart in Exhibit 1).

In early September, Page had decided to ask an experienced engineer to learn about the IS activities, investigate all the issues, and develop a recommendation, or at least some options for her to consider for getting IS on track for good. While she recognized she had undertaken an unconventional approach, she knew Charles Browning was the right person for the task. Browning was a staff engineer with

an extensive scientific computing background, finishing his MBA at a major Midwestern university. He reported to the development engineering manager at the Fort Wayne plant.

At a meeting on September 3, 2002, Page had given the charge to Browning:

I need you to survey the total IS picture and give me three or four basic directional options which will satisfy our IS needs over the next several years. I want you to report your findings in six weeks. Plan on giving it to me straight. I will review the findings with you and then incorporate one of the alternatives into my business plan for 2003. There should be no limits on the type of recommendations you provide, Charlie.

By using Browning, Page hoped to cut through the layers of management that might have been filtering out the root causes of IMT's IS problems.

She heard the knock on her office door and assumed that Browning was ready with his report.

The Custom Machine Industry

Exhibit 2 summarizes the additions to production capacity for U.S. suppliers of custom production machines. Until the mid-1970s, there had been a clear upward trend of production capacity additions. But the growth in worldwide demand for the machines began to decline as industrial production in developed countries slowed.

As the market share of U.S.-based industrial production companies declined, demand decreases were soon felt in the U.S. custom machine industry. Excess production capacity suddenly became a reality. Underutilized plants became targets for closing, and plans for scores of new plant and additions were canceled. Annual capacity additions declined after 1975. By the mid-1990s, annual capacity additions had fallen below the level of the early 1960s. When the data were released for 2000, experts expected additions to capacity to be nearly zero.

The industry slowdown caused Williamson Machines and Engineering Corporation (WILMEC), which held about 30 percent of the U.S. market, to close its "medium

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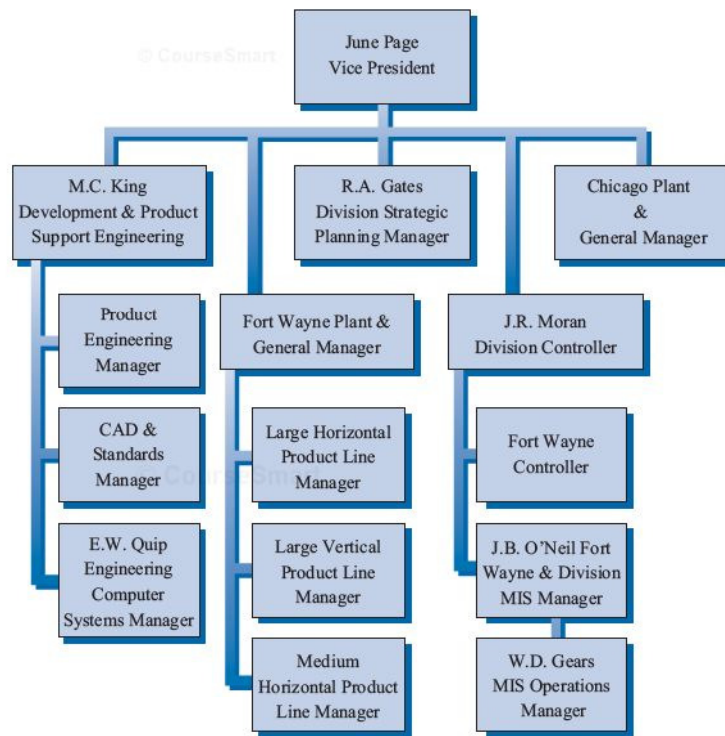
EXHIBIT 1   Organization Chart: IMT Custom Machine Company, Inc.

horizontal"–type machine factory in Cleveland, Ohio, in 1983, moving its medium horizontal production capability to its one remaining custom machine factory in Fort Wayne, Indiana. The Fort Wayne facility was constructed in the early 1970s specifically to manufacture a similar, but technically different, type of custom machine called a "large vertical."

In 1988, General Engineering, Inc., which in previous years had been an equal market rival to WILMEC, abandoned its custom machine business by closing its Detroit, Michigan, plant. General Engineering (GE) sold its technology to WILMEC, and GE's production equipment was moved to WILMEC's Fort Wayne plant. The result of WILMEC's technology acquisition from GE was that a third, and very different, technology called "large horizontal" also started being manufactured in Fort Wayne. At this time, WILMEC also expanded its custom machine reconditioning operation in Chicago to handle the assembly of one-third of its medium horizontal machines. By 1990, the Fort Wayne plant produced all three custom machine types: large horizontal, large vertical, and medium horizontal.

Starting in late 1993, WILMEC refocused its strategy away from the machine fabrication industry into various service industries. WILMEC sold all of its custom machine engineering, manufacturing, and sales operations to International Machine and Tool (IMT) of Bonn, Germany, in mid-1995. IMT was itself the result of a 1987 merger between Europe's two largest machine manufacturers—International Machines (English translation) of Germany and Tools of Commerce (English translation) of Italy. Numerous plant closings and consolidations had rippled through Europe as well as the United States in the late 1980s and early 1990s.

By 1995, the production capacity for custom production machines in the U.S. market had essentially stabilized at 95 percent of the demand level. As was true for most cyclical industries, a significant increase in demand would cause capacity problems and delay deliveries. Indeed, some industry observers suggested that the custom machine industry might return to a robust building program by 2005.

