MIT Leaders for Manufacturing Program

The Challenge at Instron

Will Downing arrived at work with a lot on his mind. He had just been promoted to manager of the electromechanical grip organization at the Instron Corporation. The organization had only a few employees, but was authorized to expand somewhat as it assumed worldwide responsibility for grip production. Executive management at Instron had mandated the consolidation of the European supply chain with that based in the U.S. The management team was also urging the manufacturing groups to dramatically cut costs and convert from MRP to "demand-flow" production. But the demand flow was highly variable; Will wondered how he should manage the capacity of his new organization under the counter-pressures of dramatically lowering costs while meeting stringent customer delivery requirements.

Electromechanical Grips at Instron

Instron Corporation of Canton, MA, produces instruments, systems, software, and accessories used to evaluate the mechanical properties and performance of metals, plastics, composites, textiles, ceramics, rubber materials, biomedical materials, and adhesives. Specific properties tested include tensile strength, fatigue, response to impact, and hardness. Tensile strength testing is performed by holding the test sample at each end with a mechanical "grip," pulling in opposite directions, and measuring the resulting forces. A variety of grips accommodate different test sample features, including flat bar stock, round bar stock, cord and yarn, fiber, and elastic.

Instron maintains two distinct supply chains for the marketing, design, manufacture, and service of electromechanical (EM) grips. One chain is based at the company's global headquarters in Canton, MA, with a major internal supplier of machined components in Binghamton, NY. The other chain is based at the company's European regional headquarters in High Wycombe,

 This case was prepared by LFM Fellow Dan Wheeler under the direction of Professor Stephen C. Graves as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation. The case is based on the author's thesis, "Pulling a Job Shop into Supply Chain Management," supervised by Professor Donald B. Rosenfield and Professor Alvin W. Drake, from an LFM internship at the Instron Corporation during July-Dec., 1999.

England, which houses a second internal machine shop. Instron has adopted a "Center of Excellence" strategy: all electromechanical systems and accessories (such as EM grips) will be designed and built at the Canton plant. As an additional motivation, executive management has identified inventory management as a primary method to achieve cost reduction goals, targeting the EM grip inventory for immediate attention.

The company manufactures a wide range of EM systems for testing tensile strength. A typical double-column system is shown in Exhibit 1. The main components are the base, vertical columns, carriage with load cell, grips, control panel, and computer. The base contains the motor, the control panel interface electronics, and the computer interface; it also supports a connector to which the lower grip is attached. The vertical columns house ball screws driven by the motor. The carriage rides the ball screws and a load cell is connected to the carriage to provide measurements of the applied forces. Finally, the upper grip is connected to the load cell.

The grip models are categorized into families by the mechanical feature or technology by which the gripping action is accomplished - wedge, pneumatic, or screw, also shown in Exhibit 1. Within each family of grips exists a range of force capacities; the wedge grip family, for example, ranges from a capacity of 5 kilo-newtons (kN) for the smallest grip to 100 kN for the largest. The complete line of ten grip models is shown in Exhibit 2.

Demand for EM Grips

Instron's EM grip customers include material testing service providers as well as large manufacturing firms with in-house test capabilities. Some customers purchase total systems (as shown in Exhibit 1) with various grips included as accessories and others purchase individual grips for new applications using existing machines. The total system orders are also known as custom machine (CM) orders while the individual grip orders are referred to as over-the-counter (OTC) orders. Grips are almost always ordered one pair at a time.

Exhibit 3 shows a sample of the orders for EM grips and a full year of order data is provided in electronic form. Will Downing knew that the demand for other Instron products exhibited strong seasonal patterns of demand as the sales organization closed most orders near the end of the sales period to meet incentive goals; he suspected he would find similar patterns in the grip demand stream.

Customers placed orders throughout the year for both entire systems and over-the-counter orders. The cycle time for systems ranged from four to twelve weeks, while OTC grips were expected to ship within two weeks of being ordered. System orders had to be completed two weeks before their final shipping dates, so that the grips could be integrated and tested with the systems. Last year, Instron management had corrected plant-wide problems with on-time delivery; now, the effects of all cost-reduction initiatives were specifically monitored to make sure that order delivery performance maintained excellent customer ratings.

Inventory Levels Are Excessive

Instron executives were also concerned about high levels of inventory. Many organizations, including the grip work cell, turned inventory less than twice each year. Offering a wide variety of products and promising quick delivery times required a significant investment in finished goods and component inventories. Will felt that the company's manufacturing resource planning (MRP) system compounded the problem by relying on demand forecasts that were frequently in error. The system planners not only scheduled assembly jobs in large lot sizes, they also built up component inventories just in case a demand spike depleted the finished goods.

