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Diecraft Australia

This case was prepared by Associate Professor Kannan Sethuraman and Visiting Professor Devanath Tirupati of the Melbourne Business School as a basis for classroom discussion rather than to illustrate either effective or ineffective handling of an administrative or business situation.

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On the morning of May 15, 2002 Mark Jackson, General Manager of Diecraft, arrived at the premises of his firm in Reservoir, a northern suburb of Melbourne, at 6.30 am. There were several pressing matters that had brought him in quite early on that chilly morning. He poured himself a cup of hot coffee and mulled over the discussions he had had with Jim Winthorpe, Vice President, Mould Engineering, Tupperware earlier that week. In their meeting, Mr. Winthorpe not only demanded better delivery schedule adherence from Diecraft but was also pressing Jackson to accelerate the design and delivery efforts for new moulds by more than a week.

Jackson realized that Diecraft had not done particularly well with respect to meeting the targeted due dates in 2001. More than 70% of the jobs in that year were delayed, and Jackson knew that he needed to find ways to remedy the situation immediately. He called Geoff Little, his Human Resources Manager, and requested he schedule an emergency meeting with key division personnel to discuss this issue later that afternoon.

HISTORY AND BACKGROUND

Diecraft, formerly known as Rabin Engineering, was founded by John Rabin in 1953. During the initial years John Rabin ran his business with just a single machine in his own backyard garage in the inner Melbourne suburb of East Brunswick. From its inception the company developed a reputation for high quality and craftsmanship. In order to keep pace with the increasing demand for his moulds, Rabin began employing more people and expanded his range of machinery.

In 1961 Rabin Engineering was producing very complex high quality moulds for the plastic industry and others. During this period Tupperware[1], a US-based company, visited Australia to seek out a local firm to make dies and moulds for its products. It soon found itself in discussion with Rabin Engineering and, realizing Rabin moulds met its high quality requirements, asked Rabin to consider a partnership with its operation in the US. Tupperware subsequently purchased Rabin Engineering in 1963, changed the company's name to Diecraft Australia, and in 1965 moved its operation to the current premises in Reservoir.

In the four decades since its takeover by Tupperware, Diecraft Australia has developed expertise and gained a reputation for its manufacturing capability of high-quality, high-precision, close tolerance plastic injection moulds for house-ware products (see Exhibit 1 for the product range). Diecraft had a strong functional orientation from its inception, even though some matrix-form had been introduced to the organization in the recent past (see the organization chart in Exhibit 2A). The managers responsible for functional areas such as Finance, Production, Engineering and Human Resources reported directly to the General Manager. The General Manager, an appointment made by Tupperware management, acted as a liaison between the Vice President, Mould Engineering, Tupperware and Diecraft (see Exhibit 2B).

In 2001 Diecraft had sales of A$23 million and employed about 125 people in its modern manufacturing plant. The workforce size was as high as 200 in 1990 and was brought down steadily to the current level of 125. This reduction in workforce size was attributable to automation

[1]Tupperware Corporation, a $1.1 billion multinational company, is one of the world's leading direct sellers, supplying premium food storage, preparation and serving items, to consumers in more than 100 countries. Tupperware also offers premium beauty and skin care products, mainly in North America, through its Beauticontrol brand.

and modernization in both its designing and manufacturing operations.

MARKET AND COMPETITION

Diecraft's major customer had always been Tupperware, which accounted for more than 90% of its (Diecraft's) turnover. All orders were won by submitting quotes to its customers. It was known that price was not always the deciding factor; quality and dependable delivery played a significant role in winning many of these contracts.

Diecraft supplied customized injection moulds for specific applications at the Tupperware facilities located in over 14 countries (see Exhibits 3 and 4 for a sample mould and an illustration of a general mould layout). A large fraction of Tupperware mould requirements were met by Diecraft. As more and more new competitors emerged, Diecraft needed to combine both cost efficiency and flexibility in its offering to remain a preferred supplier to Tupperware. Through its investments in more automated machinery in the 1990's, and its use of advanced automation of the mould design, Diecraft enhanced its ability to offer both flexibility and cost efficiency to its customers. Asked to comment on the competition that Diecraft faced Geoff Little, the Human Resource Manager, stated,

> We face stiff competition from Korea, Portugal and Japan. In particular competitors from Korea and Japan promise faster turnaround times and lower prices to the customers. Given the fact that we run our facility only two shifts a day as opposed to some of these competitors who run their facilities for three shifts a day, it doesn't surprise me to see how they achieve their faster turnaround times. Also, the lower labor costs existing in some of these countries give them the price advantage. However, we firmly believe that our competence in design, machining of hard metals, effective use of electric discharge machining, and final fitting gives us a substantial edge over our competition.

PRODUCT OFFERINGS

Diecraft product offerings were broadly classified as new moulds[2] and conversions. The conversions represented requests for alterations to old moulds that had been in the field for some time. Diecraft had an annual capacity to manufacture 130–150 moulds, which included 20–30 conversions. A new mould request was further classified as either a standard or non-standard request based on the similarities that the request shared with earlier jobs done by Diecraft.

The typical life of a mould was dependent on the type of steel that was used to make the mould and its usage frequency. Soft steel moulds were less expensive, easier and faster to make. However, they had a shorter life in terms of the number of cycles of use, and their quality typically eroded quickly towards the end of their lives. On the contrary, hardened steel moulds were more expensive but were capable of delivering more than a million cycles with minimal maintenance. The price of a mould depended upon the material choice, complexity of the mould, the number of cavities per mould (typically the number ranged from 2 to 8 per mould), and other aesthetic requirements that mandated more sophisticated ejector mechanisms.

ORDER PROCESSING

Most of the orders that Diecraft was processing were obtained through a bidding process. Typically, the process began with a request for quote (RFQ) from a purchasing department of a Tupperware region. The customer's purchasing department requested Diecraft and other competitors to generate a "quotation" for the work it wanted to have done. The request for quote was accompanied by detailed drawings of

[2]A new mould typically consisted of several components including bolster plates, cores, cavities, and stripper ring. Bolster constitutes the frame of the mould that forms the exterior and holds the mould together. A core is a unit that forms the inside of the plastic product and a cavity is a unit that forms the outside of the product. A stripper ring performs the purpose of ejecting the final product off the core.

the final product and specified the due date for the order. Sometimes, the request for quote included a mould concept developed by the customer firm, and this greatly facilitated the quotation process. Jackson, the General Manager, made his decision to bid for the order based on the prevailing load in the machine shop. Once the decision to bid was made, the request was handed over to Loc Nheu, Sales Engineer, who was responsible for preparing the detailed "quote package".