International Machine and Tool

International Machine and Tool used a matrix-style organization throughout its operations, modeled after the structure of

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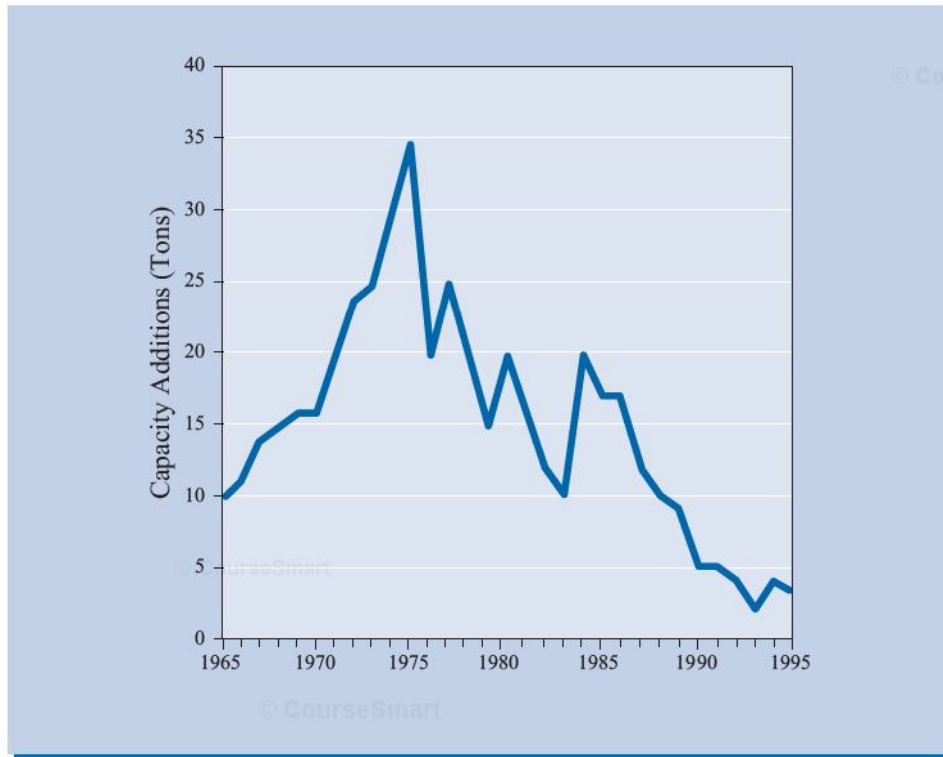
EXHIBIT 2   The U.S. Custom Machine Industry Production Capacity Additions from 1965 to 1995

other large, European-based global companies. Dr. Wilhelm Schlein, Chairman of IMT, summarized the organization as "a federation of national companies with a global coordination center—a distributed organization which has many homes." Schlein's strategy for building a decentralized, multidomestic enterprise was critical to achieving IMT's goal of "think global, act local."

One side of IMT's matrix organization was country-based. Each country manager (president of the national holding company) was responsible for financial targets for all of IMT's companies in that country. Country presidents coordinated synergistic relationships across IMT operations within the country (e.g., the same distribution and service networks). They were also responsible for maintaining relationships with national government officials.

The second side of IMT's matrix was technology-based (product classes) and reported through a separate transnational technology management group, called a business group (BG). The mission of each BG was to support shared knowledge and operations among many international factories in the same industry. BG leaders served as business strategists who set global "rules of the game" and then let local managers (like Page) pilot the execution.

In 2002, IMT had eight international custom machine factories, two of which were located in the United States. The U.S. plants represented nearly one-half of IMT's global capacity. The combined capacity of the Chicago and Fort Wayne plants was far larger than any in the other countries.

Page reported to two managers in the matrix, the U.S. country manager and a Custom Machine BG manager, who often had conflicting goals. While she had to increase return on assets to support the U.S. country manager, she simultaneously was encouraged to maintain a leading technology position by the BG head. As was true for all custom machine factories, Page's division paid about one percent of sales to the BG for global research and development projects.

June R. Page

With more than 18 years of custom machine engineering experience, Page was widely known and highly respected throughout the custom machine industry. Earlier in her

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career, Page had worked her way through several engineering and manufacturing management positions at WILMEC. She had always been active in the industry by chairing and working on technical committees of various professional associations.

However, Page was not actively involved in the use of the information systems at IMT. Her personal use of a computer was limited to preparing short documents, maintaining a calendar, constructing and reviewing reports, sending e-mail at work, and browsing the Internet from home. She felt that her hectic schedule made it impossible to use the personal computer in her office for more than 50 minutes a day.

In 1999, Page was appointed Vice President of IMT Custom Machines Company, Inc. (CMCI), the IMT subsidiary in the United States. On the "country side" of the matrix, CMCI reported through the IMT-USA holding company in New York, which in turn reported to IMT's world headquarters in Bonn. On the BG side of the matrix, Page reported to the managing director of the Custom Machine BG. The headquarters for the business group was in Milan, Italy.

Shortly after taking the job, Page and other division managers worked with the IMT-USA President toward developing universally applicable (to all IMT-USA companies) statements of the corporate mission, principles, and vision. After considerable discussion and many revisions, the IMT-USA President disseminated the final product on March 26, 1999. (See Exhibit 3.)

