Project Background

Merrill Hand Tools Ltd (MHT) is a family-run business based in Sheffield that manufactures a range of hand tools, from general tooling to specialist woodworking tools and agricultural implements.

MHT was formed by Mike and Linda Merrill in 1980 who brought a vast amount of experience in Forges, both in Sheffield and in other countries including Germany.

The company's family connection with forging goes back to two generations to Robert Merrill, who was one of Sheffield's "Little Mesters", he worked independently producing hand forged cutlery items.

MHT moved premises in 1990 and the opportunity was taken to re-organise production procedures to optimise efficiency, in order to produce high quality hand tools consistently and to the relevant applicable standards. In 2000 it was found necessary to extend the premises to accommodate increasing business and machinery needed to fulfil orders.

Currently, MHT is organised into three divisions: Product Development, Manufacturing, and Marketing and Sales. Each division is headed by a vice president, who reports directly to the CEO (Mike Merrill).
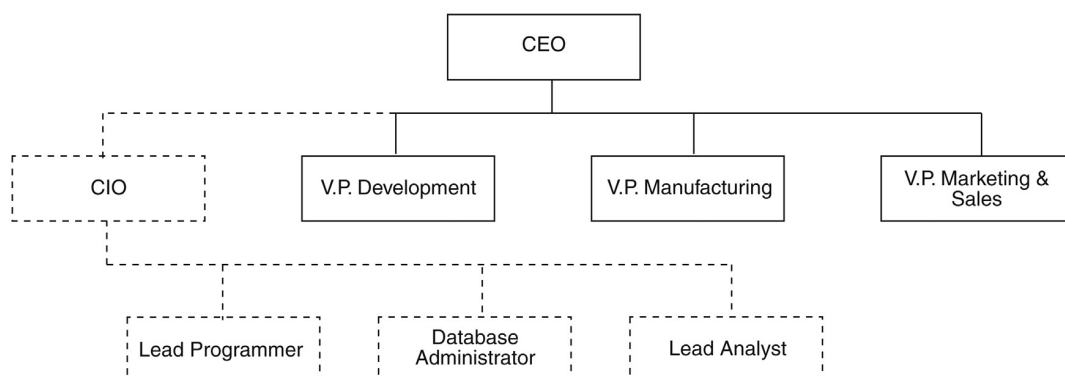
Figure 1. MHT organisation chart. The solid lines represent existing positions; dotted lines represent positions that will be added as part of the reengineering project.

Product Development Division

The Product Development division is responsible for designing and testing new and redesigned tools. The division employs tools designers. Once a design/redesign is complete, one or two prototypes are built. The prototypes are inspected for deformations (for steel-based tools), visual damage, coating inspection, quality control and pre-production anomalies. Feedback from the testers is used to refine product designs and to make decisions about which designs should actually be manufactured for mass marketing.

Manufacturing Division

The Manufacturing division is responsible for producing product for market sales. Manufacturing procures its own raw materials and manages its own operations, including human resources (hiring, scheduling, etc.) and assembly line management. Manufacturing maintains the inventory of tools ready for sale.

Marketing and Sales Division

MHT sells directly to individuals and hardware shops. Marketing and Sales employs 5 members of staff who are responsible for making managing contact with customers and hardware shops, distributing catalogues, visiting and/or calling potential resellers, and taking orders. Order accounting is also handled by Marketing and Sales; they also pass on shipping information to Manufacturing, which takes care of actual product delivery.

Current Information Systems

Current information systems at MHT are a collection of computers and applications that have grown up with little planning. The Product Development division relies primarily on stand-alone design workstations. In contrast, testing records are kept and analysed manually. Product Development employs product designers and clerical support staff, but no information systems staff. Attempts to have clerical staff develop simple database applications to store data about testers of new and redesigned tools and the results of those tests have proved futile. It has become evident that Product Development needs information systems professionals, and although the division is willing to hire IT staff, corporate management has decided to centralise the IT staff, rather than add to a decentralised model.

Manufacturing uses a stand-alone server to track purchases and inventory levels of raw materials, staff scheduling, manufacturing line scheduling, and finished product inventory. Each of the applications running on the server were custom-written by outside consultants in FoxBASE, many years ago; the most significant maintenance they have had was when they were ported from the department's original minicomputer to the server, about 15 years ago.

The data used by a Manufacturing application are contained in tables that do not share information with any of the other applications.