Nheu worked closely with the production controller, the engineering manager and the production manager in the preparation of the requested quotes. A detailed database of past jobs, maintained by Diecraft, facilitated the quick finding of relevant information. Naturally, it was easier to quote jobs that were similar to the moulds that Diecraft had done earlier. Deciding on quotes for jobs Diecraft had not previously made was more difficult and time consuming. A detailed quote package prepared by Nheu included the estimates of cost and time for the proposal and the promised delivery date. The costs were broadly broken into three categories: (i) engineering (ii) purchased material and (iii) manufacturing costs. Manufacturing cost estimates were based on the total work content for the order. Diecraft quoted an average of 1,700 hours of work per mould, including time for design, manufacturing and testing activities. The freight and other overhead costs were added to this estimate. The lead time quoted varied from 15½ weeks for a standard mould to 17 weeks for a non-standard mould. A rough delivery date was determined based on the estimated times at various departments and the notion that about 2.5 moulds/week were to be released into the shop floor. The estimates were verified by the engineering manager, the production controller and the production manager for their accuracy. Nheu took anywhere between 4 hours and 2 weeks to prepare the detailed quote package depending upon the newness of the request and the availability of the mould concept along with the RFQ. Not all of Diecraft's bids were successful. Diecraft enjoyed a long run average of 70 per cent of its quotes being accepted. Uncertainty in the outcome of the bidding process also added considerable variability in the load experienced by the shop.

Upon notification of acceptance of Diecraft's quote, a job order was prepared with a stated delivery commitment and confirmation of all the parameters agreed with the customer. Typically, jobs were fixed price orders with provision for revision of terms in the event of customer initiated design changes. Award of a contract triggered a kick-off meeting of a team comprised of the sales engineer, the production controller, the production manager and the design manager. In addition to discussing the requirements specified in the proposal package, the team discussed a tentative schedule prepared by the production controller. The key purpose of the kick-off meeting was to obtain agreement from all concerned players on the order parameters and the tentative schedule. Following the meeting the job was formally released to the shop and was scheduled for delivery. Almost all orders undertaken by Diecraft required some engineering and design work prior to their release to the shop.

ENGINEERING DESIGN PROCESS

A typical mould would require design and manufacture of several components including bolster plates, hot runner, cores, cavities and strippers. In addition, the mould would also require several small components. Starting with the mould concept design and detailed drawings of the final product for which the mould was intended, the design task consisted of developing a preliminary design and a detailed final design of the mould. A detailed design effort for a mould typically consumed between 100 and 300 hours. To design a mould using a computer one would need to begin with an electronic representation of the product to be molded, and create a negative of this to describe the geometry of the mould. To do this by hand would be tedious and time consuming and Diecraft had opted for computer aided design (CAD). Their design efforts were based on a Unigraphics CAD system. Talking about the versatility of the Unigraphics package, Mike Williams, Design engineer, stated,

> Unigraphics allows us to save time in preparing for production since it permits the mould design to automatically update itself should the master part model be altered. The deployment of this specialist mould tool design software has provided us with considerable productivity improvements as the software understands how components of a mould fit together and facilitates the design process through appropriate suggestions with respect to component selection based on past designs.

The customer usually supplied the drawings of the final product in the form of CAD data that were loaded directly onto the Diecraft's computer system. Based on the customer drawings and requirements, the design engineer developed detailed mould drawings which involved the establishment of the mould parting lines and creation of core and cavity models. He also created all mould surfaces that contact the part using the original component part model design that was received from the customer. He ensured that the parametric relationships between the part model and the individual mould component models were maintained. Any modification done to the original part design was quickly and easily incorporated into the mould design. He then created supporting mould components such as inserts, slides and lifters. He also added cooling lines, runner systems, gates and ejection components to the core and cavity models as per requirement. Once the design was completed, the bill of materials was generated and updated automatically.

Apart from designing the components and preparation of detailed drawings and specifications, the engineering group was also involved in writing the program codes for Computer-Numerically-Controlled (CNC) machines[3]. These program codes were used to instruct the CNC machines to

[3]Computer-Numerically-Controlled (CNC) machines are more versatile, more accurate, and faster that are equipped to run unmanned due to their programmability. The programmable controller in these machines controls the machine tool and dictates the precise sequence off operations, the position of cutters etc. The automatic features of these machines facilitate an operator to run more than one machine at a time.

perform the operations required for the job during production. Creation of mould components as solid models provided an opportunity to program the CNC cutter path directly from the resulting 3D geometry. Usually, a design team consisting of a design engineer and a programmer was assigned to each of the accepted jobs. However, for larger jobs requiring substantial amount of design work, it was not unusual to have more than one design engineer and/or programmer assigned to the team.

The preliminary design resulted in the determination of choice of steel with appropriate hardness and wear resistance for the required level of durability. Typically, one design engineer handled preliminary design and the task accounted for about 25% of the design effort. All major material purchases were order specific and orders for material were made as soon as the preliminary design was completed. The materials and parts requirements were communicated to the Purchasing department that, in conjunction with Stores, procured them from preferred suppliers who promised delivery in two weeks. Design team used this lead time for preparation of detailed design and program codes for CNC machines. The design team followed principles of concurrent engineering in ensuring that both detailed design and program code development progressed in parallel. Once the program codes were completed, the design and programming details were handed over to the production department.

MANUFACTURING PROCESS

The production facility at Diecraft operated on two shifts: 7.30 am to 3.30 pm and 5.00 pm to 1.30 am, with a half-hour break for lunch or dinner. The day shift consisted of 106 people (including 76 direct laborers), and the night shift ran with only 16 workers. The night shift operated with a skeleton staff and was primarily used for long, unattended jobs that required little supervision. The workers were partly unionized and were paid on hourly rates. Diecraft's hourly wages were considered to be above industry average. The guaranteed wages ranged from A$700 to A$830 per week.

Also, employees were able to augment their pay through work during weekends and after hours. The overtime rate, 50% above the normal rate, was applicable for any work done in excess of the standard 38-hour work week.

