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CAMBRIDGE COOLING SYSTEMS: GLOBAL OPERATIONS STRATEGY

David Jansen, chief operating officer at Cambridge Cooling Systems (CCS), had just finished his weekly update meeting with Harris Bell, chairman of the board and chief executive officer, late in the afternoon of January 10, 2017. David had joined CCS three months earlier, having come from Caterpillar Inc. The meeting with Harris focused on David's initial thoughts and impressions regarding the disappointing results of the company's performance for the latest quarter.

Just one year earlier, the CCS strategic plan had called for the company to double its size in five years. However, the economic impact of the collapse of oil prices required the management team to re-evaluate its plans. Many of CCS's global plants were running below full capacity, and coordination within the company, especially between engineering and manufacturing, seemed to be poor. At the end of the meeting, it was clear that Harris expected David to identify changes that would make CCS's global network of plants more effective and profitable.

In particular, Harris wanted recommendations from David regarding rationalization of CCS's plants in Canada and Mexico. Plants in both countries manufactured a mix of standard and custom products, and had the scope to serve customers across North America. At the end of the meeting, Harris asked:

> Should we have plants specialize in standard and custom products, or should we have each of our plants manufacture a range of products so that our operations are flexible? Economic conditions have changed dramatically for our business in the past 18 months. We need to re-evaluate our operations strategy with the objective of driving efficiencies in the plants. In particular, I am wondering if we should move some of our custom work from Cambridge to Mexico. I know you just started a few months ago, but I would like to have a fresh perspective on our Canadian and Mexican plants before the next board meeting at the end of the month.

CAMBRIDGE COOLING SYSTEMS

In 1934, William Jansen founded Cambridge Cooling Systems, in Cambridge, Ontario, to build customized refrigeration and cooling systems for the food industry. CCS's growth had accelerated when it began supplying product to the Canadian military, building customized cooling units for engine rooms and food storage warehouses.

Harris's father, Samuel, took over the family business in 1976. Twenty years later, CCS expanded into South America, a region experiencing rapid growth at the time. In 2001, CCS set up two plants in Mexico—G1 and G2 in Guadalajara—with the intention of expanding capacity to serve the Southern U.S. and South American markets.

In 2009, Samuel retired and Harris took over from his father as chief executive officer. Between 2010 and 2012, Harris purchased three international rivals, two based in Italy and the third based in India, with the expectation that CCS would become a global player in the industry.

Products

The market for industrial cooling solutions was estimated to be worth US$13.5 billion[1] in 2016 and was expected to grow to US$17.2 billion by 2021.[2] Competitors in the industrial cooling industry included several large players, such as General Electric, Siemens AG, and ABB Inc.

Industrial cooling applications had several uses. For example, cooling units were needed to control heat and humidity in office environments, to refrigerate perishable items such as food and medical supplies, and to dissipate heat generated from machinery. All cooling applications used coolants, either liquid or air, and a system through which heat could be absorbed and discharged into the atmosphere or into a body of water. There were four general types of cooling systems:

Type	Technology
Once-through	Harnessed water cooling capacity
Evaporative	Relied on evaporation to dissipate heat
Dry	Utilized air cooling and piped coolants
Hybrid	Some combination of two or three technologies

Once-through cooling systems were the simplest of the four designs and relied on a flow of water, such as a river or lake, as the coolant. Water was pumped through a filter, mechanically screening out debris, and sent through pipes to absorb heat generated from mills and power equipment. For applications where a limited amount of water was available, an indirect once-through cooling system could be used where heat was dissipated by passing the coolant through a tower, relying on evaporation to reduce the temperature. The cooled water was then returned through the system, and any evaporative losses were replenished.

Evaporative cooling systems transferred heat to a cooling tower via coolants running through pipes. The pipes carried the heated coolants to a tower where water was sprayed over the pipes, cooling them and dissipating heat into the atmosphere. Dry cooling systems worked by transferring steam through an array of tubes, where fans channelled colder air over the tubes.

Hybrid cooling systems contained a combination of any of the three technologies. Hybrid systems were needed when geography or the application required more than one technology to conserve water and/or

[1] Currency amounts are in Canadian dollars unless specified otherwise; CA$1 = US$0.74383 on January 1, 2017.
[2] "Industrial Cooling System Market Worth 17.24 Billion USD by 2021," Markets and Markets, accessed May 5, 2016, www.marketsandmarkets.com/PressReleases/industrial-cooling-system.asp.

power. For example, a hybrid cooling system could utilize evaporative cooling technology when air temperatures were hot and could use dry cooling in colder, humid conditions.

