DESIGN FOR ECONOMIC MANUFACTURE AND ASSEMBLY

'Design' can result in new and novel products, or incremental developments of existing ones.

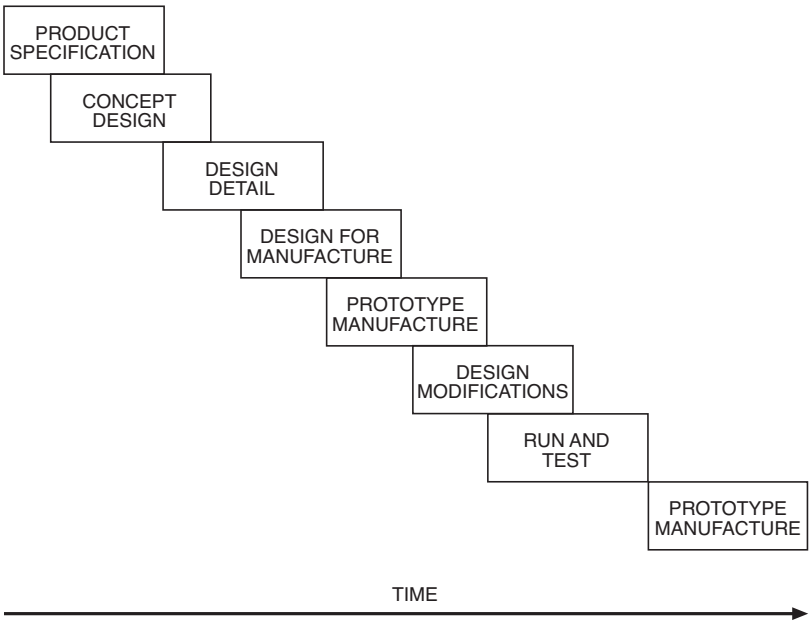
"Some novel designs have had important implications for society, the internal combustion engine and television being two examples. However, most design is incremental, that is each design is an improvement on what has gone before. Internal combustion engines are much more fuel efficient and their power to weight ratios higher than that of their ancestors. Similarly the design of a modern television with a large, flat, high definition colour screen, with 'picture in picture' teletext, and stereo digital sound facilities, is quite a different product from the small low definition monochrome screen of the massive, valve operated sets of half a century ago."

(Gordon Mair - 'Mastering Manufacturing', p71)

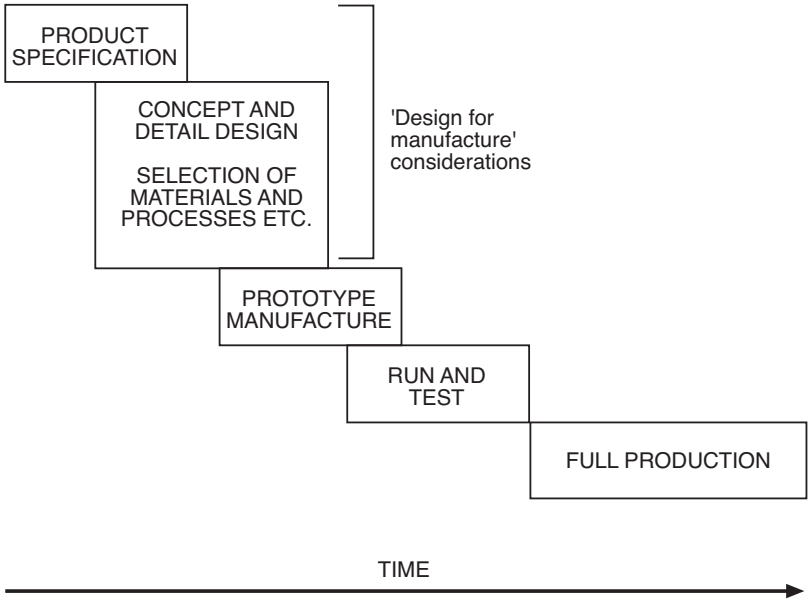
IDENTIFYING THE NEED

The first stage in the development of a new product is a result of a perceived market need. This may be as a result of research carried out by the marketing department in a large organisation, or the 'bright idea' of an individual inventor - in the case of the 'Workmate' DIY product perhaps.

In the past, the processes of turning ideas into products have been carried out in a sequential way .



Increasingly, concurrent engineering principles are used - which adopt an integrated approach to the design and manufacture of new products. It uses multi-function teams to research, design, develop, manufacture, purchase, supply and market all work in parallel, from the first idea through to the final launch of the product in the marketplace.



For further information about concurrent engineering, please refer to Study File 00

GENERATING A PRODUCT SPECIFICATION

The next stage once the basic idea for the new product has been created is to draw up a product specification. This document will form the basis of all the work that is to follow - and as such should be as detailed and comprehensive as possible.

The product specification should include considerations of:

a) ***aesthetic factors*** (the product appearance) - the shape of a product, the choice and combination of colours - even its packaging may be a significant reason why people decide to make a purchase.
These factors will have an influence upon the materials and manufacturing processes used.

b) ***performance factors*** - depending upon the product this may take a number of forms which might include the loads to be carried; the number of work cycles in the life of the product (in the case of a washing machine for example), the speed of operation, and so on.