The manufacturing facility was equipped for precision engineering with capabilities for a range of operations such as turning, milling, grinding, drilling, electrical discharge machining (EDM)[4], polishing and assembly. The facility had advanced CNC machines and EDMs that permitted very close tolerances, and provided Diecraft with a capability to work with a range of materials (refer to Exhibit 5 for details of equipment and labor in different sections of the plant). The manufacturing facility was organized by the nature of operation with all the machines grouped together by type (a layout of the plant showing the general grouping of machines is presented in Exhibits 6A and 6B). While the plant was organized by function, the layout was consistent with the sequence of operations required for most of the moulds that were produced by the company. It had no in-house capability for performing heat treatment, and this task was usually subcontracted to a local vendor who promised a one day turnaround time on most of the jobs with high reliability.

As soon as the Design Group supplied the mould design drawings and the first set of program codes for CNC machines, the production manager, in conjunction with the cell leaders, identified the machines and tools they require for the manufacture of the mould. He communicated those tooling requirements to the Tooling section and ensured that the needed tools were sharpened and kept ready for the scheduled commencement of the mould order without delay.

[4]Electrical Discharge Machining (EDM) process has been around for over 50 years, but recent advances in power supplies and computer control make it practical over wider application. This process uses wire, copper or graphite electrodes of various diameters to machine parts of any conductive material, such as metal. The conductive material would be charged positively and the electrodes negatively and the material would be "burned off" by the traveling electrodes. The advantages of this process is that it produces no burrs (thus not requiring any further grinding) as in the case of machined parts, and were capable of high precision machining on hard materials such as hardened steel and carbides. Since it does not use force to remove the material, EDM also is effective on soft materials as there is no risk of mechanical distortion or damage by cutting tools.

The manufacture of components for a mould order took place in parallel in both the Bolster and the Units Cells. The Bolster Cell was responsible for manufacturing the bolster plates that constituted the exterior frame of the mould. The Units Cell, on the other hand, was in charge of the manufacture of the interior sections of the mould such as cores, cavities and ejection system as specified in the order. Manufacture of both bolster plates and the units involved several machining operations that were carried out in three stages. In the first stage turning, milling and drilling operations were performed, following which the material was sent out to a vendor for heat treatment as per requirement. On average, this stage required about 50% of the machining time on the job. The heat treated parts, upon return from the subcontractor, went through additional machining and grinding operations to move them closer to their required tolerances. The final stage of operations involved performing finishing operations that demanded high tolerances and precision machining. These were typically performed on one of the several EDM machines available. In many instances, a preliminary check on the goodness of fit was performed prior to the EDM operation. Once the EDM operations were completed, the components were handed over to the Quality Assurance (QA) section for the verification of their dimensional accuracy with respect to the original design and product drawings. The QA department also prepared a detailed mould report that documented the actual dimensions achieved for each of the components of the mould.

At this stage, the Final Assembly Cell, responsible for fitting the bolster plates and unit components together, performed any final machining, polished the parts to the required surface finish and hand fitted all parts together. The mould was then sent to the Test Center. The testing involved detailed operational checks using injection moulding machines and verifying the output for adherence to customer specifications, aesthetic requirements and closeness of fit. The test center, equipped with a Meiki 450 tonne and a Windsor 550 tonne injection moulding machines, put the mould into action for the first time and performed various checks to verify the achieved cycle time and the different dimensional requirements on the manufactured plastic part. As and when required, they performed a debugging of the mould to ensure the required fitting. After performing the needed adjustments to the mould and conducting a dry run, a sample of the molded plastic product was forwarded to the customer for approval. On receipt of the customer approval, the mould was then shipped out to the customer.

While most of the moulds followed the sequence of operations described above, the diversity of end products contributed significantly to the variation in processing requirements of the orders. Depending on the order size and complexity of a mould, the assembly operation might require anywhere from 50 to 1,000 hours. Also, the total processing time in manufacturing would vary considerably with an average mould requiring 1,700 hours including about 300 hours of design effort (see Exhibit 7 for the details on a sample of recent orders processed by Diecraft).

PLANT LOADING, PRODUCTION SCHEDULING AND CONTROL

The production controller, Steve Walters and the production manager, Manuel Goodson, worked closely on a day to day basis to ensure that adequate capacity was made available to meet delivery commitments. While Steve dealt primarily with the planning of aggregate capacity requirements in various sections, the responsibility for detailed scheduling involving task assignments, organization of the operations within each task, scheduling of overtime and evaluation of subcontracting options rested with Manuel. These plans were also used as a basis for making delivery estimates made in quote packages.

Describing the available capacity and his process of estimation for determining the manufacturing lead time, the production controller, Steve Walters, said:

> We currently are operating with a capacity to handle about 125 moulds per year and this translates into an average release rate of 2.5 moulds per week.

> Precisely measuring the capacity of the system is quite difficult due to the constantly changing product mix. Based on our availability of workers and machines, we have estimated that an average of 140 hours of work can be assigned each week on a job. This is consistent with our practice of assigning 2 and 3 workers to a job. Our estimates of lead times for new proposals are based on these assumptions and we check our current plan to ensure that release of a new order does not cause any disruptions to our pre-established schedule.

To support detailed scheduling, the production controller develops, on a weekly basis, a detailed job loading plan for each section for the next 14–15 weeks. The loading plan is driven primarily by delivery commitments, processing requirements for each job and assumptions related to complement of labour and machine resources available for each order. The resulting loading plan (refer to Exhibit 8 for a sample plan) displayed the demand and capacity available in each section. The primary purpose of the loading plan was to recognize early any potential mismatch between available capacity and proposed work load, so that appropriate action could be initiated. Thus a shortage of capacity would trigger exploration of alternatives such as increasing amount of overtime or subcontracting. Similarly excess capacity would prompt efforts to aggressively seek new orders. The loading plan formed the basis for several reports generated by the production controller. These included the following:

- Prioritization of jobs with tasks to be completed during the week. The report was prepared on a weekly basis, by section and by job and given to the Production Manager and section leaders.
- Summary reports indicating the status of each order and projected completion dates.

The priority list provided by the production controller was the primary input for detailed scheduling as done by the production manager. Typically, the detailed scheduling involved disaggregating the tasks into basic work elements, assignment of tasks to workers, scheduling of overtime and, if necessary, subcontracting some of the tasks. In addition, inputs were provided to help workers plan the subtasks appropriately. This was particularly important in assembly operations which required coordination of several sub-tasks. Usually these tasks were performed by the section leaders, if necessary in consultation with the production manager. The section leaders also made assignment of tasks to workers keeping in mind the special capabilities that individual workers possessed. The production manager was more actively involved in decisions related to subcontracting work outside the plant. Apart from job complexity and competence of the subcontractor, this decision required an assessment of impact on lead time for the job, since subcontracting a task precluded performance of other operations on the job during that period.