Industrial cooling systems could be purchased as a standard or a customized product. Standard cooling systems were typically either evaporative or dry cooling systems, and were designed to fit within a 10-foot cube space, connected to an office or factory's cooling system with minimal alterations. In cases that were more complex, customized cooling systems had to work within a specific layout, to serve a particular purpose and/or to deliver a certain level of cooling capacity. For example, custom cooling systems frequently had to be designed to fit within a specific area in the customer's plant requiring pipes and controls to be placed in a specified configuration.

By 2017, CCS was the largest industrial cooling systems manufacturer in North America focusing on small unit installations. Its products excelled in remote, arid conditions and were used in mining, oil and gas, and military applications. The company kept a record of every customized device it had made providing its engineers access to more than 80 years of product history.

While CCS had many competitors, a key success factor for the company had been its focus on combining a deep understanding of customer requirements with engineering design to deliver products that performed to specification but that were often 80 per cent of the price of competitors' products. CCS's strength was its ability to design cooling systems for harsh environments—high heat, high salt, and/or remote locations.

CCS had seven distribution centres located throughout Canada and the United States allowing it to ship standard product for delivery to 90 per cent of its customers within 48 hours of receiving an order. Standard products could be customized, at a higher cost per unit, according to customer specifications, requiring a two- to three-week lead time.

MANUFACTURING OPERATIONS

CCS had six manufacturing facilities; two of these were located in Mexico, and the others were located in Canada, the United States, Italy, and India. In addition, it had seven regional distribution centres throughout North America. Approximately 70 per cent of CCS's workforce was made up of hourly manufacturing workers. The following is a description of CCS's North American factories:

- *Cambridge*: Located next to corporate headquarters, the Cambridge plant was 120,000 square feet, and it largely specialized in custom cooling systems. It had 230 employees. Five main production areas were set up in the plant: job shops focused on custom products for each of the four cooling system types and a fifth area for the production of standardized products. Dedicated teams assembled custom products, based on customer requirements, using general purpose equipment. CCS had a single production line that alternated on a weekly basis between producing standardized stock for each of the three cooling systems (hybrid cooling systems were always custom projects). The production schedule was set according to how quickly the Cambridge plant's inventory of each of its three standardized product lines was being depleted.
- *Guadalajara 1 (G1) and Guadalajara 2 (G2)*: The two CCS facilities in Guadalajara, Mexico, were built in 2001. Located beside each other, both plants were about 50,000 square feet with approximately 20 employees at G1 and 40 employees at G2. G1 was focused on customized products and was set up with a similar configuration to the Cambridge plant, using general purpose equipment. G2 focused on standardized products and was divided into three main production lines. Product from G1 and G2 was sold in North America with almost all of the custom products produced by G1 sold in the United

States. A key difference between the Cambridge and the Mexican plants was that plant operations staff in Cambridge were easily able to consult with CCS engineers and sales personnel at corporate headquarters. At both G1 and G2, working with engineering and sales personnel required telephone or video conference calls.

- *California*: CCS had a small plant in Compton, California, that produced products specifically for regional food manufacturing customers in the Western region of the United States.

International expansion beyond North America was the company's focus in 2010 when CCS purchased Gaurav Khan Enterprises in Delhi, India. In 2011 and 2012, CCS purchased two Italian firms, Galeazzo S.p.A. in Rome and Moretti Industriale in Palermo. The following provides a brief description of each of the firms purchased by CCS:

- *Gaurav Khan Enterprises*: Gaurav Khan Enterprises manufactured customized and standard products for food manufacturers and logistics providers in the regional market, mainly in Delhi and northern India.
- *Galeazzo S.p.A.*: Galeazzo S.p.A. produced customized and standard cooling units, with a focus on food manufacturers and industrial cooling, servicing the Southern European market.
- *Moretti Industriale:* Moretti Industriale manufactured large standard cooling units and had 50 per cent of the market in Italy for small and medium-sized standard and custom units. It serviced the Northern European market.

Manufacturing

All production scheduling for North America, including Mexico, was controlled at the head office in Cambridge. A team of five schedulers worked with the sales and customer service departments to ensure that production—especially of customized products—was properly sequenced. A significant amount of planning was done in preparation for the production of customized products. For example, customer specifications had to be verified, unique parts had to be purchased, and engineering designs had to be drawn up and approved.