Manufacturing employs one programmer that knows the FoxBASE code (who will be retiring shortly) and a system administrator. Although the programmer is talented, the most he can do is fix superficial user interface issues and repair corrupted data files; he was not part of the original program development, which was poorly written and even more poorly documented. The applications no longer meet the needs of the Manufacturing division and management has determined that it is not cost effective to write new applications to access the existing data files.

Marketing and Sales, which wasn't computerised until late 1990's, has a local area network consisting of one server and 5 workstations. The server provides shared applications, such as word processing and spreadsheets. It also maintains a marketing and sales database that has been developed using a PC-based product. The database suffers from several problems, including a limit to the number of simultaneous users and concurrency control problems that lead to severe data inconsistencies. The marketing and sales database was developed by two IT employees in the division, both of whom have since left the company. No current staff understands the software. Regardless of the amount of time spent trying to maintain the database, inaccurate data continue to be introduced. The sales database is not connected to the Internet; therefore, salespeople must email their orders to the central office, where the orders are manually input into the database.

Reengineering Project

MHT's CEO has decided to undertake a major systems reengineering project. The overall aim of the project is to provide an information system that will better support product testing, analysis of sales patterns, control of the manufacturing process, and enhanced communications options throughout the organisation. New information systems will be based on a client/server model and include one or more databases running on an Internet-connected network of servers, workstations, and PCs. The ultimate goal is to create a self-service Web application for the company so that clients can place orders online.[1]

New Information Systems Division

The first step in the reengineering project is to establish an information technology division. This new division will also be in the company's headquarters, along with the three existing divisions. To accommodate the new division, MHT will be extending their premises.

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[1] Note: It is important to keep in mind that the implementation of a Web app for the company is relatively independent of the database design. The Web app will require the same data as all the other types of data entry. Concerns about hosting and security are rarely the job of the database designer.

MHT is in the process of searching for a Chief Information Officer (CIO). This individual, who will report directly to the CEO, will manage the new division and be responsible for overseeing the reengineering of information systems that will handle all of the organisation's operations, as well as the creation, implementation, and maintenance of the company's Web app.

All current IT personnel (those who work for the Manufacturing, and Marketing and Sales divisions) will be transferred to the new IT division. The division will hire (either internally or externally) three professionals: a Lead Programmer (responsible for overseeing application development), a Database Administrator (responsible for database design and management), and a Lead Analyst (responsible for overseeing systems analysis and design efforts). The company will investigate various solutions for the development of the Web app to determine whether it should be done in-house or outsourced to a consulting firm.

Basic System Goals

The CEO has defined the following goals for the reengineering project:

- Develop a company-wide data administration plan, which should include a requirements document detailing organisational functions that require technology support and the functions that the reengineered system will provide.
- Provide an application roadmap that documents all application programs that will be needed to support corporate operations.
- Investigate alternatives for developing and hosting a Web app that will allow online orders. Conduct a cost-benefit analysis of those alternatives.
- Document all databases to be developed for the company. This documentation will include ER diagrams and data dictionaries.
- Create a timeline for the development of applications and their supporting databases.
- Specify hardware changes and/or acquisitions that will be necessary to support the reengineered information systems.
- Plan and execute a security strategy for an expanded company network that will include both internal and external users.
- Implement the planned systems.

Current Business Processes

To support the systems analyst in their assessment of MHT's information needs, the CEO has asked all existing division heads to document the way in which information is currently processed. This documentation, which also includes some information about what an improved system should do, provides a starting point for the redesign of both IT processes.

Sales and Ordering Processes

MHT receives orders at its plant in two ways: by telephone directly from customers, or from members of the sales team who have visited customers in person. Orders from the remote sales staff usually arrive by email.

Figure 2. MHT standard Customer Order Form.

Each order is taken on a standard order form (Figure 2). If the order arrives by email, it will already be on the correct form. Telephone orders are written directly onto the form. Several times a day, a clerk enters the orders into the existing database. Unfortunately, if the sales office is particularly busy, order entry may be delayed. This backlog has a major impact on production line scheduling and thus on the company's ability to fill orders. The new information system must streamline the order entry process, including online order entry and the direct entry of in-house orders.

The in-house sales staff has no access to the files that show the current finished-goods inventory. They are therefore unable to tell customers when their orders will ship. They can, however, tell customers how many orders are ahead of theirs to be filled and based on general manufacturing timetables, come up with an approximation of how long it will take to ship a given order. Therefore, another goal of the information systems reengineering project is to provide better company-wide knowledge of how long it will take to fulfil customer orders.