The Fort Wayne Plant

The work environment at the Fort Wayne plant over the prior 25 years was dynamic, to say the least. Over that period, the plant first transitioned from a busy single-product factory into a stagnant operation that nearly closed due to a lack of orders. A few short years later, it evolved into a facility that supported three technically different products (large horizontal, large vertical, and medium horizontal custom machines), each originating from a different company with different engineering design systems. In 2002, IMT's Fort Wayne facility was producing near its capacity and was staffed with about 1,200 employees.

Until the mid-1990s, all the engineering and marketing operations for the Fort Wayne and Chicago plants were located in Cleveland, Ohio (200 miles from Fort Wayne and 350 from Chicago). In 1995, IMT closed the Cleveland site and transferred the engineering and marketing staffs to either Fort Wayne or Chicago.

As the Fort Wayne plant evolved to support multiple product lines, a number of informal procedures emerged to handle day-to-day situations. These undocumented processes worked well enough, despite the incompatibilities among the three different machine technologies, which used

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The following was taken from a presentation given by the IMT-USA President on March 26, 1999.

Mission
- Serve U.S. customers to their individual needs and total satisfaction.
- Create an organizational environment that allows all IMT-USA's employees to add value.
- Promote an atmosphere of thirst and eagerness to perform that allows delegation of responsibility to the lowest possible organizational level and attracts good people.
- Generate a sense of urgency and results orientation in the development of capital and human resources to ensure proper return for both our employees and our shareholders.
- Expand the horizon of the organization to share in and contribute to our worldwide core competencies.

Guiding Principles
- Create a sense of urgency—concentrate on priority actions rather than procedural issues.
- Promote a unifying culture: "can do—do it."
- Remove barriers to performance.
- Shift organizational focus to servicing the customers and beating the competition.

Vision
- Demonstrate leadership in serving the U.S. marketplace in its transition to cleaner industry, where products are more efficiently produced, distributed, and applied.

EXHIBIT 3   IMT-USA Mission, Guiding Principles, and Vision Statements

three separate drafting systems as well as unique manufacturing processes. Very little capital had been invested in upgrading the operations during the last several years of WILMEC's ownership. In fact, it was not until IMT had completed its WILMEC purchase that a major capital upgrade was even considered. Low margins and strict capital budget limits always prevented significant upgrades. As a result, the informal processes continued under IMT ownership, as company executives focused on making the acquisition show a profit.

In early 1996, the plant was reorganized into three "machine-type" product lines, each operating as a separate product line and profit center. In June 1997, CMCI's Quality Assurance Manager, Edward Fortesque, completed the mission statement for CMCI. (See Exhibit 4.) Finally, the company's reorganization was coming together.

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The following was issued throughout the Fort Wayne plant on June 25, 1997 by Edward Fortesque, Manager of Quality Assurance.

Mission
- To be recognized as the outstanding custom machine manufacturer in the world.

Goals
- *Provide market leadership*
  - Customer satisfaction
    - Quality
    - Reliability
    - Delivery
    - Service
  - Serve the market with optional products and services
  - Be the technology leader

- *Achieve business (operational) excellence*
  - Zero failures
  - On-time performance
  - Low throughput time for orders through the factory
  - High productivity of labor
  - Return on capital employed >30% (pre-tax)
  - Revenue to total compensation growth of at least 5% per year

Vision
- To be perceived by each of our customers as superior to the best of our competitors in the overall quality of our products and services.

EXHIBIT 4　Mission/Vision Statement, IMT Custom Machine Company, Inc.

The following was issued to top division and plant management on July 30, 2002, by Joe O'Neil, division MIS manager.

Direction
- Pursue a more structured MIS strategy with a reasonable and manageable level of risk that will be consistent with our being a leader in the custom machine industry.
- Develop and execute a plan that will continually upgrade our hardware, software, applications, database, and network environments to accomplish the above.

Objectives
- Recognize our business is designing and producing custom machines, not chasing ever-changing computer technology and theories.
- Coordinate MIS strategy with our business objectives of:
  - Zero defects
  - Low throughput time
  - ROCE (return on capital employed) of 30%
- Control our own destiny.
- Minimize risk and hidden costs.
- Work from a total systems architecture plan to:
  - Develop an applications architecture
  - Select the hardware plan required to best accomplish our goals
- Maintain an integrated environment that supports the various functions of our division.

EXHIBIT 5　Fort Wayne MIS Direction and Objectives, IMT Custom Machine Company, Inc.

CMCI's Information Systems

Charles Browning began his investigation shortly after receiving his charge from June Page. By mid-September 2002, he had uncovered considerable data about the information systems at Fort Wayne and Chicago.

Support for Fort Wayne's information systems was split into two groups: an engineering systems (ES) group and a management information systems (MIS) group (again see Exhibit 1). The ES group consisted of eight of the 25 people who reported to Dr. Michael C. King, Fort Wayne's Development Engineering Manager. Dr. King had been trained as an engineer and was known as an industry-wide expert on the design of automated fabrication technologies.

Twenty MIS support staff members reported directly to Bill Gears, who in turn reported to Joe O'Neil, the division MIS manager. Chicago had its own one-person MIS "group" who reported directly to O'Neil. O'Neil reported through the division controller's organization. O'Neil was a former IBM employee with extensive experience on large mainframes and on the IBM AS/400 platform. He had been the MIS manager at another IMT site before coming to Fort Wayne in 1998.