Standard products were generally manufactured using a hybrid batch-flow process with dedicated equipment. Customized products were manufactured in a job shop configuration using flexible general equipment. There were work areas for each of the four technologies (once-through, evaporative, dry, and hybrid) in each factory, with the exception of the G2 and Compton plants, which did not manufacture hybrid cooling systems.

Production rates for standard products were constant, and the inventory of finished goods averaged 60 days. David collected this and other information on CCS's Cambridge and Mexico plants (see Exhibits 1 to 6).

Staff at the Cambridge head office included 50 people working on product design for custom orders and new product development. CCS had several patents, which helped to provide the company with a layer of protection against competitors. Its engineering department continued to develop new designs, relying on a combination of the department's product expertise, input from customers, and more than 80 years of industry experience producing and designing cooling systems.

Sourcing for custom products manufactured in North America was handled in Cambridge by a team of 10 people in purchasing. Buyers coordinated with sales and engineering to ensure that the right mix of raw materials was available before production parts were ordered from suppliers in Canada and the United

States. These suppliers frequently delivered products to Cambridge on a daily basis. Materials and components were shipped from Cambridge to Mexico in full truckloads based on the product schedule. Any shortages or rush orders were handled by air freight.

Electronic components, such as control systems, were purchased off the shelf, and were customized with CCS's software, and installed during the assembly process. Most fully assembled systems were tested at the factory. Transportation often required partial disassembly for customized systems. The cooling system was then positioned at the customer's site and reassembled, if necessary, under the supervision of a CCS engineer.

There were no engineering or product design personnel in Mexico or Compton, and manufacturing staff at these plants worked with engineers in Cambridge to design custom products and to troubleshoot issues. Operations in Italy and India were expected to function independently, designing products for local and regional customers with the support of a small local engineering group. In practice, however, control over engineering designs resided at head office in Cambridge.

Operating expenses at Cambridge were 58 per cent of sales for both standardized and custom manufacturing. A breakdown of the total operating expenses at the Cambridge plant was as follows: labour at 17 per cent, raw materials at 68 per cent, and overhead at 15 per cent (see Exhibit 7). David noted that labour and overhead costs were less expensive at the Mexican plants compared to Cambridge, while material costs were similar at both locations. Labour rates were $6 an hour at G1 and G2, compared to $24 an hour in Cambridge, and overhead costs were approximately 25 per cent less in Mexico. David observed: "Making the same product—standardized or custom—in Mexico would reduce our labour and overhead costs."

Sales and Marketing

CCS employed a direct salesforce and had non-exclusive independent distributors. The focus of the sales team was to target three primary markets: food manufacturing, mining, and oil and gas. Direct selling accounted for approximately two-thirds of sales, with the remaining coming from distributors. About 65 per cent of CCS's unit sales were custom designs. There was the potential for plants to supply units to other regions globally. Typical transportation costs for in-country customers was 2 per cent of the price of a unit; in-region (e.g., North America) costs were 5 per cent, and out-of-region costs were in the 10-per-cent range (e.g., shipping product manufactured in North America to a North American client would cost 5 per cent, and shipping to a client in the Middle East would cost 10 per cent).

The sales process for customized products in North America—from customer inquiry to the start of manufacturing—took 30 to 40 days. As part of the business development process, CCS's product engineers drafted drawings based on customer specifications. Once approved by the customer, a bill of materials was sent to the CCS purchasing department so that raw materials and component parts could be ordered. The mechanical engineering department created a product master file for the project, and other departments, such as product costing and production control, provided input. When pricing, design, and scheduling details were finalized with the customer, the order was released to manufacturing.

EVALUATING CAMBRIDGE AND MEXICO

David wondered if the manufacturing of custom product could be moved from Cambridge to G1:

> Custom products are a lot more complicated, requiring close coordination with sales and engineering. There are also operational and supply chain issues to consider. Currently, scheduling, planning, and logistics are handled in Cambridge, and most of our key suppliers are located within five hours of Cambridge. We have an experienced workforce in Cambridge, with the capability to manufacture a broad range of products.

About 5 per cent of the plant's manufacturing processes were automated, and David believed this level was appropriate for a plant focused on custom products. "In fact, the equipment required to produce custom and standard products is similar," said David.