The top concerns for Diecraft were appropriate utilization of all its workers and satisfactory performance with respect to its due date commitments. The production manager was constantly aware of the promised due dates, and he continuously strived to reduce the lead times wherever possible. Describing the opportunities for lead time reduction through effective scheduling, Manuel, the production manager, added:

> One of the important aspects of scheduling that we focus on for achieving lead time reduction is to exploit possibilities for using the same operator to work simultaneously on multiple machines. Since the running time per piece on the automatic CNC machines can be considerably long, it enables the operator to be working at another machine while the piece is being machined on a particular machine. Scheduling two or more jobs simultaneously to the same worker also leads to greater labor productivity. This is one of the primary reasons for our grouping of similar kind of machines together on the shop floor. We try to identify and match jobs that permit this kind of labor savings.

The practice at Diecraft was to account for all work by customer order. Thus, completed tasks on each order were routinely recorded and formed the basis for updates, revisions and review of progress. The updating was typically done in real time but reported and reviewed on a weekly basis.

EMERGENCY MEETING ON MAY 15, 2002

The emergency meeting Jackson requested took place from 2 to 4 pm in the conference room adjacent to Jackson's office. In addition to Jackson and Little, those attending were Steve Walters, the production controller; Manuel Goodson, the production manager; and Greg Lewis, the engineering manager. Jackson began by explaining the reason for calling this emergency meeting:

> Our poor due-date adherence record in 2001 has not gone unnoticed with Tupperware senior management. I have just finished a meeting this morning with Mr Winthorpe and he is not too happy with our performance and is demanding a significant effort from our side to improve our delivery performance. In fact, he has demanded a reduction of more than a week in our average turnaround time for a mould. Also, he pointed out that our costs are not as competitive as some of our rivals. I am quite keen to hear your views on this matter.

Greg Lewis, Jackson's engineering manager, elaborating the issues pertaining to the unforeseen delays in engineering design, argued:

> Promised delivery dates would be a lot simpler and easier to achieve if we never had requests for engineering changes from our customers. A number of jobs that we handle have had many engineering change requests during their processing. In some instances, we have had to make significant changes to the design even after the commencement of production. However, the customer, although willing to pay for the extra work that the changes warrant, is rarely

> accommodative about schedule delays imminent due to the proposed changes. I have compiled some data (shown in Exhibit 9) that highlights the acuteness of this problem we faced in 2001.

Agreeing with Greg's sentiment about the adverse impact of engineering change orders on schedule adherence, Manuel added:

> Design changes create other problems on the shop floor not captured by Greg's data. For example, holding a job waiting for customer clearance disrupts our schedule and delays other jobs in the shop. Frequent interruptions to planned schedules happen not only as a result of design changes but also due to rework necessitated at the time of final fitting and assembly of moulds. We often make this up through overtime and subcontracting and all of this adds to our costs. One way to become more efficient may be through adding more people in our second shift and reducing our excessive dependency on overtime and subcontracting.

Geoff Little broke into the conversation:

> Look, adding people is not such an easy task given the scarcity of skilled workforce in our industry. The long training periods of 3 to 6 months required for building their proficiency further necessitates that we hire only if we need them for the long term. Adding more full time labor without sustainable work load will make us less competitive with respect to cost.
>
> One of the key reasons behind our high retention rate of skilled workforce has been our remuneration package. Due to our capacity shortage, we have consistently deployed overtime to augment capacity and our workers have found it attractive to be able to supplement their regular income through overtime earnings. I think it may be premature to rush and hire more people at this point in time.

Asked to comment on how the loading and scheduling of jobs impacted Diecraft's ability to meet delivery schedules, Steve said:

> Scheduling probably ranks as the most difficult function around here. Our orders always seem to come in lumps and this causes difficulties in smoothing the load on our system. In the first quarter of 2001, we had accepted almost double of what we were capable of handling and this overload had a domino effect on the subsequent quarters and caused inordinate delays.

Jackson, after hearing all their views, said:

> I understand and appreciate the issues you have brought up. However, I think we have no choice but to respond to our customer needs. The market is a very competitive one and we can't afford to miss deliveries and still expect to maintain our leadership and grow. I suggest we meet in a week's time with concrete alternatives.

After the group dispersed, Jackson walked down the aisles of his shop floor and tried to sort out all the information he had gathered during the meeting. He then pondered what he should do to resolve this issue both in the short term and in the long term.