Will knew that implementation of a pull production system, with two-bin kanbans for components, would help reduce the uncertainty in the production planning system and lower the grip inventory. Installing such a system was one of his top priorities. But how much of each component should be kept on hand? And how many of each should be ordered as replenishment as they were consumed?

The Model A100-5 wedge grip was a good example. It had numerous components (see Exhibit 4), each with its own pattern of usage, due to spare parts being pulled from the component inventory bins regularly by the service organization. Exhibit 5 shows the A100-5 bill of materials along with monthly usage statistics. The costs for the individual components varied widely, and Will wondered if the work cell should maintain different levels of component inventories based on cost. He also knew there was a tradeoff between the cost of frequent ordering (about $45/order at Instron) and inventory carrying costs (25% of the inventory value). He made a mental note to talk to one of the material buyers later that day about supplier arrangements for grip components.

Staffing The Job Shop

The EM grip work cell operated as a job shop. Orders were placed by the MRP planners and sent to the work cell. The stock room pulled the required components from the inventory racks and delivered them to the work cell for assembly. As jobs were finished, the assembly mechanics in the cell set up the area for the next job and built the required number of grip sets, typically in batches of fifty or more.

There were currently three mechanics in the grip work cell and Will could call on two others to fill in for absences as well as help out during periods of peak demand. Each full-time worker represented 1880 hours of effective labor each year. The High Wycombe production facility had a similar number of mechanics and it was hoped that combining the two supply chains would reduce the overall labor requirement. Furthermore, the effective labor rate of $30/hour in Canton was somewhat lower than that in High Wycombe.

The most pressing issue facing Will was identifying the number of additional workers he needed to complete all grip assembly jobs on time. He was under pressure to reduce costs, but he also had to make sure that no order waited longer than two weeks before assembly and delivery.

Exhibit 2. Product Line

	BOM	Capacity	Gripping	Setup	Assembly	Standard
Model	Parts	(N)	Action	Time (hrs)	Time (hrs)	Cost ($)
A100-5	15	5,000	Wedge	1.0	3.0	403.23
A100-30	18	30,000	Wedge	1.0	4.0	513.38
A50-1	30	100,000	Wedge	2.0	7.0	1,048.01
A200-1	20	250	Pneumatic	1.0	3.6	318.36
A200-2	24	1,000	Pneumatic	1.0	4.0	266.28
A200-3	18	10,000	Pneumatic	1.5	4.0	935.22
A300-3	8	500	Screw	1.0	2.0	263.47
A300-4	10	5,000	Screw	1.5	3.0	620.66
A600-1	8	5	Fiber	1.0	2.0	322.05
A700-1	12	50,000	Capstan	2.0	2.4	6,782.55

Exhibit 3. Grip Order Sample

Canton Orders (US)

Order No.	Model No.	Post Code	Ship Date	Qty
109043*3	A50-1	CM	Jan 2	1
109807*2	A200-2	CM	Jan 2	1
112125*3	A100-5	OTC	Jan 2	1
108946*8	A100-5	CM	Jan 3	1
109663*7	A300-4	CM	Jan 3	1
109887*8	A50-1	CM	Jan 3	1
110470*4	A200-2	CM	Jan 3	1
110690*1	A200-2	CM	Jan 3	1
112379*6	A200-1	OTC	Jan 3	1
108256*4	A50-1	CM	Jan 4	1
108539*6	A100-5	CM	Jan 4	1
109293*7	A200-2	CM	Jan 4	1
110249*4	A200-1	CM	Jan 4	1
110575*5	A200-3	CM	Jan 4	1
110640*1	A100-30	CM	Jan 4	1
112471*1	A300-4	OTC	Jan 4	1
108379*7	A50-1	CM	Jan 5	1
108520*8	A100-5	CM	Jan 5	1
108928*3	A200-2	CM	Jan 5	1
110522*4	A300-4	CM	Jan 5	1
110794*8	A200-2	CM	Jan 5	1
111864*3	A100-5	OTC	Jan 5	1
112711*4	A200-1	OTC	Jan 5	1
108890*5	A300-4	CM	Jan 6	1
109835*3	A200-2	CM	Jan 6	1
110254*6	A200-2	CM	Jan 6	1
112588*8	A300-4	OTC	Jan 6	1
108666*5	A100-30	CM	Jan 9	1
109213*3	A300-4	CM	Jan 9	1
109734*1	A200-2	CM	Jan 9	1
110926*6	A200-2	CM	Jan 9	1
112393*4	A200-1	OTC	Jan 9	1
109508*4	A200-2	CM	Jan 10	1
110694*6	A300-4	CM	Jan 10	1
111149*7	A200-2	CM	Jan 10	1
112942*1	A100-5	OTC	Jan 10	1
109300*1	A300-4	CM	Jan 11	1
109700*8	A200-2	CM	Jan 11	1
110582*6	A200-2	CM	Jan 12	1
110611*7	A300-4	CM	Jan 12	1
111271*8	A100-5	CM	Jan 12	1
109308*5	A200-2	CM	Jan 13	1
111040*8	A100-30	CM	Jan 13	1
111612*8	A300-4	CM	Jan 13	2
112481*2	A50-1	OTC	Jan 13	1
112957*5	A200-2	OTC	Jan 13	1
109373*2	A100-5	CM	Jan 16	1
110025*2	A700-1	CM	Jan 16	1
110993*2	A200-2	CM	Jan 16	1
111802*4	A300-4	CM	Jan 16	1
113775*2	A300-4	OTC	Jan 16	1