> The difference is how production is set up and the skill levels of the workers. For custom products, each order is designed and built in a job shop configuration, with employees working on the same cooling system at a time. For standard products, imagine a line of 10 units in a row, with employees moving from unit to unit in sequence, similar to an assembly line.

Data from the quality department indicated that the historical defect rate for Cambridge was running at approximately 35 defects per million units produced. However, there was limited emphasis on incorporating quality into the production process, and defects were identified and fixed during the final inspection, just prior to shipping. As far as David could determine, the quality control inspectors were not able to establish how, where, or why defects occurred.

Typically, products manufactured in Cambridge were sold in North America—due to shipping costs—but there were instances where products were shipped to the Middle East and to South and Central America. David estimated that sales outside North America for the Cambridge plant accounted for about 10 per cent of total sales. In reviewing the past six months' sales and delivery records, David found that the Cambridge plant had on-time delivery performance of 90 per cent.

The Guadalajara plants were intended to complement each other, with G1 focused on custom products and G2 on standard products. G1 currently manufactured approximately 90 cooling systems per year, significantly less than its capacity of 500. While it was originally intended that G1 would serve the Southern U.S. and South American markets, CCS currently produced the majority of these orders at the Cambridge plant.

In 2014, about $4 million worth of automated equipment was purchased for G2, with the intent of designing a high volume, automated production line. "They overbuilt G2 in 2014, bringing machines that were world class. But it was a mistake because the production of standard cooling systems still requires a high degree of manual processing at our current volumes," said David. "The volumes that automated machines were expected to support did not materialize. Now most of the automated equipment is sitting idle and is likely worth $1 million or less."

G2 employees had a high level of manufacturing experience, but the level of engineering expertise at the plant was low. David noted from the quality reports that there was a high degree of attention to quality at G2, and that the defect rate was about 10 defects per million parts produced. Supervisors and line employees at both G1 and G2 monitored quality at each station, and defects were identified during the manufacturing process. Both plants had on-time delivery performance of 99 per cent.

Following the large capital investment at G2 in 2014, there had been almost no re-investment in CCS's Mexican plants. Employee turnover was in the 20-per-cent range at both plants, largely because of the increase in manufacturing firms in the region. "Three American car companies have opened up assembly operations within five kilometres of us in the past two years," noted David. "Their suppliers have also moved to the area to provide local support, creating competition for workers."

Developing Recommendations

David was considering recommending changes to the production mandates of the Cambridge and Mexico plants. "We have a cost advantage in Mexico and I think we should consider moving some of our production from Cambridge down to Mexico," he stated.

> Our hybrid cooling system is the most sophisticated product. I believe we should keep this product in Cambridge because it requires complex engineering work. In the long run, everything else could be moved to G1 and G2. I would like to focus specifically on whether it makes sense for us to move production of the once-through, evaporative, and dry products from Cambridge to G1. I need to determine if that is the right decision and how it would be implemented.

Given that the three other types of cooling systems—once-through, evaporative, and dry—were similar in complexity, David wondered how he would plan for transferring the production of custom products from Cambridge to G1 if Harris Bell approved the change in operations strategy. He estimated that it would cost $1 million in equipment and upgrades for every 500 units of additional annual capacity. "We could move equipment from Cambridge to Mexico," said David, "but there have been advances in equipment in the past few years. It might make more sense to purchase new equipment rather than dismantling and shipping old equipment from Canada to Mexico."

"We have to consider our people as well. It will take time to train our workforce in Mexico," said David. "What do I need to take into account with respect to the capabilities of our plant employees, and how can we find, hire, train, and assimilate a large number of new workers?"

David also wondered how he would develop appropriate management capabilities in Mexico to support the production of custom products at G1 in areas such as sourcing, scheduling, and engineering. "How do we develop these capabilities and what role should head office be expected to play? We cannot continue with the present arrangement of shipping truckloads of pre-packaged custom parts to G1 if we intend to ramp up production there," he reasoned. "Should we start asking suppliers to ship directly to Mexico, or should we begin cultivating local suppliers?" There would be significant engineering and testing required to qualify new suppliers, and this could take several months and would occupy the efforts of a number of engineers and sourcing managers.

David also considered the option of building a six-to-12 month inventory of component parts for custom production in Mexico as safety stock. "Carrying excess inventory for custom products might allow us to concentrate on building expertise without having to worry about sourcing during the transition period," he said. "But would the additional carrying costs be justified?" David estimated that CCS had a cost of capital of about 12 per cent.