Exhibit 1. Range of Products for Which Diecraft Dies and Moulds Are Used

Exhibit 2A. Diecraft Organization Chart

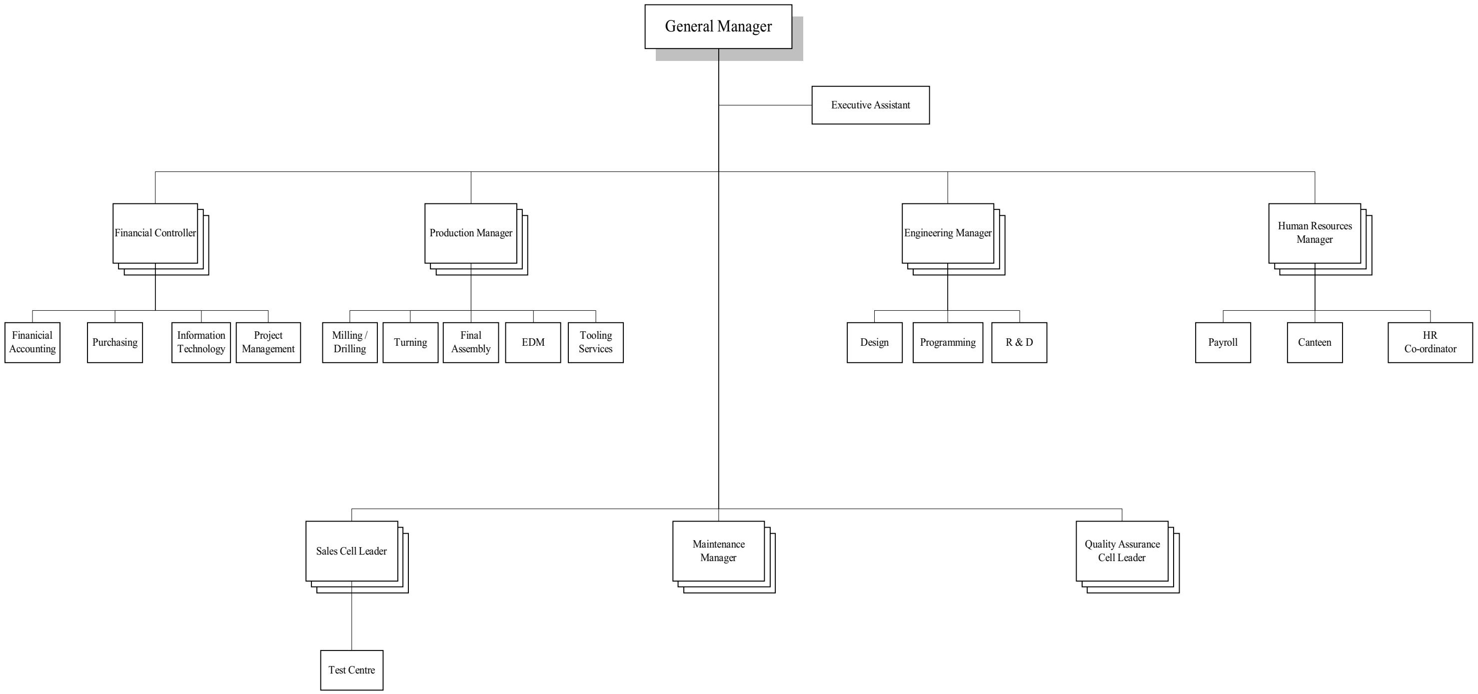


Exhibit 2B. Relationship between Tupperwave and Diecraft

