# Technological Evolution

## *Case II–4*
## *EMI and the CT Scanner (A)*

*Christopher A. Bartlett*

In early 1972 there was considerable disagreement among top management at EMI Ltd., the U.K.-based music, electronics, and leisure company. The subject of the controversy was the CT scanner, a new medical diagnostic imaging device that had been developed by the group's Central Research Laboratory (CRL). At issue was the decision to enter this new business, thereby launching a diversification move that many felt was necessary if the company was to continue to prosper.

Complicating the problem was the fact that this revolutionary new product would not only take EMI into the fast-changing and highly competitive medical equipment business, but would also require the company to establish operations in North America, a market in which it had no prior experience. In March 1972 EMI's board was considering an investment proposal for £6 million to build CT scanner manufacturing facilities in the United Kingdom.

## Development of the CT Scanner

### Company Background and History

EMI Ltd. traces its origins back to 1898, when the Gramophone Company was founded to import records and gramophones from the United States. It soon established its own manufacturing and recording capabilities, and after a 1931 merger with its major rival, the Columbia Gramophone Company, emerged as the Electric and Musical Industries, Ltd. EMI Ltd. quickly earned a reputation as an aggressive technological innovator, developing the automatic record changer, stereophonic records, magnetic recording tape, and the pioneer commercial television system adopted by the BBC in 1937.

Beginning in 1939, EMI's R&D capabilities were redirected by the war effort toward the development of fuses, airborne radar, and other sophisticated electronic devices.

The company emerged from the war with an electronics business, largely geared to defense-related products, as well as its traditional entertainment businesses. The transition to peacetime was particularly difficult for the electronics division, and its poor performance led to attempts to pursue new industrial and consumer applications. EMI did some exciting pioneering work, and for a while held hopes of being Britain's leading computer company.

Market leadership in major electronics applications remained elusive, however, while the music business boomed. The 1955 acquisition of Capitol Records in the United States, and the subsequent success of the Beatles and other recording groups under contract to EMI, put the company in a very strong financial position as it entered the 1970s. In 1970 the company had earned £21 million before tax on sales of £215 million, and although extraordinary losses halved those profits in 1971, the company was optimistic for a return to previous profit levels in 1972 (see Exhibit 1).

Around that time, a change in top management signaled a change in corporate strategy. John Read, an accountant by training and previously sales director for Ford of Great Britain, was appointed chief executive officer after only four years in the company. Read recognized the risky, even fickle, nature of the music business, which accounted for two-thirds of EMI's sales and profits. In an effort to change the company's strategic balance, he began to divert some of its substantial cash flow into numerous acquisitions and internal developments.

To encourage internal innovation, Read established a research fund that was to be used to finance innovative developments outside the company's immediate interests. Among the first projects financed was one proposed by Godfrey Hounsfield, a research scientist in EMI's Central Research Laboratories (CRL). Hounsfield's proposal opened up an



Harvard Business School case 383–194.

**EXHIBIT 1** **EMI Limited: Profit and Loss Statement, 1969–1971 (£ in thousands)**

| Years Ended June 30 | 1969 | 1970 | 1971 |
|---|---|---|---|
| **Sales** | | | |
| Music | £110,554 | £129,439 | £128,359 |
| Leisure | 20,960 | 32,651 | 35,798 |
| Television | 4,640 | 10,625 | 13,593 |
| Electronics | 40,170 | 42,571 | 52,819 |
| Total | 176,324 | 215,286 | 230,569 |
| **Profit (loss) before Interest and Taxation** | | | |
| Music | 13,293 | 16,427 | 1,970 |
| Leisure | 1,691 | 3,875 | 4,146 |
| Television | 733 | 992 | 3,833 |
| Electronics | 3,741 | 3,283 | 3,090 |
| Subtotal | 19,458 | 24,577 | 13,039 |
| Property | — | (20) | 939 |
| Total | 19,458 | 24,557 | 13,978 |
| **Sales** | | | |
| United Kingdom | 63,144 | 89,069 | 103,824 |
| Europe | 25,987 | 27,017 | 39,673 |
| North America | 65,528 | 74,622 | 58,989 |
| Other countries | 21,665 | 24,578 | 28,083 |
| Total | 176,324 | 215,286 | 230,569 |
| **Profit (loss) before Interest and Taxation** | | | |
| United Kingdom | 8,301 | 10,465 | 13,113 |
| Europe | 3,176 | 3,230 | 3,113 |
| North America | 5,525 | 7,627 | (5,754) |
| Other countries | 2,456 | 3,235 | 3,506 |
| Subtotal | 19,458 | 24,557 | 13,978 |
| Net interest payable | (1,857) | (3,599) | (5,010) |
| Total | £17,601 | £20,958 | £8,968 |
| As a percentage of net assets | 15.8% | 17.3% | 7.4% |
| **Taxation** | £8,407 | £10,443 | £3,541 |
| As a percentage of profit | 47.8% | 49.8% | 39.5% |
| **Profit after Taxation** | £9,194 | £10,515 | £5,427 |
| As a percentage of net assets | 8.3% | 8.7% | 4.5% |

opportunity for the company to diversify in the fast-growing medical electronics field.

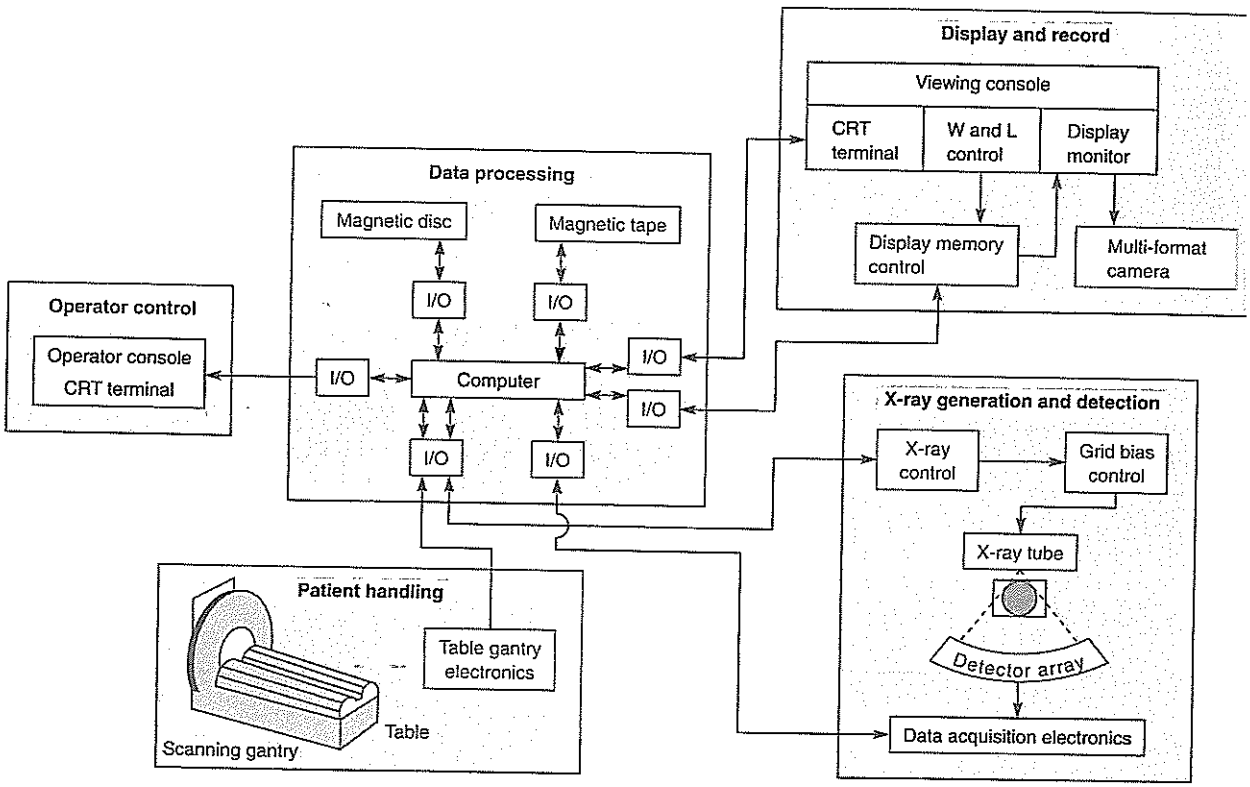
## CT Scanning: The Concept

In simple terms, Hounsfield's research proposal was to study the possibility of creating a three-dimensional image of an object by taking multiple X-ray measurements of the object from different angles, then using a computer to reconstruct a picture from the data contained in hundreds of overlapping and intersecting X-ray slices. The concept became known as computerized tomography (CT).[1]

Although computerized tomography represented a conceptual breakthrough, the technologies it harnessed were quite well known and understood. Essentially, it linked X-ray, data processing, and

[1]Sometimes called CAT scanning, for computerized axial tomography.