Manufacturing, Inventory, and Shipping Processes

The Manufacturing division occupies a large portion of MHT premises. The division controls the assembly lines, a storage area for finished goods, a storage area for raw materials, and offices for supervisory and clerical staff.

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Order Summary

Date: 12-June-2019

Tool#	Quantity Ordered
001	3
003	5
006	12
007	6
010	21
011	9
012	25

Figure 3. Order Summary

The manufacturing process is triggered when a batch of order forms is received each morning by the manufacturing office. The batch consists of all orders that were entered into the sales database the previous working day. A secretary takes the individual order forms,

and completes a report summarising the number ordered by model (Figure 3). This report is then given to the Manufacturing Supervisor, whose responsibility it is to schedule what tools will be produced each day.

The scheduling process is rather complex, because the Manufacturing Supervisor must take into account previously placed orders, which have determined the current manufacturing schedule, and current inventory levels, as well as the new orders. The availability of raw materials also influences the scheduling decision. This is one function that MHT's management understands will be almost impossible to automate; there is just too much human expertise involved to translate into an automatic process. However, it is vital that the Manufacturing Supervisor have access to accurate, up to date information about orders, inventory, and the current time schedule so that judgments can be made based on as much hard data as possible.

As finished tools come off the assembly line, they are packed for shipping, labelled, and sent to finished goods storage. Each shipping box contains one tool, which is marked with its model number, serial number, and date of manufacturing. The Shipping Manager, who oversees finished goods storage and shipping, ensures that newly manufactured items are entered into the shipping inventory files.

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Current Finished Tools Inventory Levels

Date: 13-June-2019

Tool#	Quantity Ordered
001	2
002	12
003	10
004	32
005	5
006	20
007	3
008	112
009	40
010	15
011	9
012	50

Figure 4. Inventory report

The Shipping Manager receives Customer Order Forms after the order report has been completed (photocopies of the order forms are kept in the Marketing and Sales office as backup.) The orders are placed in a box in reverse chronological order so that the oldest orders can be filled first. The Shipping Manager checks orders against inventory levels by looking at the Inventory Level report (Figure 4). If the manager sees that there is enough inventory to fill an order, then the order is given to a shipping clerk for processing. If there is not enough inventory, then the order is put back in the box, where it will be checked again the following day. Under this system, no partial orders are filled, because they would be extremely difficult to track -it is expected that the new information system should allow handling of partial shipments.

The Shipping clerk is given orders to fill. They create shipping labels for all tools that are part of a shipment. The boxes are labelled and set aside for pickup by the Parcel Delivery Company (PDC). The shipping clerk create PDC manifests, ensures that the items being shipped are removed from the inventory file, and returns the filled orders to the Shipping Manager. The orders are then marked as filled and returned to Marketing and Sales. The reengineered information system should automate the generation of pick-up lists, packing slips, and updating of finished-goods inventory.

MHT's raw materials inventory is maintained on a just-in-time basis. The Manufacturing Supervisor checks the Line Schedule (Figure 5) and the current Raw Materials Inventory (Figure 6) daily to determine what raw materials need to be ordered. This process relies heavily on the Manufacturing Supervisor's knowledge of which materials are needed for which tool model. Mike Merrill, MHT's CEO, is very concerned about this process because the Manufacturing Supervisor, while accurate in scheduling the manufacturing line, is nowhere near as accurate in judging raw materials needs. The result is that occasionally manufacturing must stop because raw materials have run out. Mike would therefore like to see ordering of raw materials triggered automatically. The new information system should keep track of the raw materials needed to produce each tool and, based on the line schedule and a reorder point established for each item, generate orders for items when needed.

Raw materials are taken from inventory each morning as each manufacturing line is set up for the day's production run. The inventory files are modified immediately after all raw materials have been removed from storage for a given manufacturing line. There is no way to automate the reduction of inventory; however, the new information system should make it very easy for nontechnical users to update inventory levels.