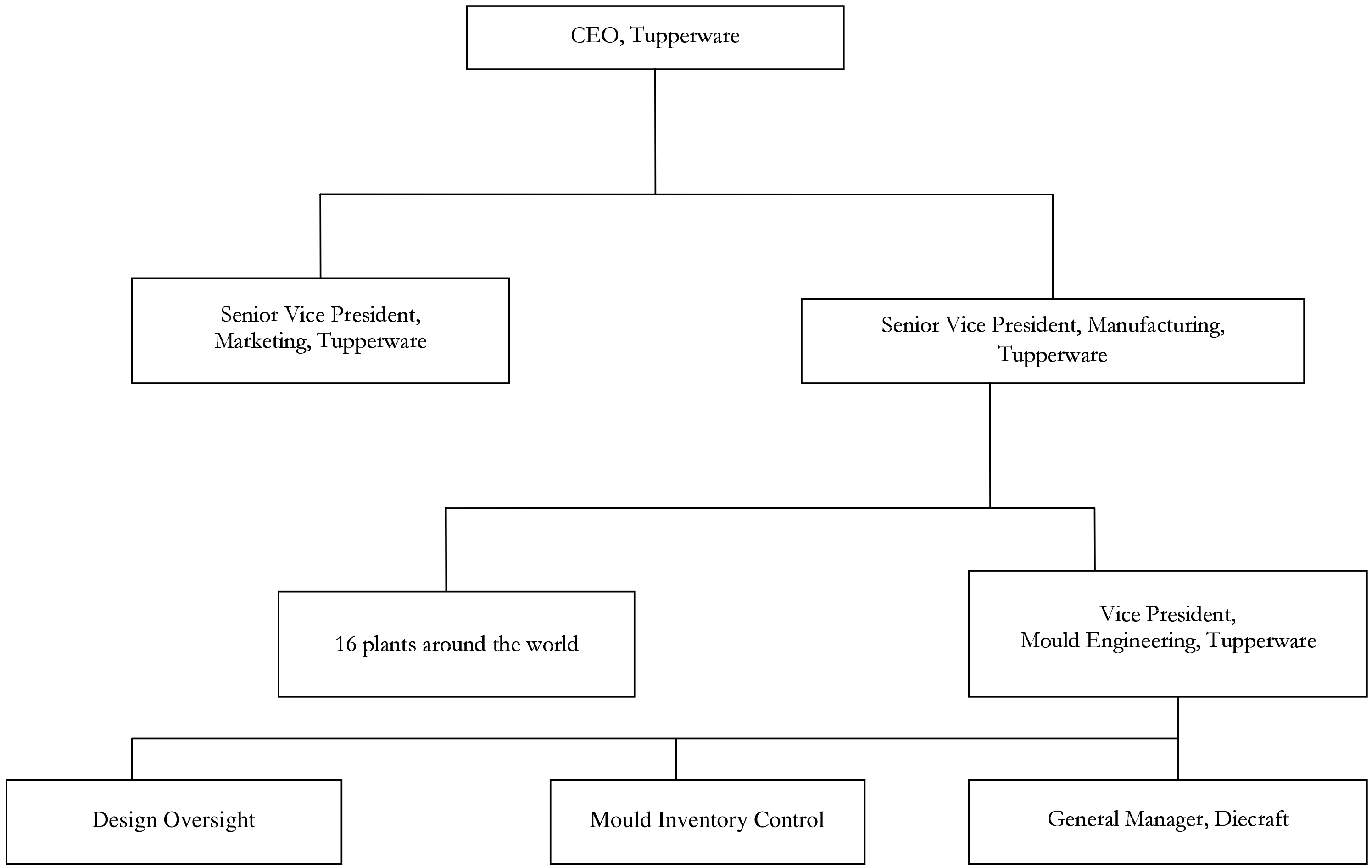


Exhibit 3. A Sample Plastic Injection Mould

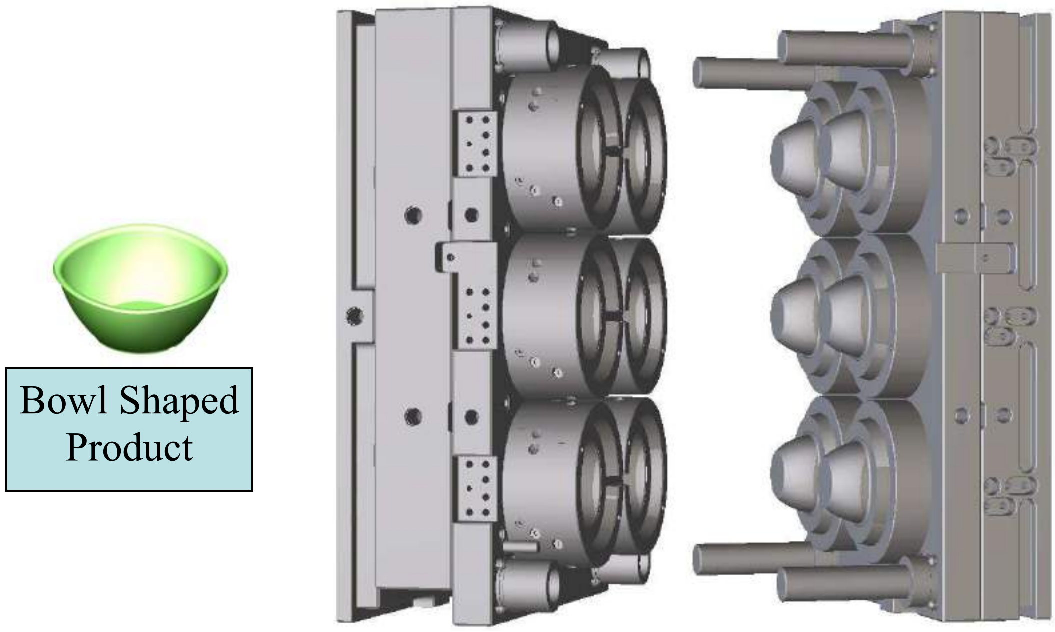


Exhibit 4. General Mould Layout

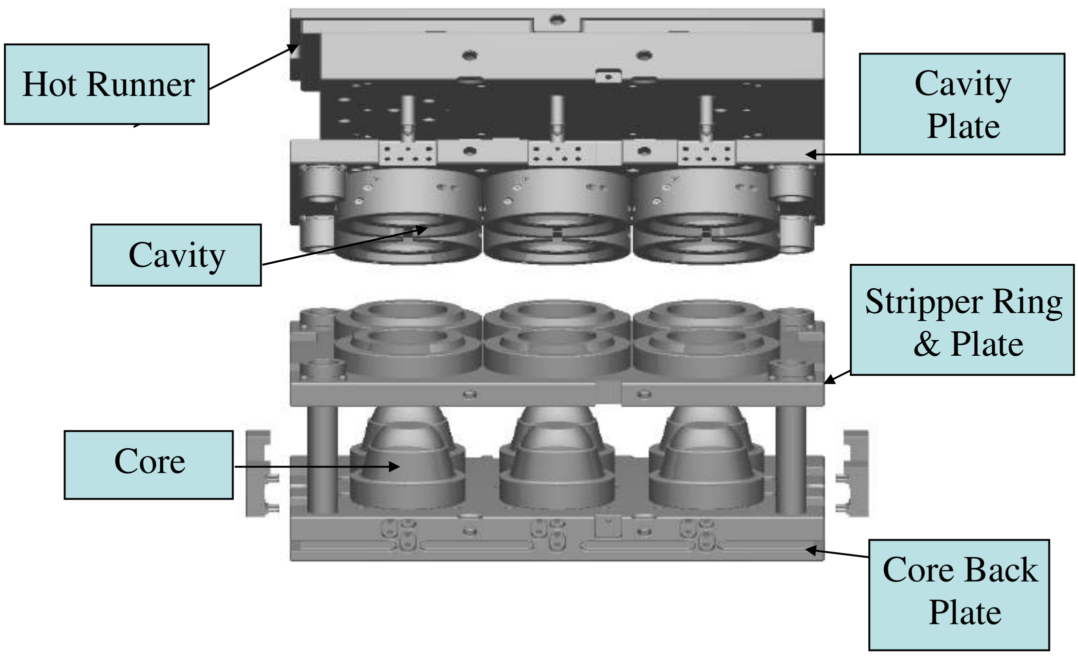
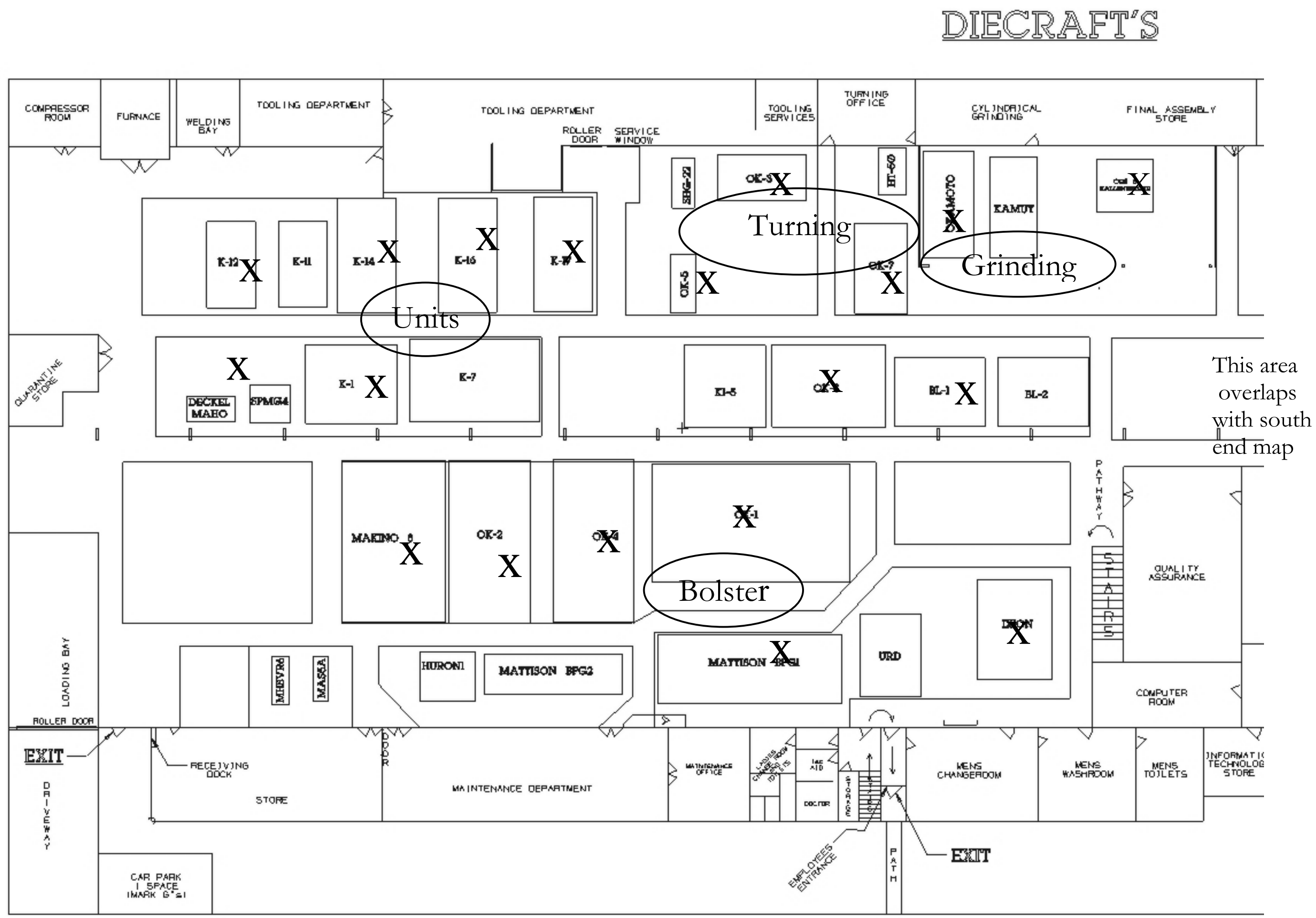