High Wycombe Orders (UK)

Order No.	Model No.	Post Code	Ship Date	Qty
507426*4	A100-5	CM	Jan 2	1
507617*8	A300-4	CM	Jan 2	1
509038*6	A200-2	CM	Jan 2	1
511682*2	A700-1	OTC	Jan 2	1
509963*5	A300-4	CM	Jan 3	1
507532*1	A200-1	CM	Jan 4	1
508423*2	A100-5	CM	Jan 4	1
512236*3	A200-1	OTC	Jan 4	1
507791*4	A300-4	CM	Jan 5	2
508996*6	A300-4	CM	Jan 6	1
510015*8	A100-30	CM	Jan 6	1
510132*6	A100-5	CM	Jan 6	1
512363*8	A200-2	OTC	Jan 6	1
508120*2	A300-3	CM	Jan 9	1
508682*1	A100-30	CM	Jan 9	1
508894*6	A200-2	CM	Jan 9	1
510311*3	A200-2	CM	Jan 10	1
512256*6	A700-1	OTC	Jan 10	1
512362*4	A300-4	OTC	Jan 10	1
510431*5	A300-4	CM	Jan 11	1
510880*1	A100-5	CM	Jan 12	1
508913*2	A100-5	CM	Jan 13	1
510335*8	A300-4	CM	Jan 13	1
510725*2	A300-3	CM	Jan 13	1
512858*7	A50-1	OTC	Jan 13	1
513105*7	A100-30	OTC	Jan 13	1
508844*8	A100-5	CM	Jan 16	1
511105*7	A300-4	CM	Jan 16	2
509641*6	A300-3	CM	Jan 17	1
510807*4	A100-5	CM	Jan 17	1
511153*4	A200-1	CM	Jan 17	1
512912*1	A200-2	OTC	Jan 17	1
513709*1	A300-4	OTC	Jan 17	1
510172*8	A300-4	CM	Jan 18	1
509226*6	A300-4	CM	Jan 19	1
509343*2	A100-30	CM	Jan 19	1
510347*5	A200-2	CM	Jan 19	1
511560*4	A100-5	CM	Jan 19	1
513003*2	A200-2	OTC	Jan 19	1
513374*8	A300-4	OTC	Jan 19	1
509286*5	A200-1	CM	Jan 20	1
513836*2	A300-4	OTC	Jan 20	1
513910*3	A100-5	OTC	Jan 20	1
510505*2	A200-2	CM	Jan 23	1
510630*6	A300-4	CM	Jan 23	1
510867*5	A100-5	CM	Jan 23	1
509448*2	A200-1	CM	Jan 24	1
509586*4	A300-4	CM	Jan 24	1
510197*4	A100-5	CM	Jan 25	1
510723*1	A200-2	CM	Jan 25	1
514441*7	A300-3	OTC	Jan 25	1

Exhibit 5. A100-5 Bill Of Materials

ID	Qty per Assy	Part Number	Description	Std Cost	Monthly Usage Mean	Monthly Usage Std Dev	Lead Time (days)
1	2	M200-1	Body	58.23	105	70	90
2	2	M200-2	Spindle	22.52	98	48	60
3	2	M200-3	Adjusting Nut	11.58	102	85	60
4	4	M200-7	Handle	3.76	236	174	60
5	2	M100-21	Bearing Washer	8.12	124	81	45
6	2	K206-121	Dowel Pin	0.52	170	68	30
7	2	M100-28	Check Nut	2.05	107	95	45
8	2	K200-230	Dowel Pin	0.50	158	76	30
9	2	M200-5	Spindle Pad	1.23	102	85	45
10	2	K610-003	Spindle Screw	0.15	164	274	14
11	4	M700-4	Face	6.25	320	249	60
12	8	K320-5	Spring	0.45	576	258	30
13	16	K206-133	Dowel Pin	0.68	976	763	30
14	8	M200-6	Side Plate	1.53	426	216	45
15	8	K620-001	Plate Screw	0.12	984	543	14