On July 30, 2002, O'Neil circulated a memo to the top division and plant managers that summarized his objectives for Fort Wayne's MIS group (see Exhibit 5). O'Neil later told Browning, "I do not have a formal mission for the MIS group, but essentially I am looking to provide an adequate, responsive, and economical network structure of data processing support for all sites within the division."
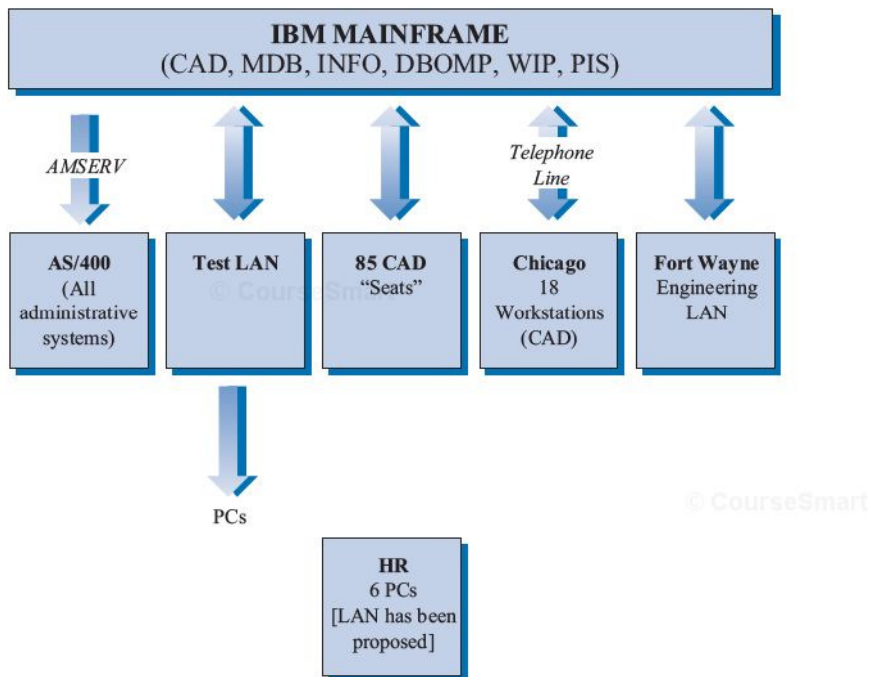
Browning found that a variety of computing hardware was used to support the division. (See Exhibit 6.)

The division operated an IBM mainframe located at Fort Wayne that could be used by anyone in the division

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IBM MAINFRAME
(CAD, MDB, INFO, DBOMP, WIP, PIS)

AMSERV

Telephone Line

AS/400
(All administrative systems)

Test LAN

85 CAD
"Seats"

Chicago
18 Workstations (CAD)

Fort Wayne
Engineering LAN

PCs

HR
6 PCs
[LAN has been proposed]

EXHIBIT 6   Computing Systems and Applications,* IMT Custom Machine Company, Inc.
* Applications are in parentheses

with no direct charge. All lease and operating costs for the mainframe were covered in the division's overhead. When they joined the company, new engineers and other professionals were supplied with a mainframe user account, a personal computer (PC) equipped with a board to enable it to communicate with the mainframe, and several PC software packages for local work. The mainframe arrived in March 1999 on a 5-year lease. A mainframe upgrade in 2001 was driven by the need for improvements in computer-aided design (CAD) response time and an increasing number of users. From 1999 to 2001, 65 new users throughout the factory and front offices were connected to the mainframe.

CMCI also had an IBM AS/400 that it had inherited from General Engineering. Immediately after the acquisition, MIS personnel attempted to create a procedure to move data between the two mainframes, but that proved to be difficult. Most exchanges were done by "pulling" data from one system to the other. Although a routine (called AMSERV) was available to "push" data to the other system, its use was not fully understood. Another

reason AMSERV was not used was that the receiver's data file could be updated without the user's knowledge. As a result, data security issues slowed the practice of sharing data between the two systems. In sequential applications, where data were created in one system and used by another, identical data files were needed on each system.

From 2001 on, the heaviest use of the mainframe was by drafting and engineering staff. IMT Fort Wayne used IBM's CAD product on the mainframe. The CAD application, along with additional drafting and engineering programs, represented about 65 percent of mainframe use. Total usage in August 2002 was estimated at 54 percent of the mainframe's CPU capacity.

The division also used personal computers extensively. The policy at Fort Wayne was that anyone who needed a PC could get one. Financial justification was not necessary, as PCs were considered a tool. Fort Wayne's standard PC configuration included the latest Intel processor running the latest version of Microsoft Windows as well as the Microsoft Office suite and several other popular

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packages—all connected to an inkjet printer. PCs were obtained under a three-year lease from a local supplier.

Many users felt that the lack of sufficient mainframe software support and lengthy systems development time on the part of the MIS group had been partially compensated by the use of PCs. For example, production scheduling in major work centers in the factory was done with a spreadsheet on PCs. However, the principal use for many PCs was as a "dumb" terminal to the mainframe for database inquiry or sending e-mail. In addition, secretaries and engineers routinely used PC word processing to write memos. Of the 300 users on Fort Wayne's mainframe, about 210 were accessing it through PCs. The remaining users were CAD users.