Exhibit 5. Diecraft Capacity Data

Section	Number of Machines	Number of Workers	Fraction of Time Workers Presence is Required for Running the Machines	Fraction of Time the Machine Can be Run Unattended
Design and Engineering	NA	17	1.00	0
Bolster	9	10	0.77	0.23
Milling	15	10	0.8	0.2
Turning	6	6	0.91	0.09
EDM	12	7–10	0.71	0.29
Assembly and Polishing	NA	28	1.00	0
Testing	NA	2	1.00	0

Notes:
1. Availability of each worker: 53.5 hours/week, 50 weeks/year

Exhibit 6A. Diecraft Plant Layout (North End)



Critical machines are marked as X and are typically run up to 5000 hours per annum.

Exhibit 6B. Diecraft Plant Layout (NorthEnd)

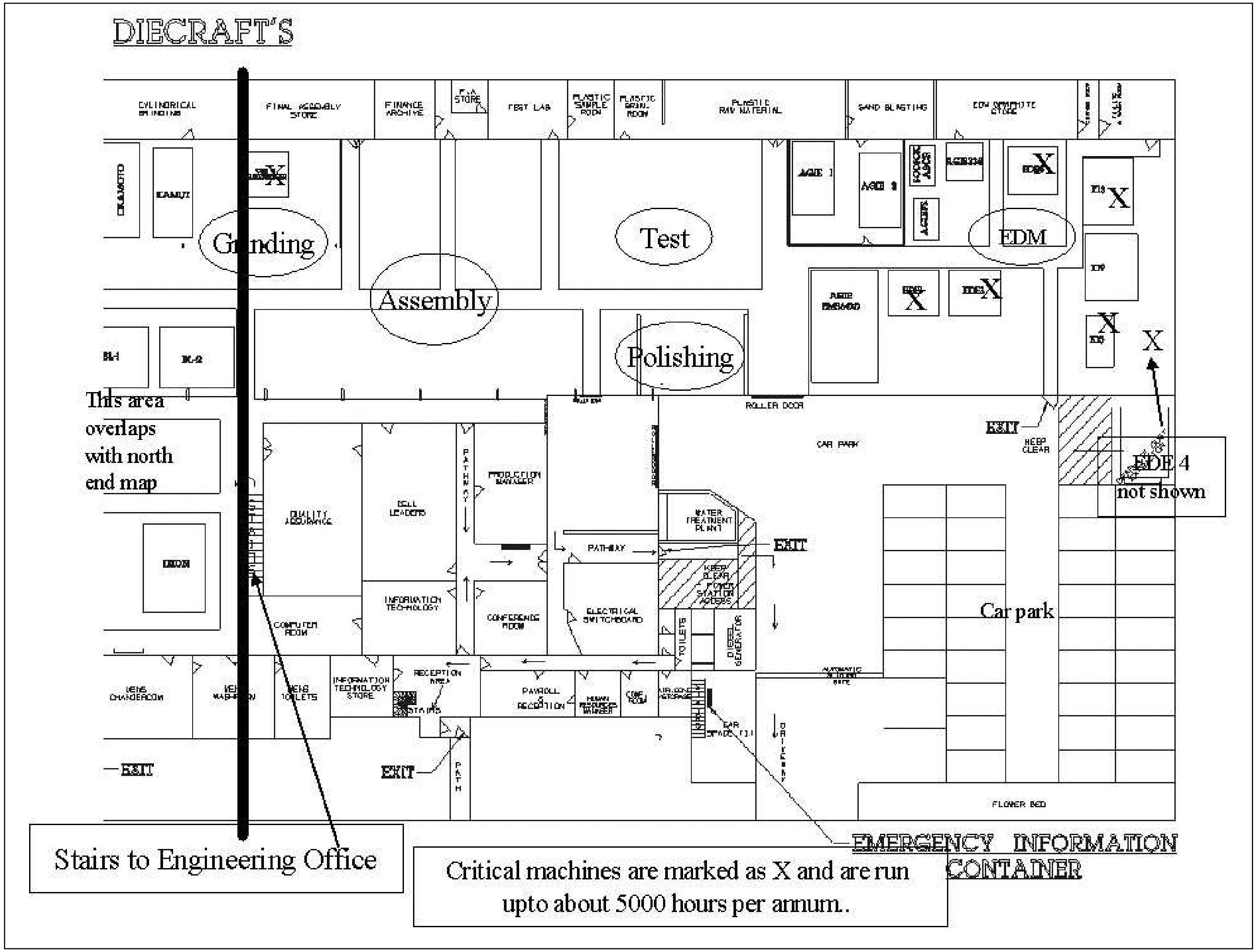


Exhibit 7. Details of Recent Orders Processed by Diecraft

Distribution of Estimated Time (Internal) based on a sample of 25 orders

Range	% of Orders	Mean
0–1000	16	751
1000–1500	32	1242
1500–2000	12	1780
2000–2500	16	2269
>2500	24	2916

Distribution of Actual Time (Internal) based on a sample of 25 orders

Range	% of Orders	Mean
0–1000	24	689
1000–1500	28	1193
1500–2000	20	1797
2000–2500	4	2217
>2500	24	3013

Distribution of Subcontracted Time per job based on a sample of 25 orders

Range	% of Orders	Mean
0–100	24	57
100–200	32	144
200–300	20	238
>300	24	430

Exhibit 7. Details of Recent Orders Processed by Diecraft (continued)