David commented on the potential future of the Cambridge operation if production was shifted to Mexico: "I can see where Cambridge would continue to support our research and development activities and do a limited amount of manufacturing, mainly for hybrid systems."

As David sat down at his desk, he reviewed the information he had collected and assessed his options:

It would be a bold move to shift production of custom products from Canada to Mexico. I will need to present a plan to Harris that provides the financial justification and specifics on execution of the move. Cambridge Cooling Systems has had a presence in the local community for more than 80 years. Harris and the other members of the board will be sensitive to the impact on our people and the city. The transition will be difficult and we don't want to jeopardize our brand image and customer relationships. Maybe the easiest thing to do is not to change our manufacturing strategy and look for ways to trim costs and wait for the market to turn around.

EXHIBIT 1: CAMBRIDGE PLANT SALES, 2016

Total sales	Once-through cooling systems	Evaporative cooling systems	Dry cooling systems	Hybrid cooling systems	Total
Custom	$ 7,000,000	$ 8,125,000	$ 16,875,000	$ 42,750,000	$ 74,750,000
Standard	$ 600,000	$ 1,050,000	$ 1,600,000	$ -	$ 3,250,000
Total sales	$ 7,600,000	$ 9,175,000	$ 18,475,000	$ 42,750,000	$ 78,000,000

Total units					
Custom	350	325	375	450	1,500
Standard	60	70	80	0	210
Total units	410	395	455	450	1,710

Note: Sales figures are in Canadian dollars
Source: Company records.

EXHIBIT 2: CAMBRIDGE PLANT CAPACITY (UNITS)

Capacity	Once-through cooling systems	Evaporative cooling systems	Dry cooling systems	Hybrid cooling systems	Total
Custom	550	550	600	600	2,300
Standard	90	100	120	0	310
Total	640	650	720	600	2,610

Source: Company records.

EXHIBIT 3: CAMBRIDGE PLANT TOTAL LABOUR HOURS BY PRODUCT TYPE

Labour Hours	Once-through cooling systems	Evaporative cooling systems	Dry cooling systems	Hybrid cooling systems	Total
Custom	26,974	32,315	67,744	168,606	295,640
Standard	3,000	3,850	5,200	0	12,050
Total	29,974	36,165	72,944	168,606	307,690

Source: Company records.

EXHIBIT 4: MEXICO PLANTS SALES, 2016

Total sales	Once-through cooling systems	Evaporative cooling systems	Dry cooling systems	Hybrid cooling systems	Total
Custom - G1	$ 600,000	$ 625,000	$ 675,000	$ 1,900,000	$ 3,800,000
Standard - G2	$ 1,200,000	$ 3,000,000	$ 5,000,000	$ -	$ 9,200,000
Total sales	$ 1,800,000	$ 3,625,000	$ 5,675,000	$ 1,900,000	$ 13,000,000

Total units					
Custom - G1	30	25	15	20	90
Standard - G2	120	200	250	0	570
Total units	150	225	265	20	660

Source: Company records.

EXHIBIT 5: MEXICO PLANTS CAPACITY (UNITS)

Capacity in units	Once-through cooling systems	Evaporative cooling systems	Dry cooling systems	Hybrid cooling systems	Total
Custom - G1	150	100	150	100	500
Standard - G2	200	320	300	0	820
Total	350	420	450	100	1,320

Source: Company records.

EXHIBIT 6: MEXICO PLANTS TOTAL LABOUR HOURS BY PRODUCT TYPE

Labour Hours	Once-through cooling systems	Evaporative cooling systems	Dry cooling systems	Hybrid cooling systems	Total
Custom - G1	1,890	2,265	2,200	6,428	12,783
Standard - G2	4,200	10,000	17,000	-	31,200
Total	6,090	12,265	19,200	6,428	43,983

Source: Company records.

EXHIBIT 7: GROSS MARGINS FOR CAMBRIDGE AND MEXICO PLANTS

Operating Costs	Cambridge		Mexico	
	Operating Costs (%)	Operating Costs (% sales)	Operating Costs (%)	Operating Costs (% sales)
Labour	17	9.9	5.2	2.5
Raw Material	68	39.4	81.4	39.4
Overhead	15	8.7	13.4	6.5
Total (%)	100		100	
Operating Costs*		58.0		48.4

* Operating costs as a percentage of sales were 58 per cent in Cambridge and 48.4 per cent in Mexico.
Source: Company records.