The division also had powerful personal workstations for technical work. As of 2002, Fort Wayne had six IBM workstations used by the development engineering group for special projects. They were connected through a local area network (LAN). Several Sun workstations were also linked into the LAN during the previous year. Personnel at the Chicago facility used 18 IBM CAD workstations for normal production work. At Fort Wayne, there were also 25 Sun and IBM workstations used for the production of drawings.

Drawings made in Chicago on workstations were stored on Fort Wayne's mainframe and uploaded and downloaded over a high-speed dedicated telephone line. Chicago's designers liked their CAD stations, but they were having trouble with the connection between the mainframe and the Chicago LAN. Tom Goodman, the MIS support person in Chicago, told Browning, "I feel like we are the beta site for linking sites together."

Data Flow and Functional Responsibilities

Exhibit 7 illustrates the generalized data flow among the main functional areas of the Fort Wayne operation. Of the seven functions, only the human resources (HR) department was not connected to the main information flow. The remaining six organizational areas participated in a continuous sequential flow of information.

The flow of business information started with the interaction between marketing and the customer. Information originated from the customer when a technical description or specification (a "spec") was sent to IMT for a new machine. The length of the spec could be from ten to several hundred pages. A marketing engineer would then read the spec and enter his or her interpretation of it into a mainframe negotiation program. The negotiation program (MDB), inherited from WILMEC, required the input of about fifty computer screens of data and was written in COBOL. For presentations, marketing used Excel and PowerPoint on their PCs.

If a marketing engineer had a question about a spec, he or she called a design engineer or another local expert. Most estimates had to be turned around in 10 working days. Because of the volume of requests and a staff of only two engineers covering all of the United States, negotiations were sometimes very hectic. Mike Truelove, a marketing engineer, told Browning, "We do the best we can, but we miss some things from time to time. Almost always after winning the order, we go back and negotiate with the customer over what we missed."

Another frequently used mainframe application was a query system (called INFO) automatically linked to data from the negotiation program. It was used to analyze data from ongoing negotiations as well as contracts after they were won or lost.

The administration and finance group was the home for most business support systems. The purchase order, accounts payable, and accounts receivable systems were applications used by purchasing, receiving, and other groups. All three systems had been custom developed on the AS/400 by the General Engineering MIS staff (some of whom now worked at CMCI). Although wages and salaries were maintained locally, an external data service company handled the payroll.

As of 2002, human resources used only stand-alone computers. HR had plans to install a LAN that operated customized corporate programs for handling HR functions, including benefits and pension/investment plans. There were no plans to connect the LAN with Fort Wayne's mainframe due to security concerns for the confidential personnel records residing on HR's computers.

Production Requirements

Each machine the company made was electrically and mechanically custom designed to a customer's exact specifications. Customization requirements, when mixed with the complexities of the economic and engineering limits, required sophisticated computer programs for modeling and design work. In 2002, Fort Wayne had three separate design systems, one for each of the three types of custom machines. Design engineers for each product line were experts on their own programs.

The first step in design engineering was to receive electronically the data previously entered into the negotiation program. The process entailed pulling the data records from the negotiation database. The design engineer reread the customer's spec and decided which additional data needed to be added to the input files for the design program. The program then generated a design that the engineer reviewed in detail and often revised. After the design was accepted by the engineer, the electronic computer file

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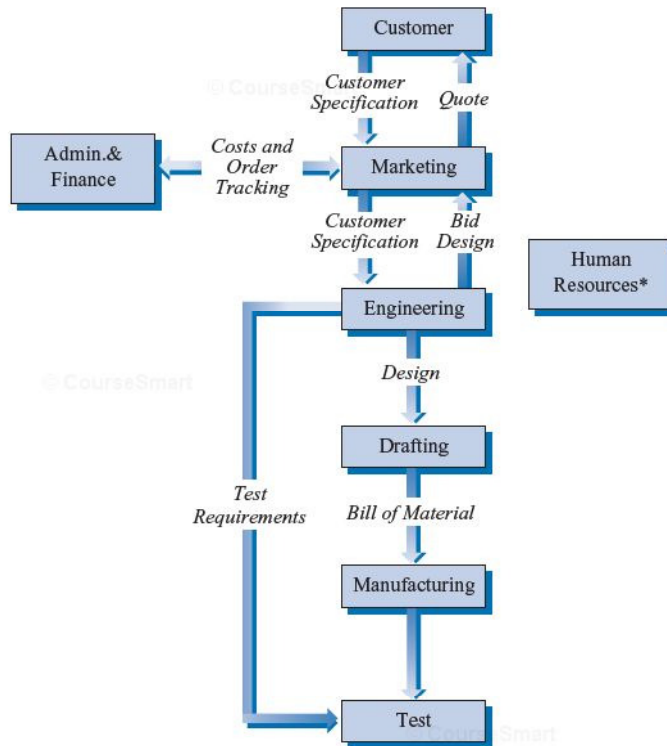
EXHIBIT 7   Data Flow Among Functional Areas,*
IMT Custom Machine Company, Inc.
* Uses only applications supported by IMT-USA.

and a paper folder with completed job forms were sent to a drafting supervisor for completion.

The ES group had designed all of Fort Wayne's design systems. The number of routines used by each of the three systems was a relative measure of size and complexity. Large vertical had about 500 routines, medium horizontal had about 400 routines, and large horizontal had about 2,400 routines.