**EXHIBIT 2** Schematic Drawing of Scanner System

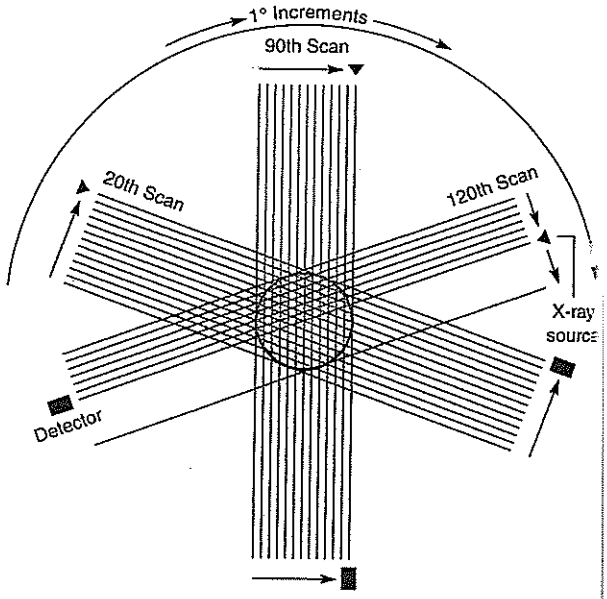



cathode ray tube display technologies in a complex and precise manner. The real development challenge consisted of integrating the mechanical, electronic, and radiographic components into an accurate, reliable, and sensitive system. Exhibit 2 provides a schematic representation of the EMI scanner, illustrating the linkage of the three technologies, as well as the patient handling table and X-ray gantry.

Progress was rapid, and clinical trials of the CT scanner were under way by late 1970. To capture the image of multiple slices of the brain, the scanner went through a translate-rotate sequence, as illustrated in Exhibit 3. The X-ray source and detector, located on opposite sides of the patient's head, were mounted on a gantry. After each scan, or "translation," had generated an X-ray image comprising 160 data points, the gantry would rotate 1° and another scan would be made.

This procedure would continue through 180 translations and rotations, storing a total of almost 30,000 data points. Since the detected intensity of

**EXHIBIT 3** Translate-Rotate CT Scanning



an X-ray varies with the material through which it passes, the data could be reconstructed by the computer into a three-dimensional image of the object that distinguishes bone, tissue, water, fat, and so on.

At about the time of the CT clinical trials, Dr. John Powell, formerly managing director of Texas Instruments' English subsidiary, joined EMI as technical director. He soon became convinced that the poor profitability of the nonmilitary electronics business was due to the diffusion of the company's 2,500-person R&D capability over too many diverse small-volume lines. In his words, "EMI was devoted to too many products and dedicated to too few."

Because the CT scanner project built on the company's substantial and well-established electronics capability, Powell believed it gave EMI an important opportunity to enter an exciting new field. He felt that this was exactly the type of effort in which the company should be prepared to invest several million pounds.

## Diagnostic Imaging Industry

During the first half of this century, diagnostic information about internal organs and functions was provided almost exclusively by conventional X-ray examination, but in the 1960s and 1970s, several new imaging techniques emerged. When the CT scanner was announced, three other important technologies existed: X-ray, nuclear, and ultrasound.

EMI management believed its CT scanner would displace existing diagnostic imaging equipment in only a few applications, specifically head and brain imaging.

### X-ray

In 1895 Wilhelm Roentgen discovered that rays generated by a cathode ray tube could penetrate solid objects and create an image on film. Over the next 40 to 50 years, X-ray equipment was installed in almost every health care facility in the world. Despite its several limitations (primarily due to the fact that detail was obscured when three-dimensional features were superimposed on a two-dimensional image), X-rays were universally used. In 1966 a Surgeon General's report estimated that between one-third and one-half of all crucial medical decisions in the United States depended on interpretation of X-ray films. That country alone had more than 80,000 X-ray installations in operation, performing almost 150 million procedures in 1970.

The X-ray market was dominated by five major global companies. Siemens of West Germany was estimated to have 22 percent of the world market, N.V. Philips of the Netherlands had 18 percent, and Compagnie Generale de Radiologie (CGE), subsidiary of the French giant Thomson Brandt, held 16 percent. Although General Electric had an estimated 30 percent of the large U.S. market, its weak position abroad gave it only 15 percent of the world market. The fifth largest company was Picker, with 20 percent of the U.S. market, but less than 12 percent worldwide.

The size of the U.S. market for X-ray equipment was estimated at $350 million in 1972, with an additional $350 million in X-ray supplies. The United States was thought to represent 35–40 percent of the world market. Despite the maturity of the product, the X-ray market was growing by almost 10 percent annually in dollar terms during the early 1970s.

A conventional X-ray system represented a major capital expenditure for a hospital, with the average system costing more than $100,000 in 1973.

### Nuclear Imaging

In the mid-1960s a nuclear diagnostic imaging procedure was developed. Radioisotopes with a short radioactive life were projected into the body, detected and monitored on a screen, then recorded on film or stored on a tape. Still in an early stage of development, this technology was used to complement or, in some instances, replace a conventional X-ray diagnosis. Both static and dynamic images could be obtained.

Following the pioneering development of this field by Nuclear-Chicago, which sold the first nuclear gamma camera in 1962, several other small competitors had entered the field, notably Ohio Nuclear. By the late 1960s larger companies such as Picker were getting involved, and in 1971 GE's Medical Systems Division announced plans to enter the nuclear medicine field.

As new competitors, large and small, entered the market, competition became more aggressive. The average nuclear camera and data processing system sold for about $75,000. By 1973, shipments of nuclear imaging equipment into the U.S. market were estimated to be over $50 million.

### *Ultrasound*

Ultrasound has been used in medical diagnosis since the 1950s, and the technology advanced significantly in the early 1970s, permitting better-defined images. The technique involves transmitting sonic waves and picking up the echoes, which when converted to electric energy could create images. Air and bone often provide an acoustic barrier, limiting the use of this technique. But because the patient was not exposed to radiation, it was widely used as a diagnostic tool in obstetrics and gynecology.

In 1973 the ultrasound market was very small, and only a few small companies were reported in the field. Picker, however, was rumored to be doing research in the area. The cost of the equipment was expected to be less than half that of a nuclear camera and support system, and perhaps a third to a quarter that of an X-ray machine.

## U.S. Market Potential

Because of its size, sophistication, progressiveness, and access to funds, the U.S. medical market clearly represented the major opportunity for a new device such as the CT scanner. EMI management was uncertain about the sales potential for their new product, however.