Distribution of deviations from estimated total hours

Error = (Actual – Estimate) × 100/Estimate

Range of Deviations	% of Orders	Average Deviation
< –20%	20	–27.4
–15%–20%	16	–16.6
–10%–15%	16	–12.3
–5%–10%	12	–9.3
0–5%	24	–2.8
> 0	12	17.8

Distribution of Effort by Section

Section	Range of Hours/Order	Relative Workload in the Section as % of Total Hours
Engineering design	32–804	13.16
Bolster	0–557	13.61
Turning	0–276	4.72
Units (M&G)	13–606	17.55
EDM	0–723	17.69
Assembly	61–1103	29.84
Test	0–109	1.77
Rework & Misc.	0–196	1.67

Exhibit 8. Total Estimated Hours Left per Week for Diecraft

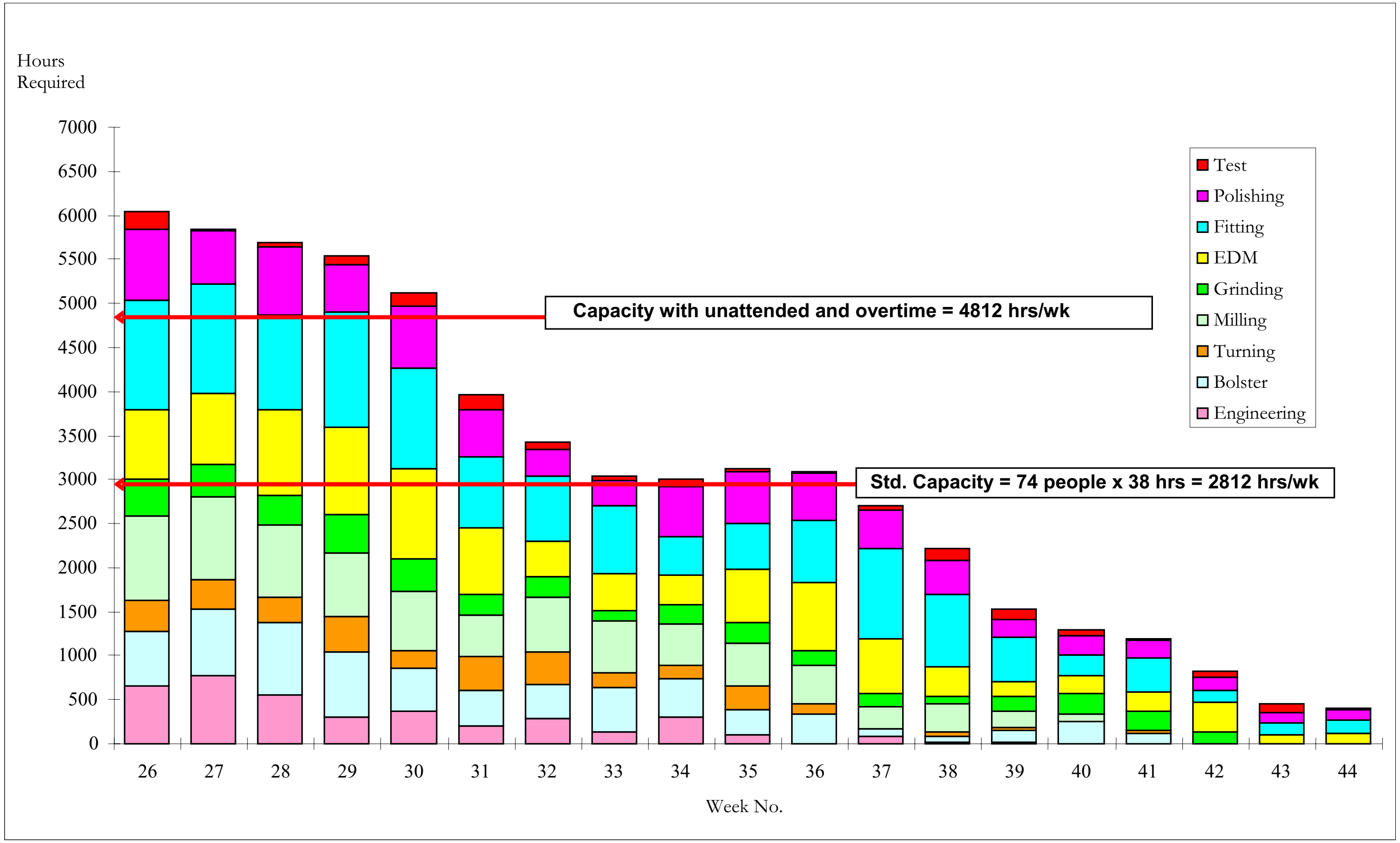


Exhibit 9. Sample Data on Engineering Change Orders

Mould	# Changes	Original Quote		Final Quote	
		Hours	Delivery Date	Hours	Delivery Date
4553A	2	311	10/9/2000	388	10/16/2000
4681A	1	899	1/21/2001	1226	2/4/2001
4793A	0	1224	1/28/2001	1085	1/28/2001
4806A	0	3182	1/28/2001	2979	1/28/2001
4518B	0	1922	2/11/2001	1616	2/11/2001
3971A3	0	295	3/4/2001	237	3/4/2001
4549A	1	2895	5/21/2001	2940	5/28/2001
4693A	0	3743	10/15/2001	4087	10/22/2001
4722A	4	2451	10/22/2001	2693	11/26/2001
4555B	1	199	11/12/2001	287	11/26/2001
4737A	0	1150	12/17/2001	1367	12/17/2001
4819A1	0	1094	12/17/2001	989	12/17/2001
4819A2	0	1500	12/17/2001	1064	12/17/2001
4808A	2	2895	3/25/2002	3196	4/1/2002
4809A	2	1202	4/8/2002	1294	4/15/2002
4876A	0	969	4/8/2002	763	4/8/2002
4795A	0	1658	4/15/2002	1629	4/15/2002
4858A	0	180	4/29/2002	196	4/29/2002
4822A	0	1799	5/13/2002	1802	5/13/2002
4823A	0	1705	5/13/2002	1575	5/13/2002
4850A	5	2767	6/3/2002	2896	6/17/2002
4739A	1	1060	6/10/2002	1333	6/17/2002
4738A	4	2180	6/17/2002	2589	6/24/2002
4949A	0	2025	6/17/2002	1904	6/17/2002
4963A	6	972	6/24/2002	988	7/1/2002