All drafting at Fort Wayne and Chicago was performed on a CAD applications system. At Fort Wayne, the CAD application ran on the IBM mainframe, and in Chicago it ran on the local IBM workstations. There were 85 CAD "seats" at Fort Wayne and 18 at Chicago. (A "seat" is equivalent to one hardware CAD setup with a high-resolution screen, keyboard, function-button box, and a pointing device that worked like a mouse.) During the prior 5 years, additional programs had been written to take output automatically from the design programs and create

CAD drawings or references to drawings of standard parts. About 60 percent of the drawings for the average 4,000 parts per machine were created in this way. The remaining 40 percent of drawings had to be created by a draftsman from the design specifications. All jobs were reduced to drawings prior to being released to the factory.

A standard part drawing included the material specification on the drawing. Assembly work orders contained the bill of material (BOM). Having CAD and the design programs on the same platform made the development of the automatic drawing programs very convenient. Jennifer Velan, an engineer in the development group, told Browning, "There are things we have been able to do with this setup that would be impossible if the jobs were split between two separate systems."

When all the drawings for a custom machine were completed, the BOM was manually transferred from the drawings into the BOM database system, called DBOMP.

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DBOMP was originally written by IBM and extensively modified for Fort Wayne in the 1990s to handle bills of material for the vertical type machines. When production of the medium and large horizontal machines was transferred to Fort Wayne, DBOMP's limitations forced many "work-arounds." For example, when the General Engineering large horizontal technology was moved to Fort Wayne, it was discovered that DBOMP could not handle the longer General Engineering drawing numbers. Moreover, there was no one at Fort Wayne who knew the DBOMP code well enough to make a change in the software.

The work-in-process (WIP) inventory tracking system for the shop floor at Fort Wayne was very limited and worked only for items required for the main aisle assembly area. It could only handle made-to-order parts, not stock items. The system worked by having a main aisle supervisor request a "pull" from the storeroom to get parts delivered. The tracking systems for items within feeder aisles were either done manually or on a spreadsheet, with each aisle having its separate system. The WIP main aisle tracking system resided on the mainframe, and the data were loaded by hand from the DBOMP.

The parts inventory system (PIS) was very limited and similar to the tracking system except that it worked for all stocked inventory items for the main and all feeder aisles. It used an identical process to the WIP system.

The MIS group was backlogged in supporting the rapid changes occurring at the Fort Wayne plant. The lead time on most system upgrades was 3 weeks for emergencies and 6 to 9 months for nonemergencies. When a computerized system failed to provide needed functionality, paper systems were created to support the information needs.

Because each custom machine was a significant investment—between $2 million and $8 million—all machines were fully tested at Fort Wayne or Chicago, and the testing was personally witnessed by an employee or agent of the customer company. The test department, along with the witness, certified that every machine met the customer's test requirements set forth in the specification.

Scheduling information and other test details were forwarded to the test department by hand. Test information was written on a form that was interpreted or copied from the customer specification in marketing and engineering. The biggest complaint from the test department was that sometimes the marketing department did not properly interpret the customer's test requirement specification. A failed or unnecessary test that resulted from misinterpreting a customer's specification could cost IMT well over $100,000.

The test department had several personal computers connected to a LAN. Although all PCs in the test department were also connected to the mainframe, this connectivity was only used occasionally. The test department

was a part of the quality assurance organization at Fort Wayne, which was responsible for the data and production of the test reports sent to customers. Electronic test result data, however, remained only on the test department's LAN. The test department maintained its own LAN applications.

Personnel Issues

Browning uncovered some additional information about the information systems personnel at the company. The programmers in MIS had extensive backgrounds in COBOL and in RPG for the AS/400. None of them, however, knew the UNIX operating system or its related programming languages. Of the 14 programmers, four had over 25 years experience at Fort Wayne, two had about 12 years, and the remaining eight had three years or less.

Engineers who supported the engineering system in the development group had significant backgrounds in scientific computing and four had some experience with UNIX. Each engineer had more than 10 years of experience with the company. One of the recently added programmers in the engineering systems group knew UNIX very well.

Browning heard many comments during his investigation that suggested that the MIS and engineering systems staff at Fort Wayne always made the systems work—despite the constant change.

Browning concluded that as a result of employing informal systems, work-arounds, and an extraordinary amount of human effort, Fort Wayne was profitable in 2001—its first profitable year in several years. Slowly, things were stabilizing at Fort Wayne—the informal systems were being corrected and formalized. Restructuring into three product lines had helped to clarify the focus and purpose of operations systems and procedures. Overall, the primary reason many staff members saw progress was that each product line was allowed independent control and responsibility.

Computer systems support, however, remained an issue. The engineering systems group supported engineering and drafting, and the MIS group supported everything else. The HR organization was not considered a local issue because its applications were supported from the corporate MIS group in New York (IMT-USA). A small group within MIS maintained all PCs and miscellaneous computer hardware for all the functional groups across the plant.

Support for Engineering and Drafting Systems

Browning also discovered an ongoing debate over where the IT support for the engineering and drafting

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systems should be located. Browning summarized the three alternatives that arose from the debate on a legal pad at his desk:

1. *In the engineering support systems group*: Arguments for leaving support for engineering and drafting in the development engineering line of authority were strong. The design and drafting programs produced models for the three product line technologies. The three principal people supporting these design systems were engineers with strong computer backgrounds. Two of the three had master's degrees in engineering. Support for these programs required a balance of custom machine design knowledge, creativity, and programming. By working close to the user engineers in the product line, the ES engineers could update the systems rapidly. The engineers feared that MIS programmers had little understanding of the underlying design technology. Some of the engineers speculated that the MIS people might make coding changes that "would cost millions to correct once a design was committed and the parts were made."