As of 1972, there were around 7,000 hospitals in the United States, ranging from tiny rural hospitals with fewer than 10 beds to giant teaching institutions with 1,000 beds or more.

| Size (number of beds) | Number of Hospitals | | |
|---|---|---|---|
| | Short-Term | Long-Term (chronic) | Total |
| Less than 100 | 3,110 | 375 | 3,485 |
| 100–299 | 1,904 | 385 | 2,289 |
| 300–499 | 574 | 141 | 715 |
| More than 500 | 537 | 91 | 628 |
| Total | 6,125 | 992 | 7,117 |

Since the price of the EMI Scanner was expected to be around $400,000, only the largest and financially strongest short-term institutions would be able to afford one. But the company was encouraged by the enthusiasm of the physicians who had seen and worked with the scanner. In the opinion of one leading American neurologist, at least 170 machines would be required by major U.S. hospitals. Indeed, he speculated, the time might come when a neurologist would feel ethically compelled to order a CT scan before making a diagnosis.

During the 1960s the radiology departments in many hospitals were recognized as important money-making operations. Increasingly, radiologists were able to commission equipment manufacturers to build specially designed (often esoteric) X-ray systems and applications. As their budgets expanded, the size of the U.S. X-ray market grew from $50 million in 1958 to $350 million in 1972.

Of the 15,000 radiologists in the United States, 60 percent were primarily based in offices and 40 percent in hospitals. Little penetration of private clinics was foreseen for the CT scanner. Apart from these broad statistics, EMI had little ability to forecast the potential of the U.S. market for scanners.

## EMI's Investment Decision

### Conflicting Management Views

By late 1971 it was clear that the clinical trials were successful and EMI management had to decide whether to make the investment required to develop the CT scanner business. One group of senior managers felt that direct EMI participation was undesirable for three reasons. First, EMI lacked medical product experience. In the early 1970s EMI offered only two very small medical products, a patient-monitoring device and an infrared thermography device, which together represented less than 0.5 percent of the company's sales.

Second, they argued that the manufacturing process would be quite different from EMI's experience. Most of its electronics work had been in the job shop mode required in producing small numbers of highly specialized defense products on cost-plus government contracts. In scanner production, most of the components were purchased from subcontractors and had to be integrated into a functioning system.

Finally, many believed that without a working knowledge of the North American market, where most of the demand for scanners was expected to be, EMI might find it very difficult to build an effective operation from scratch.

Among the strongest opponents of EMI's self-development of this new business was one of the scanner's earliest sponsors, Dr. Broadway, head of the Central Research Laboratory. He emphasized that EMI's potential competitors in the field had considerably greater technical capabilities and resources.

As the major proponent, John Powell needed convincing market information to counter the critics. In early 1972 he asked some of the senior managers how many scanners they thought the company would sell in its first 12 months. Their first estimate was five. Powell told them to think again. They came back with a figure of 12, and were again sent back to reconsider. Finally, with an estimate of 50, Powell felt he could go to bat for the £6 million investment, since at this sales level he could project handsome profits from year one. He then prepared an argument that justified the scanner's fit with EMI's overall objectives, and outlined a basic strategy for the business.

Powell argued that self-development of the CT scanner represented just the sort of vehicle EMI had been seeking to provide some focus to its development effort. By definition, diversification away from existing product-market areas would move the company into somewhat unfamiliar territory, but he firmly believed that the financial and strategic payoffs would be huge. The product offered access to global markets and an entry into the lucrative medical equipment field. He felt the company's objective should be "to achieve a substantial share of the world medical electronics business not only in diagnostic imaging, but also through the extension of its technologies into computerized patient planning and radiation therapy."

Powell claimed that the expertise developed by Hounsfield and his team, coupled with protection from patents, would give EMI three or four years, and maybe many more, to establish a solid market position. He argued that investments should be made quickly and boldly to maximize the market share of the EMI scanner before competitors entered. Other options, such as licensing, would impede the development of the scanner. If the licensees were the major X-ray equipment suppliers, they might not promote the scanner aggressively since it would cannibalize their sales of X-ray equipment and consumables. Smaller companies would lack EMI's sense of commitment and urgency. Besides, licensing would not provide EMI with the major strategic diversification it was seeking. It would be, in Powell's words, "selling our birthright."

### The Proposed Strategy

Because the CT scanner incorporated a complex integration of some technologies in which EMI had only limited expertise, Powell proposed that the manufacturing strategy should rely heavily on outside sources of those components rather than trying to develop the expertise internally. This approach would not only minimize risk, but would also make it possible to implement a manufacturing program rapidly.

He proposed the concept of developing various "centers of excellence" both inside and outside the company, making each responsible for the continued superiority of the subsystem it manufactured. For example, within the EMI U.K. organization a unit called SE Labs, which manufactured instruments and displays, would become the center of excellence for the scanner's viewing console and display control. Pantak, an EMI unit with a capability in X-ray tube assembly, would become the center of excellence for X-ray generation and detection subsystem. An outside vendor with which the company had worked in developing the scanner would be the center of excellence for data processing. Finally, a newly created division would be responsible for coordinating these subsystem manufacturers, integrating the various components, and assembling the final scanner at a company facility in the town of Hayes, not far from the CRL site.

Powell emphasized that the low initial investment was possible because most of the components and subsystems were purchased from contractors and vendors. Even internal centers of excellence such as SE Labs and Pantak assembled their subsystems from purchased components. Overall, outside vendors accounted for 75–80 percent of the scanner's manufacturing cost. Although Powell felt his arrangement greatly reduced EMI's risk, the £6 million investment was a substantial one for the company, representing about half the funds available for capital investment over the coming year. (See Exhibit 4 for a balance sheet and Exhibit 5 for a projected funds flow.)

The technology strategy was to keep CRL as the company's center of excellence for design and software expertise, and to use the substantial profits Powell was projecting from even the earliest sales to maintain technological leadership position.

**EXHIBIT 4 EMI Group Consolidated Balance Sheet, 1972 (£ thousands)**

| | | |
|---|---|---|
| **Employment of Capital** | | |
| Goodwill | | 80,814 |
| Fixed assets | | 104,174 |
| Other investments | | 14,354 |
| Current assets: | | |
| Inventories | 45,508 | |
| Films, programs, and rights | 7,712 | |
| Accounts receivable | 82,483 | |
| Liquid funds | 20,086 | |
| | 155,789 | |
| Less: | | |
| Current liabilities: | | |
| Accounts payable | 96,942 | |
| Bank borrowings | 14,168 | |
| Taxes payable | 17,174 | |
| Dividends declared | 4,202 | |
| | 132,486 | |
| Net current assets | | 23,303 |
| Total | | 222,645 |
| **Capital Employed** | | |
| Share capital | | 40,937 |
| Reserves | | 90,239 |
| Minority shareholders' interests | | 14,992 |
| Loan capital | | 76,011 |
| Deferred taxes | | 466 |
| Total | | 222,645 |

**EXHIBIT 5 EMI Group Projected Funds Flow, 1972 (£ thousands)**

| | |
|---|---|
| **Sources of Funds** | |
| Profit before tax | 18.3 |
| Depreciation | 6.7 |
| Sale of fixed assets | 5.5 |
| Sale of investments | 5.4 |
| Loan capital | 0.3 |
| Decrease in working capital | 4.5 |
| Total | 40.7 |
| **Uses of Funds** | |
| Tax payments | 5.9 |
| Dividends paid | 5.6 |
| Fixed asset additions | 13.0 |
| Repayment of loan capital | 3.4 |
| Reduction in short-term borrowings | 12.8 |
| Total | 40.7 |

Powell would personally head up a team to develop a marketing strategy. Clearly, the United States had to be the main focus of EMI's marketing activity. Its neuroradiologists were regarded as world leaders and tended to welcome technological innovation. Furthermore, its institutions were more commercial in their outlook than those in other countries and tended to have more available funds. Powell planned to set up a U.S. sales subsidiary as soon as possible, recruiting sales and service personnel familiar with the North American health care market. Given the interest shown to date in the EMI scanner, he did not think there would be much difficulty in gaining the attention and interest of the medical community. Getting the $400,000 orders, however, would be more of a challenge. In simple terms, Powell's sales strategy was to get machines into a few prestigious reference hospitals, then build from that base.