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Line Schedule

Date: 12-June-2019

12-Jun-2019
Line #1:	Model 003	15 units
Line #2:	Model 006	20 units
Line #3:	Model 007	25 units

13-Jun-2019
Line #1:	Model 010	15 units
Line #2:	Model 011	20 units
Line #3:	Model 024	15 units

14-Jun-2019
Line #1:	Model 002	30 units
Line #2:	Model 005	30 units
Line #3:	Model 021	10 units

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⋮
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Total Production scheduled:
Tool Model 002	35 units
Tool Model 003	20 units
Tool Model 005	50 units
Tool Model 006	25 units
Tool Model 007	40 units
Tool Model 008	20 units
Tool Model 010	15 units
Tool Model 011	15 units
Tool Model 012	20 units
Tool Model 021	25 units
Tool Model 024	30 units

Figure 5. Line Schedule

Raw Materials Inventory
Inventory Levels

Date: 13-June-2019

Item#	Item Description	QOH
001	Carbon steel(CS)	25 meters
002	Chromium-vanadium steel(Cr-	12 meters
003	Chrome molybdenum steel(Cr-	10 meters
004	Aluminum bronze	32 meters
005	Beryllium bronze	5 meters
006	Maple	20 planks
007	Oak	3 planks
008	Hickory	112 planks
009	Plastic #3	40 kilos
010	Plastic #4	15 kilos
011	Solder	9 tubes
012	Welding electrodes	50 pieces

[Next Screen]

Figure 6. Raw Materials Inventory

Product Testing and Support Function

MHT leadership team makes decisions about which tools to produce, based on data from product testing and fault reports. However, MHT would also like access to these data by model and serial number to make it easier to notify customers if a recall occurs. Management would also like summaries of the data by model sold, and customer details -e.g. region in the country where they are located.

Fault reports (Figure 7) are taken by customer support representatives who work within the product testing division. These reports include the serial number and model experiencing problems, along with the date and type of problem. Currently, the problem descriptions are nonstandard, made up of whatever terms the customer support representative happens to use. It is therefore difficult to summarise problem reports to get an accurate picture of

which tools are experiencing design and or manufacturing problems that should be corrected.

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Faults Report

Order Date: **Time:**

First Name:

Last Name:

Street:

City   **Post Code:**

Phone: **e-Mail:**

Model: **Serial Number:**

Problem description:

Figure 7. Faults Report

MHT would therefore like to introduce a standardised method for describing problems and faults, probably through a set of problem codes. The result should be regular reports on the problems reported for each tool model that can be used to help make decisions about which tools to continue, which to discontinue, which to redesign, and which to recall. When a problem report is received, the customer is directed to return the product to the store where it was purchased for an exchange (during the first 30 days after purchase).

Product test results are recorded on paper forms (Figure 8). After a testing period is completed, the forms are collated manually to produce a summary of how well a new tools or redesigned tools (e.g. when different alloys or materials are used for their manufacturing) performed. MHT would like the test results stored within an information system so that the

testing report can be produced automatically, saving time and effort. Such a report will be used to help decide which changes to make on manufacturing of current tools and/or new models to be placed in production.

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Test Report

Date:

Time:

Location

Model tested:

Test Type:

Test Description

Test result and comments:

Figure 8. Test Report

Catalogue of Products[2]

Floor Board Lifter

Thin sharp blade acts as a normal chisel, used for cutting the floorboard tongue. Floor board lifter where the 'kink' in the blade becomes a built-in fulcrum, giving greatly improved leverage and minimising damage to the adjoining floorboards.

Model #001   Price: £13.75

Wrecking Bar

Steel Oval Shafts, that have been heat-treated and hardened. They have a black powder-coated finish with polished tip. Abrasion-resistant

Model #003   Price: £12.00

Slate Ripper

Have a thin, flat blade two feet long, with a square, chiselled tip. Used to chop through roofing nails, freeing the slate from the roof

Model #004   Price: £15.75

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[2] Only a sample of all available products have been included here.
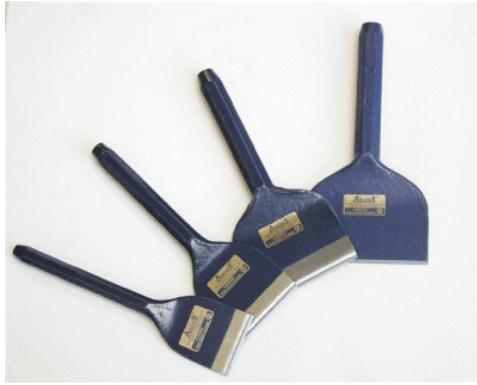
Brick Bolster

Brick Bolsters are used for splitting bricks. Forged steel; hardened and tempered.