2. *In the product lines*: Arguments for product line support of engineering systems included the fact that product line engineers had extensive firsthand knowledge of how the system was used. As a result, feedback on problems would be more obvious to those who supported the system. Furthermore, it could be argued that ultimate control of the software should be in the hands of each of the profit centers. They should have the option to regulate the level of computer support based on their own strategy. However, if the engineering systems support responsibilities were located within the product lines, a programmer would need to be transferred from the engineering support systems group to each of the product lines.

3. *In the MIS group*: Arguments for MIS-based support of engineering and drafting systems included an alignment of all computer-related functions in one functional group—thus providing a common responsibility point for all computer support and integrated applications. Product line and development engineering would have to submit change requests that were more completely documented. Support through MIS would guarantee that coding changes would be better documented. If support were the responsibility of the product line engineers, MIS people argued that the end result might be "spaghetti code," which no one but the original programmer could understand.

The Move to a Common Custom Machine Design System

Browning discovered that in early 2002, Page had received instructions that her subsidiary would have to use a redeveloped set of custom machine design programs from Germany. The BG management team believed it was appropriate to institute a common custom machine design system across all factories. The BG strategy was based on porting the German programs onto a UNIX workstation platform and then distributing and supporting it worldwide. When the announcement was made that the German programs would be used, however, none of the programs would work with UNIX. Nor did the German developers possess more than a few years of total experience in the UNIX environment.

A New Marketing and Negotiation System

Browning learned that marketing and engineering saw the existing negotiation program as inefficient and ineffective. Two years of studying how the IMT division should do business with its customers led the marketing group to propose a reengineered "front-end information" system. The proposed system would include capabilities to optically scan in all customer proposals, including text. Customer specs could then be analyzed and processed more quickly.

The proposed system had an initial price tag of over $2.5 million. The original idea for the system was conceived in the marketing department, which employed two staff engineers and had hired an independent outside consultant as its own IS expert. Only recently had MIS been involved with planning the system. The project was being led by the division strategic planning manager, which isolated the project from division MIS and engineering input. Hardware purchases were to begin in November 2002, and the system was to be completed and operational by the end of 2003.

CMCI's Interface to Field Sales

Browning discovered that IMT's field sales group had itself been planning to implement a new customer relationship management (CRM) application using a service called Salesforce.com. Russ Nelson, Vice President of Sales, noted that this Web-based service could be put in place with no capital investment. This new CRM system would have to be enhanced for transferring order information to the factories. The new system to transfer order information to the factories, called SPEC, was planned to come online in late 2003. By mid-2003, each factory was to have installed high-speed access to the Internet to use Salesforce.com. They would need to develop system connectivity to accommodate the data downloaded from field sales personnel.

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As of September 2002, SPEC had been plagued with delays because staff could not arrive at a consensus on the exact information that should be transmitted to each of the factories and the creation of the necessary system interfaces.

New Software Design Tools

After asking some questions in the controller's office, Browning found that payments from Fort Wayne and Chicago accounted for 25 percent of the funds used for the BG's R&D development budget. CMCI's MIS group felt that about 30 percent of its investment was received back in the form of useful information technologies while the remaining 70 percent benefited production hardware improvements. The BG was definitely committed to additional investments in UNIX application tools. Various software engineering and applications development tools had been mentioned, but the specific software and the number of seats that would be leased or purchased had not been finalized as of the end of September 2002.

Bill of Material (BOM) System Replacement

The production scheduling people told Browning that the DBOMP system was nearly 15 years old and could not handle the new German-developed design system that was to replace the three older systems. To support the new design system and its subsequent BOM structure, a new BOM system would be required. Fort Wayne systems staff had identified a system that would run on the IBM mainframe and could be acquired at no cost. The program, called PUFR, was free because it was in the process of being discarded by IMT-USA's corporate MIS group. The only requirement was that Fort Wayne MIS staff had to support PUFR.

By September 2002, over 4,000 staff hours had been consumed by Fort Wayne MIS personnel trying to make PUFR operational. Projections suggested that approximately 10 percent more work had to be done in order to get PUFR into a test mode. To get this far, the Fort Wayne MIS group had already purchased additional modules that were not originally included in the free IMT corporate version of PUFR. The effort had also included converting some of the approximately 400 auxiliary programs that used the old DBOMP format. Occasional discussions of replacing PUFR "in a few years" were heard in the halls.

Browning's Meeting with Page

In an October 2002 meeting with Page, Browning summarized the findings of his six-week investigation as follows:

"The best way to characterize the current information systems situation at Fort Wayne is as a lot of manual points where data are transferred between a patchwork of old, semiautomatic, and outdated processes. The result is that since each place where information is transferred has a probability of introducing a new error, checking and rechecking is necessary to ensure integrity. And since the outdated processes require constant fixes and work-arounds, the newer processes never move ahead. What we really need is a clear vision to guide our decisions today, so we can be ready for tomorrow."

"I was afraid of that, Charlie. So do we have any options?" asked Page.