## The Decision

In March 1972 EMI's chief executive, John Read, considered Powell's proposal in preparation for a board meeting. Was this the diversification oppor-

...e had been hoping for? What were the ...Could they be managed? How? If he decided ...the proposal, what kind of an implementa... program would be necessary to ensure its ...d success?

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## *EMI and the CT Scanner (B)*

*Christopher A. Bartlett*

...ned as if 1977 would be a very good year for ...Medical Inc., a North American subsidiary of ...d. EMI's CT scanner had met with enormous ...ss in the American market. In the three years ...the scanner's introduction, EMI medical elec... sales had grown to £42 million. Although this ...re represented only 6 percent of total sales, the ...business contributed pretax profits of £12.5 mil... almost 20 percent of the corporate total (see ...bit 6). EMI Medical Inc. was thought to have ...most three-quarters of all scanners world... And with an order backlog of more than 300 ..., the future looked rosy.

Despite this formidable success, senior manage...ent in both the subsidiary and the parent company ...re concerned about several developments. First, ... fast-growth field had attracted more than a ...n new entrants in the past two years, and tech... gical advances were occurring rapidly. Second, ... growing political debate over hospital cost con...ment often focused on $500,000 CT scanners as ... example of questionable hospital spending. ...ally, EMI was beginning to feel some internal ...anizational strains.

## Entry Decision

### Product Launch

...llowing months of debate within EMI's top man...gement, the decision to go ahead with the EMI scanner project was assured when John Read, the company CEO, gave his support to John Powell's proposal. In April 1972 a formal press announcement was greeted by a response that could only be described as overwhelming. EMI was flooded with inquiries from the medical and financial communities, and from most of the large diagnostic imaging companies, which wanted to license the technology, enter into joint ventures, or at least distribute the product. The response was that EMI had decided to enter the business directly itself.

Powell's manufacturing strategy was immediately put into operation. Manufacturing facilities were developed and supply contracts drawn up with the objective of beginning shipments within 12 months.

In May, Godfrey Hounsfield, the brilliant EMI scientist who had developed the scanner, was dispatched to the United States, accompanied by a leading English neurologist. The American specialists with whom they spoke confirmed that the scanner had great medical importance. Interest was running high in the medical community.

In December EMI mounted a display at the annual meeting of the Radiology Society of North America (RSNA). The exhibit was the highlight of the show, and boosted management's confidence enough that it decided to establish a U.S. sales company to penetrate the American medical market.

### U.S. Market Entry

In June 1973, with an impressive pile of sales leads and inquiries, a small sales office was established in Reston, Virginia, home of the newly appointed U.S. sales branch manager, Gus Pyber. Earlier that month the first North American head scanner had been installed at the prestigious Mayo Clinic, with a second machine promised to the Massachusetts General Hospital for trials. The new sales force had little difficulty getting into the offices of leading radiologists and neurologists.

By the end of the year, however, Pyber had been fired in a dispute over appropriate expense levels, and James Gallagher, a former marketing manager with a major drug company, was hired to replace him. One of Gallagher's first steps was to convince the company that the Chicago area was a superior location for the U.S. office. It allowed better servicing of a national market, was a major center for medical electronics companies, and had more convenient linkages with London. This last point was

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**EXHIBIT 6 EMI Limited: Profit and Loss Statement, 1969–1976 (£ thousands)**

| Years Ended June 30 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 |
|---|---|---|---|---|---|---|---|---|
| **Sales** | | | | | | | | |
| Music | £110,554 | £129,439 | £128,359 | £137,755 | £169,898 | £213,569 | £258,343 | £344,743 |
| Leisure | 20,960 | 32,651 | 35,798 | 37,917 | 45,226 | 53,591 | 66,566 | 81,428 |
| Television | 4,640 | 10,625 | 13,593 | 17,165 | 22,011 | 22,814 | 29,107 | 38,224 |
| Electronics (nonmedical) | 40,170 | 42,571 | 52,819 | 58,215 | 83,516 | 104,811 | 128,644 | 164,943 |
| Medical electronics | — | — | — | — | 321 | 5,076 | 20,406 | 42,104 |
| Total | 176,324 | 215,286 | 230,569 | 251,052 | 320,972 | 399,861 | 503,066 | 671,442 |
| **Profit (loss) before Interest and Taxation** | | | | | | | | |
| Music | 13,293 | 16,427 | 1,970 | 9,333 | 16,606 | 26,199 | 19,762 | 27,251 |
| Leisure | 1,691 | 3,875 | 4,146 | 4,983 | 4,255 | 2,639 | 5,981 | 5,619 |
| Television | 733 | 992 | 3,833 | 5,001 | 6,104 | 4,465 | 2,982 | 5,646 |
| Electronics (nonmedical) | 3,741 | 3,283 | 3,090 | 1,353 | 5,264 | 5,835 | 5,378 | 13,937 |
| Medical electronics | — | — | — | — | (67) | 1,242 | 9,230 | 12,502 |
| Subtotal | 19,458 | 24,577 | 13,039 | 20,670 | 32,162 | 40,380 | 43,333 | 64,955 |
| Property | — | (20) | 939 | 2,118 | 1,842 | 402 | (103) | — |
| Total | 19,458 | 24,557 | 13,978 | 22,788 | 34,004 | 40,782 | 43,230 | 64,955 |
| **Sales** | | | | | | | | |
| United Kingdom | 63,144 | 89,069 | 103,824 | 113,925 | 142,945 | 165,641 | 198,153 | 241,972 |
| Europe | 25,987 | 27,017 | 39,673 | 52,541 | 82,405 | 105,251 | 134,450 | 170,385 |
| North America | 65,528 | 74,622 | 58,989 | 53,151 | 55,143 | 67,141 | 78,154 | 128,798 |
| Other countries | 21,665 | 24,578 | 28,083 | 31,435 | 40,479 | 61,828 | 92,309 | 130,287 |
| Total | 176,324 | 215,286 | 230,569 | 251,052 | 320,972 | 399,861 | 503,066 | 671,442 |
| **Profit (loss) before Interest and Taxation** | | | | | | | | |
| United Kingdom | 8,301 | 10,465 | 13,113 | 15,447 | 19,287 | 16,784 | 16,494 | 21,802 |
| Europe | 3,176 | 3,230 | 3,113 | 3,133 | 6,133 | 9,043 | 9,679 | 14,521 |
| North America | 5,525 | 7,627 | (5,754) | 1,091 | 3,555 | 6,412 | 7,065 | 13,067 |
| Other countries | 2,456 | 3,235 | 3,506 | 3,117 | 5,029 | 8,543 | 9,992 | 15,565 |
| Subtotal | 19,458 | 24,557 | 13,978 | 22,788 | 34,004 | 40,782 | 43,230 | 64,955 |
| Net interest payable | (1,857) | (3,599) | (5,010) | (4,452) | (6,386) | (5,690) | (8,258) | (5,604) |
| Total | £17,601 | £20,958 | £8,968 | £18,336 | £27,618 | £35,092 | £34,972 | £59,351 |
| As a percentage of net assets | 15.8% | 17.3% | 7.4% | 14.4% | 18.9% | 22.8% | 21.2% | 31.2% |
| **Taxation** | £8,407 | £10,443 | £3,541 | £8,575 | £13,227 | £18,666 | £19,549 | £31,224 |
| As a percentage of profit | 47.8% | 49.8% | 39.5% | 46.8% | 47.9% | 53.2% | 55.9% | 52.6% |
| **Profit after Taxation** | £9,194 | £10,515 | £5,427 | £9,761 | £14,391 | £16,426 | £15,423 | £28,127 |
| As a percentage of net assets | 8.3% | 8.7% | 4.5% | 7.7% | 9.8% | 10.7% | 9.3% | 14.8% |

portant since all major strategic and policy decisions were being made directly by John Powell in London.