Model #	Size	Price
006	50mm x 230mm	£5.25
007	112mm x 230mm	£8.40

Cross Cut Chisel

Used for channelling steel to get into corners where a normal chisel might jam. The cutting edge is wider than the body. Made from chrome vanadium steel for increased strength and durability.

Model #009   Price: £8.75
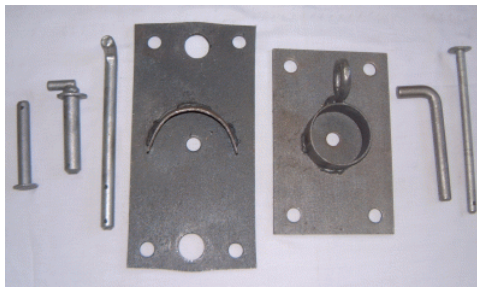
Ground plates, Pins and Shackles

High grade steel and hot dipped galvanised finish. Metal thickness: 4.5mm.

Standard size: 38mm pole/mast mount bracket; 230mm x 230mm base plate.

Made to measure to your own specifications upon request. Please contact us with details and drawings and we will quote accordingly.

Model #	Size	Price
012	230mm x 230mm	£28.99
013	Custom	TBD

Dowel Bar

Steel dowel bars are used to create a debonded dowelled joint; reinforcing the connection between two or more concrete slabs to improve strength and force transfer.

Available in mild steel at 12mm, 16mm or 20mm diameter. Carbon steel bars available if the following diameters, 10mm, 16mm, 20mm and 25mm.

Model #	Size	Price
020	Mild Steel 12mm x 900mm	£1.00
021	Mild Steel 12mm x 600mm	£1.20
022	Mild Steel 20mm x 600mm	£1.70
023	Carbon Steel 10mm x 900mm	£1.50
024	Carbon Steel 16mm x 600mm	£1.80
025	Carbon Steel 20mm x 600mm	£2.20
026	Carbon Steel 25mm x 600mm	£2.50

Skew Wood Chisels

Skew Wood Chisels are used to give a slicing action for the precise paring of a joint and for detailed finishing. The sharp point allows easy access into tight corners. Made international standards with tapered ground blades and rosewood handles. Walleted in pairs.

Model #	Size	Price
030	13mm Left and Right Hand	£22.00
031	19mm Left and Right Hand	£24.00
032	25mm Left and Right Hand	£26.00

Handsaw

For any challenging woodworking projects. Made of high quality SK5 high carbon steel. Wooden handle is made of a range of woods, all suitable for use with a mallet or hammer.

Model #	Size	Price
080	102mm saw, Rosewood	£15.00
081	102mm saw, Beech	£12.00
082	152mm saw, Beech	£14.50
083	152mm saw, Rosewood	£16.00
084	203mm saw, Beech	£21.00
085	203mm saw, Rosewood	£24.00

Customer Details

Customer Number	Customer Name	Customer Address	Phone Number	eMail	Corporate Y/N	Date account opened	Name	Last Name
C0634	Henson Hardware	227 Great Wstern St Leeds, LS17 6NA	0113 234-7654	Suppliers@HensonHardware.com	Y	20-Nov-1987	Robin	Matthews
C076	Cliff's Hardware	22 Sharrow Vale Rd Manchester, M14 4LG	0161 254-2437	Associates@CliffHardware.co.uk	Y	15-Jun-1988	Martin	Cliff
C192	Andrea Merrick	182A Fulwood Rd, Sheffield S10 6BB	0114 234-8765	a.merrick@CraftFurniture.co.uk	N	01-May-2001		
C296	Henson Hardware	10 Gidding Rd Sheffield S11 8XP	0114 263-8562	info@HensonsTools.com	Y	07-Apr-2003	Karl	Johnson
C283	Roland Casey	13 Broadfield Rd Manchester M1 2PM	0161 226-3425	Roland@Wood-Designs.co.uk	N	12-Jan-2003		
C421	William Oldfield	531 Richmond Rd Sheffield S8 0QS	0114 225-7613	W.Oldfiled@CabinetMaker.com	N	22-Aug-2010		
C6543	Turner Supplies	56 Garden St, Leeds LS6 4PJ	0113 230-2534	Info@TurnerSupplies.co.uk	Y	03-Feb-2012	Mick	Wakefield