"We do," replied Browning. "But first we really need to develop a vision, architecture, and strategy statement for all information systems consistent with our business objectives. I see three options for the basic information technology architecture."

"Let me hear the first one," replied Page.

"OK," said Browning. "The first option is to move toward a centralized, likely IBM, computing environment. Under this option, we would commit to staying with the mainframe for all important applications, discourage the use of the Sun and IBM workstations, maybe allow the use of Linux on the mainframe, and eliminate the AS/400. IBM replaced the AS/400 with the eServer iSeries the year after we acquired our system. This new platform would not only run our current operating system, OS/400, it can also run AIX (IBM's version of UNIX) and Linux. This approach would maximize the use of the lower cost, energy-efficient mainframe.

"Our commitment to the mainframe would have to be long term. To continue to maintain a large central mainframe and acquire new applications and full access for all users would require a systematic plan. The plan would include porting all the major AS/400 applications to the eServer iSeries mainframe in order to assure central usage, support, and control. Major mainframe packages would be reviewed for upgrades that could handle Fort Wayne's current capacity and requirements. Older packages used in Fort Wayne would be phased out over the next 5 years. PCs connected through LANs to the mainframe would do spreadsheet and word processing work, but almost all computational work would be done on the mainframe."

"OK," remarked Page. "I can see that as feasible even though a lot of people would be upset. Our engineers have become accustomed to using the Sun and IBM workstations whenever they want to. What is option two?"

"I call option two workstation computing," said Browning. "Here we would follow a strategy whereby the mainframe is phased out completely over time. At the same time, we would make significant investments in Sun and IBM workstations running UNIX, as well as PCs, big UNIX servers, and LANs. We could allow the use of Linux

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on the workstations. Such an architecture would allow migration to a full client/server environment.

"Our plans for a long-term shift to a distributed UNIX environment would include the migration of all applications to the new environment. A high-speed network would be installed to link all computers. Data and application servers would be distributed by functional area and profit centers (e.g., marketing, development engineering, human resources, and testing). CAD seats would be slowly transferred from the mainframe to dedicated workstations. During the transition period, the mainframe would be connected to the network and available for access from all workstations.

"One relational database server cluster would serve the entire UNIX network system, but local databases could also exist as necessary. PCs would be linked via LANs, and a wide area network (WAN) would be installed to bridge between networks.

"As CAD and other major applications were shifted off the mainframe, it would be downsized to a smaller, compatible midrange mainframe. The process could be expected to take approximately 10 years and two mainframe downgrades before all of Fort Wayne's applications would be migrated to UNIX workstations."

"All right," said Page, "but wouldn't this one be a lot more expensive and create a kind of 'disintegrated' computing environment? I have heard of other companies going this route only to have to reassert central control in a few years."

"It sure has that potential," said Browning. "And you are right—it will likely be more expensive than the mainframe option, given what has happened to the cost of mainframes over the last several years.

"Before you evaluate each option, let me explain option three. This one is even more risky. We would outsource the management of our servers to a data center hosting company that would set up and manage 'virtual machines' for us. We can operate as if we have a virtually unlimited number of servers. We would eliminate any need for additional computer hardware investment and just pay for what we need on a monthly basis.[1]

"In this option, we would pursue a course of abandoning the mainframe, but converting the complete computing platform to a Linux-powered environment. Linux is similar to UNIX as an operating system, but even more flexible. Linux-based solutions are offered by companies such as Red Hat, Corel, IBM, and HP. In the past few years, several large companies have adopted this environment for their computing needs.

"Given the diversity of our needs across the company, the Linux solution could also provide more than adequate flexibility. Utilizing services provided by a recognized supplier like IBM, specialty Linux companies, or the in-house programming staff, Linux solutions could be used for anything from tracking quality control to managing machines and monitoring production. Furthermore, some data center hosting companies employing Linux-based servers have a guaranteed 99.7 percent or higher uptime. I read that Linux had been useful for automobile simulations at DaimlerChrysler and Ford. In addition, the platform's durability has been proven at Amerada Hess and other oil companies through their exploration activities. Nevertheless, this is a major leap from IMT's current conservative environment. Someone else would be running our central computers."

"I guess," replied Page. "But at least we ought to consider it. Any more options?"

"Just one, to be complete," replied Browning. "We could consider just waiting and watching carefully. This option says do nothing fundamental at the present time. We wait and see what develops. We would decide on specific system changes only as circumstances force us to make decisions. Following the 'watch carefully' option would mean that each decision would be made in response to immediate demands. As part of this approach, we could bring in Linux and let some people experiment with it. If Linux is the wave of the future as some people claim, maybe the best idea is to not make a commitment now. It is not clear that Linux is ready for prime time. But a few years of experimenting could determine if it really is a long-term solution for the company."

A Decision and Direction for IMT IS

"OK," said Page. "Having the options is very helpful. I appreciate all the time you put into the project. Let me think about the options and make a decision."

After Browning left the office, Page began to reflect on the options he had presented. Change was going to be painful. Although Browning had captured the basic strategy alternatives, there were many considerations to take into account before a decision could be reached on which option to follow. Years of neglect, restructuring, and a growing organization had finally caught up with CMCI's information systems. Page also recognized that changes in the division's IS architecture might require organizational changes as well. A decision had to be made soon. Or did it? Now the only question was, what to do?

[1]A few years after 2002, this concept came to be called "cloud computing"—actually one of several ways of utilizing cloud computing.