During 1974 Gallagher concentrated on recruiting and developing his three-person sales force and two-person service organization. The cost of maintaining each salesperson on the road was estimated at $50,000, while a service employee's salary and expenses at that time were around $35,000 annually. Scanners were being produced at a rate of only three or four machines a month, and Gallagher saw little point in developing a huge sales force to sell a product with limited supply and unlimited customer interest.

In this seller's market the company developed some policies that were new to the industry. Most notably, they required that the customer deposit one-third of the purchase price with the order to guarantee a place in the production schedule. Sales leads and inquiries were followed up when the sales force could get to them, and the general attitude of the company seemed to have a somewhat take-it-or-leave-it tone. It was in this period that EMI developed a reputation for arrogance in some parts of the medical profession.

Nonetheless, by June 1974 the company had delivered 35 scanners at $390,000 each and had another 60 orders in hand.

## Developing Challenges

### Competition

Toward the end of 1974, the first competitive scanners were announced. Unlike the EMI scanner, the new machines were designed to scan the body rather than the head. The Acta-Scanner had been developed at Georgetown University's Medical Center and was manufactured by a small Maryland company called Digital Information Sciences Corporation (DISCO). Technologically, it offered little advance over the EMI scanner except for one important feature. Its gantry design would accommodate a body rather than a head. Although specifications on scan time and image composition were identical to those of the EMI scanner, the $298,000 price tag gave the Acta-Scanner a big advantage, particularly with smaller hospitals and private practitioners.

The DeltaScan offered by Ohio Nuclear (ON) represented an even more formidable challenge. This head and body scanner had 256 × 256 pixels[1] compared with EMI's 160 × 160, and promised a 2½-minute scan rather than the 4½-minute scan offered by EMI. ON presented these superior features on a unit priced at $385,000—$5,000 below the EMI scanner.

Many managers at EMI were surprised by the speed with which these products had appeared, barely two years after the EMI scanner was exhibited at the RSNA meeting in Chicago and 18 months after the first machine was installed in the Mayo Clinic. The source of the challenge was also interesting. DISCO was a tiny private company, and ON contributed only 20 percent of its parent Technicare's 1974 sales of $50 million.

To some, the biggest surprise was how closely these competitive machines resembled EMI's own scanner. The complex wall of patents had not provided an enduring defense. ON tackled the issue directly in its 1975 annual report. After announcing that $882,200 had been spent in Technicare's R&D center to develop DeltaScan, the report stated:

> Patents have not played a significant role in the development of Ohio Nuclear's product line, and it is not believed that the validity or invalidity of any patents known to exist is material to its current market position. However, the technologies on which its products are based are sufficiently complex and application of patent law sufficiently indefinite that this belief is not free from all doubt.

The challenge represented by these new competitive products caused EMI to speed up the announcement of the body scanner Hounsfield had been working on. The new CT 5000 model incorporated a second-generation technology in which multiple beams of radiation were shot at multiple detectors, rather than the single pencil beam and the single detector of the original scanner (see Exhibit 7). This technique allowed the gantry to rotate 10° rather than 1° after each translation, cutting scan time from 4½ minutes to 20 seconds. In addition, the multiple-beam emission also permitted a finer image resolution by increasing the number of pixels from 160 × 160 to 320 × 320. Priced over $500,000, the CT 5000 received a standing ovation when Hounsfield demonstrated it at the radiological meetings held in Bermuda in May 1975.

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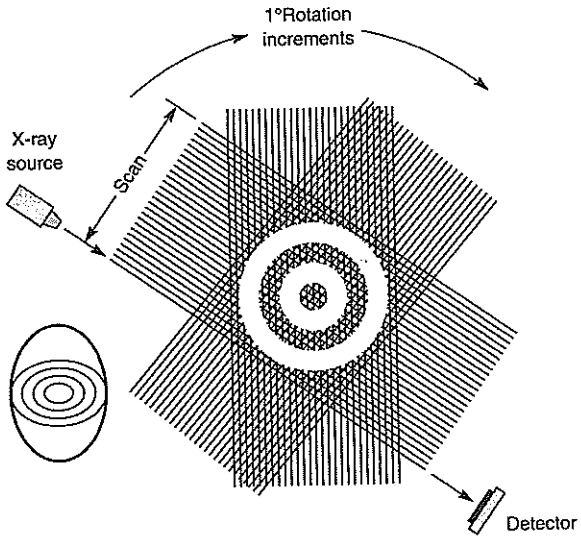
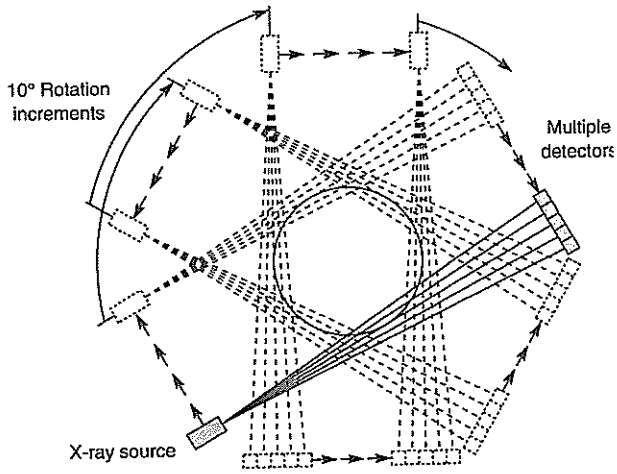
[1]Pixels were the picture element cells that made up the image. The more elements in the matrix of cells that composed the image, the greater the theoretical resolution.

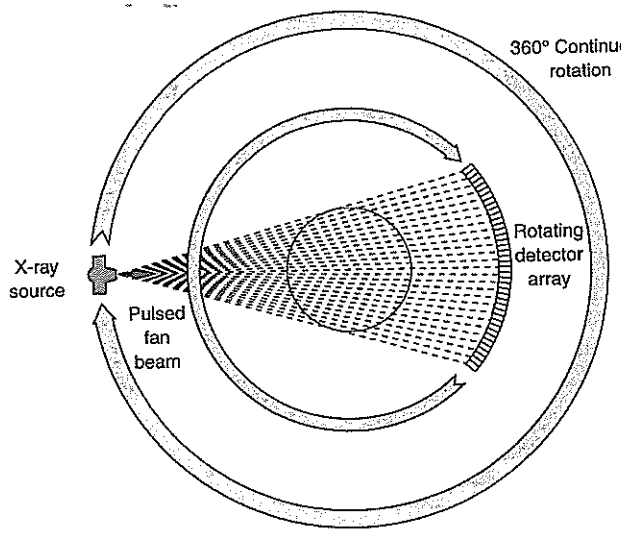
**EXHIBIT 7 Three Generations of CT Scanning Technology**




First generation CT scanning rectilinear pencil beam




Second generation CT scanning rectilinear multiple pencil beam and multiple detectors




Third generation CT scanning continuously rotating pulse fan X-ray beam

Despite EMI's reassertion of its leadership position, aggressive competitive activity continued. In March 1975, Pfizer Inc., the $1.5 billion drug giant, announced it had acquired the manufacturing and marketing rights for the Acta-Scanner.

By June 1975, managers at EMI estimated competitors' cumulative orders as follows:

| | Total Shipped | On Or |
|---|---|---|
| EMI | 122 | 110 |
| Ohio Nuclear | 2 | 50 (es |
| Pfizer | 0 | 20 (es |

EMI was then operating at an annual production rate of 150 units, and ON had announced plans to double capacity to 12 units per month by early 1976. Pfizer's capacity plans were unknown.

The most dramatic competitive revelation came at the annual RSNA meeting in December 1975, when six new competitors displayed CT scanners. Although none of the newcomers offered immediate delivery, all were booking orders with delivery dates up to 12 months out on the basis of their spec sheets and prototype or mock-up equipment exhibits.

Some of the new entrants (Syntex, Artronix, and Neuroscan) were smaller companies, but others (General Electric, Picker, and Varian) were major medical electronics competitors. Perhaps most impressive was a General Electric CT/T scanner, which took the infant technology into its third generation (see Exhibit 7). By using a 30°-wide pulsed fan X-ray beam, the GE scanner could avoid the time-consuming "translate-rotate" sequence of the first- and second-generation scanners. A single continuous 360° sweep could be completed in 4.8 seconds, and the resulting image was reconstructed by the computer in a 320 × 320 pixel matrix on a cathode ray tube. The unit was priced at $615,000. Clinical trials were scheduled for January, and shipment of production units was being quoted for mid-1976.

The arrival of GE on the horizon signaled the beginning of a new competitive game. With a 300-person sales force and a service network of 1,200, GE clearly had marketing muscle. The company had reputedly spent $15 million developing its third-generation scanner and was continuing to spend at a rate of $5 million annually to keep ahead technologically.

During 1975 one industry source estimated that about 150 new scanners were installed in the United States and more than twice as many orders were entered. (Orders were firm, since most were secured with hefty front-end deposits.) Overall, orders were split rather evenly between brain and body scanners. EMI was thought to have accounted for more than 50 percent of orders taken in 1975, ON for almost 30 percent.

### Market Size and Growth

Accurate assessments of market size, growth rate, and competitors' shares were difficult to obtain. The following represents a sample of the widely varying forecasts made in late 1975:

> Wall Street was clearly enamored with the industry prospects (Technicare's stock price rose from 5 to 22 in six months), and analysts were predicting an annual market potential of $500 million to $1 billion by 1980.[2]
>
> A market analysis by Frost and Sullivan, however, predicted a U.S. market of only $120 million by 1980, with 10 years of cumulative sales only reaching $1 billion by 1984 (2,500 units at $400,000).[3]
>
> Some leading radiologists suggested that CT scanners could be standard equipment in all short-term hospitals with 200 beds or more by 1985.
>
> Technicare's president, R. T. Grimm, forecast a worldwide market of over $700 million by 1980, of which $400 million would be in the United States.
>
> Despite the technical limitations of its first-generation product, Pfizer said it expected to sell more than 1,500 units of its Acta-Scanner over the next five years.

Within EMI, market forecasts had changed considerably. By late 1975 the estimate of the U.S. market had been boosted to 350 units a year, of which EMI hoped to retain a 50 percent share. Management was acutely aware of the difficulty of forecasting in such a turbulent environment, however.

### International Expansion

New competitors also challenged EMI's positions in markets outside the United States. Siemens, the $7 billion West German company, became ON's international distributor. The distribution agreement appeared to be one of short-term convenience for both parties, since Siemens acknowledged that it was developing its own CT scanner. Philips, too, had announced its intention to enter the field.

Internationally, EMI had maintained its basic strategy of going direct to the national market rather than working through local partners or distributors. Although all European sales had originally been handled out of the U.K. office, it quickly became evident that local servicing staffs were generally required. Soon separate subsidiaries were established in most continental European countries, typically with a couple of salespeople and three or four service personnel. Elsewhere in the world, salespeople were often attached to EMI's existing music organization in a particular country (e.g., in South Africa, Australia, and Latin America). In Japan, however, EMI signed a distribution agreement with Toshiba, which in Octo-

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[2]"Heard on the Street," *The Wall Street Journal,* November 21, 1975, p. 47.

[3]Frost and Sullivan, *Advanced Medical Imaging Equipment Market,* May 1975.

ber 1975 submitted the largest single order to date: a request for 33 scanners.

## EMI in 1976: Strategy and Challenges

By 1976 the CT scanner business was evolving rapidly, but EMI had done extremely well financially (see Exhibit 6). Although smaller competitors had challenged EMI somewhat earlier than might have been expected, none of the big diagnostic imaging companies had brought its scanner to market, even four years after the original EMI scanner announcement. Technology was evolving rapidly, but the expertise of Hounsfield and his CRL group and the aggressive reinvestment of much of the early profits in R&D had given EMI a strong technological position. And although market size and growth were highly uncertain, the potential was unquestionably much larger than EMI had forecast in its early plans. In all, EMI was well established, with a strong and growing sales volume and a good technical reputation. The company was undoubtedly the industry leader.

Nonetheless, the company would face a new set of strategic tasks in the years ahead.

### Strategic Priorities

EMI's first sales priority was to protect its highly visible and prestigious customer base from competitors. When its second-generation scanner was introduced in mid-1975, EMI promised to upgrade without charge the first-generation equipment already purchased by its established customers. Although each of these 120 upgrades was estimated to cost EMI $60,000 in components and installation costs, the U.S. sales organization felt that the expense was essential to maintain the confidence and good faith of this important core of customers.

To maintain its leadership image, the U.S. company also expanded its service organization substantially. Beginning in early 1976 new regional and district sales and service offices were opened, aiming to provide customers with the best service in the industry. A typical annual service contract cost the hospital $40,000 per scanner. At year's end the company boasted 20 service centers with 150 service engineers—a ratio that represented one service representative for every two or three machines installed. The sales force had grown to 20 and ha become much more attuned to the customer.

Another important task was to improve deliver performance. The interval between order an promised delivery had been lengthening; mean while, promised delivery dates were often misse By late 1975 a 6-month promise frequently converte into a 12- or 15-month actual delivery time. Fortu nately for EMI, all CT manufacturers were in back order and were offering extended delivery date However, EMI's poor performance in meetin promised dates was hurting its reputation. The com pany responded by substantially expanding its pro duction facilities. By mid-1976 there were si manufacturing locations in the United Kingdom, ye because of continuing problems with component suppliers, combined capacity for head and bod scanners was estimated at less than 20 units a mont

### Organizational and Personnel Issues

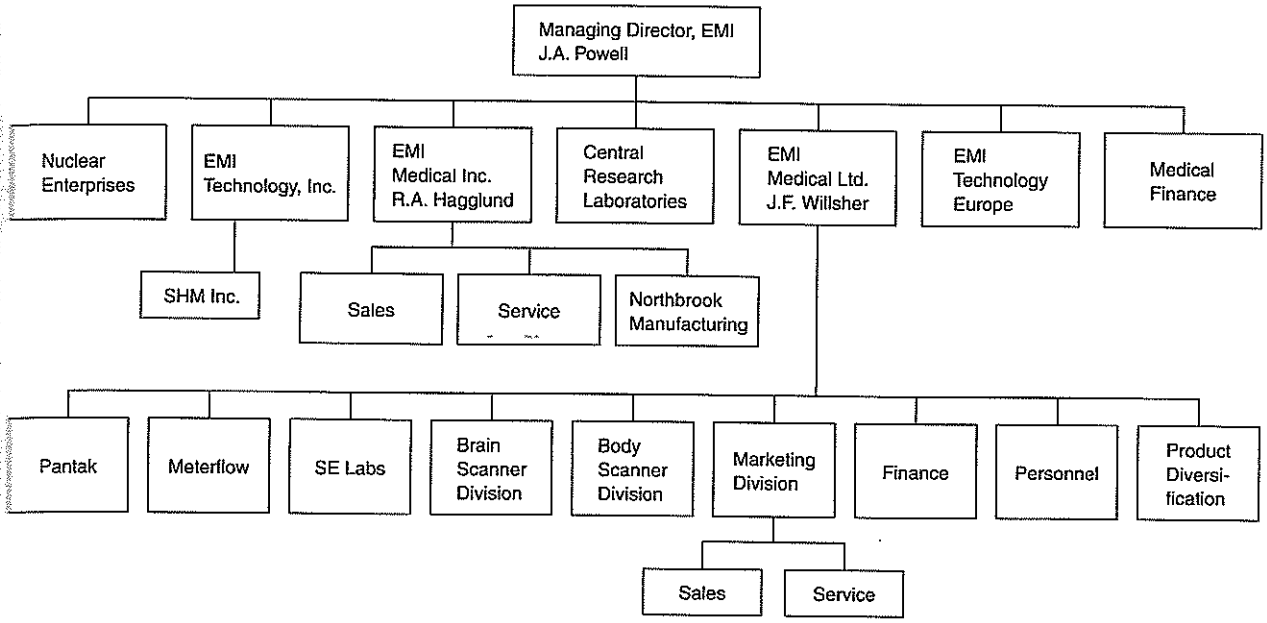
As the U.S. sales organization became increasingl frustrated, it began urging top management to mar ufacture scanners in North America. Believing tha the product had reached the necessary level o maturity, Powell judged that the time was ripe t establish a U.S. plant to handle at least final assem bly and test operations. A Northbrook, Illinois, sit was chosen.

Powell had become EMI's managing director an was more determined than ever to make the ne medical electronics business a success. A capabl manager was desperately needed to head the bus ness, particularly in view of the rapid development in the critical North American market. Consequentl Powell was delighted when Normand Provost, wh had been his boss at Texas Instruments, contacte him at the Bermuda radiological meeting in Marc 1975. He was hired with the hope that he coul build a stronger, more integrated U.S. company.

With the Northbrook plant scheduled to begi operations by mid-1976, Normand Provost bega hiring skilled production personnel. He also env sioned a Northbrook product development cente to allow EMI to draw on U.S. technical expertise an experience in solid-state electronics and data pro cessing. The company began seeking people wit strong technological and scientific backgrounds.

Having hired Provost, Powell made several impo tant organizational changes aimed at facilitating th medical electronics business's growth and develop ment. In the United Kingdom, he announced the cr

**EXHIBIT 8 EMI Medical Electronics Organization, 1976**




[a]Only the medical business responsibilities reporting to John Powell are shown. In addition, he had overall responsibility for EMI's other businesses (music, industrial electronics, etc.).

ation of a separate medical electronics group. The various operating companies—EMI Medical Ltd. (previously known as the X-Ray Systems Division), Pantak (EMI) Ltd., SE Labs (EMI) Ltd., and EMI Meterflow Ltd.—could now be grouped under a single executive, John Willsher (see Exhibit 8). At last, a more integrated scanner business seemed to be emerging organizationally.

The U.S. sales subsidiary was folded into a new company, EMI Medical Inc., but continued to operate as a separate entity. The intention was to develop this company as an integrated diversified medical electronics operation. Jim Gallagher, the general manager of the U.S. operations, was fired, and Bob Hagglund became president of EMI Medical Inc. Although Gallagher had been an effective salesman, Powell thought the company needed a more rounded general manager in its next phase of expansion. Hagglund, previously executive vice president of G. D. Searle's diagnostic business, seemed to have the broader background and outlook required to manage a larger integrated operation. He reported through Provost back to Powell in the United Kingdom.

Although Provost's initial assignment was to establish the new manufacturing and research facilities in the United States, it was widely assumed within EMI that he was being groomed to take responsibility for the company's medical electronics businesses worldwide. In April 1976, however, while visiting London to discuss progress, Provost died of a heart attack. As a result, the U.S. and U.K. organizations reported separately to Powell.

### Product Diversification

Since EMI wished to use the scanner as a means to become a major force in medical electronics, Powell argued that some bold external moves were needed to protect the company's leadership position. In March 1976 EMI acquired for $2 million (£1.1 million) SHM Nuclear Corporation, an innovative but somewhat shaky California-based company that had developed linear accelerators for cancer therapy

and computerized radiotherapy planning systems. Although the SHM product line needed substantial further development, the hope was that linking such systems to the CT scanner would permit a synchronized location and treatment of cancer.

Six months later EMI paid £6.5 million to acquire an additional 60 percent of Nuclear Enterprises Ltd., an Edinburgh-based supplier of ultrasound equipment. In the 1976 annual report, Sir John Read, now EMI's chairman, reaffirmed his support for Powell's strategy: "We have every reason to believe that this new grouping of scientific and technological resources will prove of national benefit in securing a growing share of worldwide markets for high-technology products."

## Future Prospects

At the close of 1976 EMI's medical electronics business was exceeding all expectations. In just three years sales of electronics products had risen from £84 million to £207 million; a large part of this increase was due to the scanner. Even more impressive, profits of the electronics line had risen from £5.2 million in 1972–1973 to £26.4 million in 1975–1976, jumping from 16 percent to 40 percent of the corporate total.

Rather than dwindling, interest in scanners seemed to be increasing. Although the company had sold around 450 scanners over the past three years (over 300 in the United States alone), its order backlog was estimated to be 300 units. At the December 1976 RSNA meeting, 120 of the 280 papers presented were related to CT scanning.

In reviewing the medical electronics business that he had built, Powell was generally pleased with how the company had met the challenges of pioneering a new industry segment. There were, however, several developments that promised to require considerable attention over the next few years. First, Powell felt that competitive activity would continue to present a challenge; second, some changes in the U.S. regulatory environment concerned him; and finally, he knew that the recent organization changes had created some strains.

### Competitive Problems

By the end of 1976, EMI had delivered 450 of the 650-odd scanners installed worldwide, yet its market share had dropped to 56 percent in 1975–1976 (198 of 352 scanners sold in that June-to-June period were EMI's). Despite its premium pricing strategy and its delivery problems, the company gained some consolation from conceding less than half the total market to the combined competitive field. Management also felt some sense of security in the 300 orders awaiting delivery. Nonetheless, Sir John Read expressed concern. "We are well aware of the developing competition," he noted. "Our research programme is being fully sustained to ensure our continued leadership."

In mid-1976 the company announced its intention "to protect its inventions and assert its patent strength," and subsequently filed suit against Ohio Nuclear claiming patent infringement. EMI, however, simultaneously issued a statement proclaiming that "it was the company's wish to make its pioneering scanner patents available to all under suitable licensing arrangements."

In December 1976 at the annual RSNA meeting, 16 competitors exhibited scanners. The year's new entrants (including CGR, the French X-ray giant; Hitachi from Japan; and G.D. Searle, the U.S. drug and hospital equipment company) were not yet making deliveries, however. The industry's potential production capacity was estimated to be over 900 units annually.

GE's much-publicized entry was already six months behind its announced delivery date, but rumors abounded that production shipments of GE's third-generation scanner were about to begin. EMI Medical Inc. anxiously awaited the event. (A summary of major competitors and their situations as of 1976 appears in Exhibit 9).

### Regulatory Problems

By mid-1976 indications suggested that the government might try to exert tighter control over hospital spending in general and purchase of CT scanners in particular.

The rapidly escalating cost of health care had been a political issue for years, and the National Health Planning and Resources Development Act of 1974 required states to control the development of costly or unnecessary health services through a procedure known as the Certificate of Need (CON). If they wished to qualify for Medicare or Medicaid reimbursements, health care facilities had to submit documentation to their state's department of health to justify major capital expenditures (typically over $100,000).

**EXHIBIT 9 Selected Competitive Data**

| Company | Product Line | Price ($000) | Delivery (months) | Company Strengths/Weaknesses |
|---|---|---|---|---|
| **EMI** | 2d generation<br>Head and body<br>20 sec. scan<br>Multiple models for various applications<br>320 × 320 pixels | $395 (head)<br>$550 (body)<br>20% deposit | 10 | Original innovator—some base in ultrasound<br>$10 million per annum in R&D<br>$1.2B sales: $85M in medical<br>Strong service base<br>Modular product line<br>Strong customer base |
| **Ohio Nuclear** | 2d generation<br>Head and body<br>20 sec. scan<br>256 × 256 pixels | $385 (head)<br>$525 (body)<br>20% deposit | 10 | Rapid follower<br>R&D increased to $8M–$10M per annum<br>Technicare sales $100M; scanners 50%<br>Had nuclear; acquired ultrasound co.<br>Strong marketing |
| **Pfizer** | 1st generation (announced 2d generation)<br>Head and body<br>30+ sec. scan | $295 (head)<br>$475 (body)<br>$25K deposit | 9 | Acquired technology—slow developing<br>Company sales $1.6B; scanners 2%<br>No other diagnostic imaging |
| **General Electric** | 3d generation<br>Head and body<br>3 sec. scan<br>320 × 320 pixels | $315 (head)<br>$595 (body)<br>$15K with order<br>$75K on mfg. start | 15 | Strong R&D capability<br>Leader in diagnostic imaging (X-ray, nuclear, entering ultrasound)<br>$16B sales: Medical Systems $400M<br>Very strong sales and service base |
| **Picker** | Hybrid 3d generation (announced)<br>Body only<br>20 sec. (est.)<br>Expected on market mid-1977 | $550 | 10–12 | Good design and development skills<br>Late entrant—but strong performance expected<br>Leader in X-ray, nuclear, and ultrasound<br>Strong marketing and service base<br>$300M sales |

Before 1976 the CON procedure had generally been a mere administrative impediment to the process of selling a scanner, delaying but not preventing the authorization of funds. By 1976, however, the cost of medical care represented 8 percent of the gross national product and Jimmy Carter made control of the "skyrocketing costs of health care" a major campaign issue. One of the most frequently cited examples of waste was the proliferation of CT scanners. It was argued that this $500,000 device had become a symbol of prestige and sophistication in the medical community so that every institution wanted its own scanner, even if a neighboring facility had one that was grossly underutilized.

Responding to heightened public awareness, five states declared a moratorium on the purchase of new scanners, including California, which had accounted for over 20 percent of total U.S. scanner placements to date. In November Jimmy Carter was elected president.

### Organizational Problems

Perhaps most troublesome to Powell were the organizational problems. Tensions within the EMI organization had been developing for some time, centering on the issues of manufacturing and product design. Managers in the U.S. company felt that they had little control over manufacturing schedules and little input into product design, even though they were responsible for 80 percent of corporate scanner sales. In their view, the company's market position was being eroded by the worsening manufacturing delivery performance from the United Kingdom, while its longer-term prospects were threatened by the competitive challenges to EMI's technological leadership.

Although the Northbrook plant had been completed in late 1976, U.S. managers were still not satisfied that they had the necessary control over production. Arguing that the quality of subassemblies and components shipped from the United Kingdom was deteriorating and delivery promises were becoming even more unreliable, they began investigating alternative supply sources in the United States.

U.K.-based manufacturing managers felt that much of the responsibility for backlogs lay with the product engineers and the sales organizations. Their unreliable sales forecasts and constantly changing design specifications had severely disrupted production schedules. The worst bottlenecks involved outside suppliers and subcontractors that were unable to gear up and down overnight. Complete systems could be held up for weeks or months awaiting one simple component.

As the Northbrook plant became increasingly independent, U.S. managers sensed that the U.K. plants felt less responsibility for them. In tight supply situations they felt there was a tendency to ship to European or other export customers first. Some U.S. managers also believed that components were increasingly shipped from U.K. plants without the rigid final checks they normally received. The assumption was that the U.S. plant could do its own quality control. The English group strongly denied both these assertions.

Nonetheless, Bob Hagglund soon began urging Powell to let EMI Medical Inc. become a more independent manufacturing operation rather than simply a final assembly plant for U.K. components. This prospect disturbed John Willsher, managing director of EMI Medical Ltd., who argued that dividing manufacturing operations could mean duplicating overhead and spreading existing expertise too thin. Others felt that the "bootleg development" of alternate supply sources showed a disrespect for the "center of excellence" concept and could easily compromise the ability of Pantak (X-ray technology) and SE Labs (displays) to remain at the forefront of technology.

Product development issues also created some organizational tension. The U.S. sales organization knew that GE's impressive new third-generation "fan beam" scanner would soon be ready for delivery, and found customers hesitant to commit to EMI's new CT 5005 until the GE product came out. For months telexes had been flowing from Northbrook to EMI's Central Research Laboratories asking if drastic reductions in scan time might be possible to meet the GE threat.

Meanwhile, scientists at CRL felt that U.S. CT competition was developing into a specifications war based on the wrong issue, scan time. Shorter elapsed times meant less image blurring, but in the trade-off between scan time and picture resolution, EMI engineers had preferred to concentrate on better-quality images. They felt that the 20-second scan offered by EMI scanners was practical since a patient could typically hold his or her breath that long while being diagnosed.

CRL staff were exploring some entirely new imaging concepts and hoped to have a completed new scanning technology ready to market in three or four

years. Although he was optimistic that it could provide a major breakthrough, Hounsfield could not guarantee that a commercially viable product would result from this research. He told Powell, however, that CRL had conducted experiments with the fan beam concept in the early 1970s, but had been unable to produce good-quality images. He argued that it was prohibitively costly to use sodium iodide detectors similar to those in existing scanners in the large numbers necessary to pick up a broad scan; to use other materials, such as xenon gas, would lead to quality and stability problems, in Hounsfield's view. Since GE and others offering third-generation equipment had not yet delivered commercial machines, he felt little incentive to redirect his staff to these areas that he had already researched and rejected.

There were many other demands on the time and attention of Hounsfield and his staff, all seemingly important for the company. They were in constant demand by technicians to deal with major problems that nobody else could solve. Salespeople wanted Hounsfield to talk to their largest and most prestigious customers, since such a visit often swung an important sale. Hounsfield and his staff also helped with internal training on all new products. The scientific community wanted them to present papers and give lectures. And increasingly Hounsfield found himself in a public relations role, accepting honors from all over the globe. EMI's reputation flourished and its image as the leader in the field was reinforced.

When it appeared that CRL was unwilling or unable to make the product changes the U.S. organization felt it needed, Hagglund made the bold proposal that the newly established research laboratories in Northbrook take responsibility for developing a three- to five-second scan, fan-beam-type scanner. Powell agreed to study the suggestion, but was finding it difficult to evaluate the relative merits of the U.S. subsidiary's views and the CRL scientists' opinions.

At year's end Powell had still been unable to find anybody to take charge of the worldwide medical electronics business. By default, the main decision-making forum became the Medical Group Review Committee (MGRC), a group of key line and staff managers that met, monthly at first, to help establish and review strategic decisions.

Among the issues discussed by this committee were the manufacturing and product development decisions that had produced tensions between the U.S. and U.K. managers. Powell had hoped that the MGRC would help build communications and consensus among his managers, but it soon became evident that this goal was unrealistic. In the words of one manager close to the events, "The problem was that there was no mutual respect between managers with similar responsibilities. Medical Ltd. was resentful of Medical Inc.'s push for greater independence, and were not going to go out of their way to help the Americans succeed."

As the business grew larger and more complex, Powell's ability to act as both corporate CEO and head of the worldwide medical business diminished. Increasingly, he was forced to rely on the MGRC to address operating problems as well as strategic issues. The coordination problem became so complex that by early 1977 there were four subcommittees of the MGRC, each with representatives of the U.S. and U.K. organizations, and each meeting monthly on one side of the Atlantic or the other. Committees included Manufacturing and Operations, Product Planning and Resources, Marketing and Sales Programs, and Service and Spares.

## Powell's Problems

As the new year opened, John Powell reviewed EMI's medical electronics business. How well was it positioned? Where were the major threats and opportunities? What were the key issues he should deal with in 1977? Which should he tackle first, and how? These were the issues he turned over in his mind as he prepared to note down his plans for 1977.

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## *Reading II–4*
## *Technological Forecasting for Decision Making*

*B. C. Twiss*

*Thus in policy research we are not only concerned with anticipating future events and attempting to make the*

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*Managing Technological Innovation*, 2d ed. (New York: Longman, 1980), pp. 206–34. Reprinted with permission.