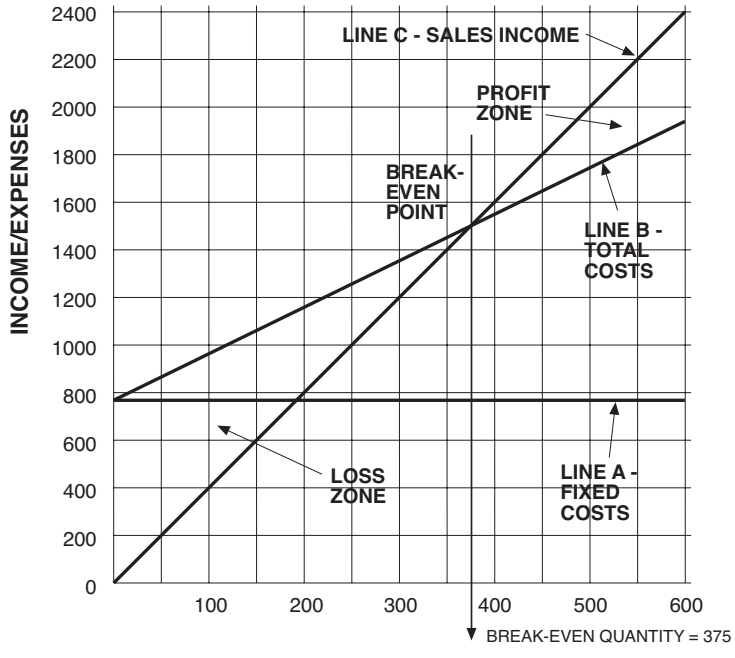
c) ***safety considerations***, and other standards and specifications - most products today must comply with a range of safety standards - to do with their electrical and mechanical performance for example. The British Standards Institute (BSI) sets the standards for a very wide range of products including crash helmets, pushchairs and buggies for small children; electrical goods such as DIY equipment etc.

d) ***maintenance considerations*** - how frequently and how easily the product is to serviced and maintained is a key consideration. Where a product is to be maintenance free, there may be additional costs involved through the use of for example, more sophisticated bearing materials.

In some cases products are deliberately designed that they cannot be disassembled. When one part of the product fails, it may be necessary to purchase a complete new unit.

e) ***quantity considerations*** - the number of products to be made, and the size of batches, will have implications for the types of manufacturing processes to be used and the organisation systems to produce them.

The 'profitability' of a design is affected by the number of articles produced, and may be investigated by comparing the costs of production with the expected income from a realistic selling price. If this investigation reveals a poor chance of making a profit, the design may need to be modified or a different production process considered.



The intersection of the total costs line (B) and the sales income line (C) shows the break-even point.

f) ***product life*** - there will be a certain product lifetime expected by the customer. In practice this may be a 'trade off' decision matched against the selling price. For many products a customer will expect a guarantee.

g) ***ergonomics*** - these factors describe the interface between the product and the user: how easy is it to use; is it comfortable in use etc. Consideration of ergonomic factors feature very significantly in the design of motor cars - the shape and adjustment of seating; the position of essential controls on the dashboard and so on.

h) ***the working environment of the product*** - in use the product may be subjected to extremes of temperature, humidity, vibration. It may be exposed salinity, acidity or other chemicals. Again, there may be standards to be met -in terms of the thickness and performance of, for example, paint finishes where these are to be used on offshore gas and oil installations.

i) ***the size, weight and complexity of the product*** - (its overall shape and the tolerances ranges to be used) of the product - these are all key issues in terms of the selection of materials, choice of manufacturing process and assembly techniques to be employed.

FACTORS INFLUENCING PRODUCT DESIGN

Design proposals should be **simple** - they should fulfil all the demands of the specification with a minimum of complexity. At the same time, the product should be **designed for manufacture** - using low manufacturing and labour costs where possible.

Where small numbers of products are required it may be that a machining process is appropriate, where these costs might be reasonable. If large numbers, for example 10,000 are required, a process such as die casting might be more suitable. Whilst the initial costs of equipment are high, the labour required to operate the die is less skilled and therefore less expensive.

Some Principles for Product Design Include the Following:

1. attempt to keep the number of individual parts in a design to a minimum

2. try to keep components as similar as possible - both in the materials used (for example, all plastics) or in the manufacturing processes used.

3. do not 'overdesign' - avoid two parts performing the same task ('redundancy'). In some products there are secondary or duplicate components or systems from the point of view of safety

4. avoid using floppy parts in a product - they can be difficult to handle and could prove difficult where automated assembly is required

5. wide tolerance bands that still allow individual components to be assembled should be used when possible as this will reduce production costs.

6. use the minimum number of parts for the maximum number of purposes. This principle of standardisation covers:

    * the use of standard sections and sizes of materials, such as metal and plastics, and fasteners such as nuts, bolts and screws

    * standard machines and tooling - such as twist drills, milling cutters, reamers etc.

    * within the product itself

CASE STUDY: DESIGN FOR ECONOMIC MANUFACTURE - TRANSPORT FOR YOUNG CHILDREN

Buggies and pushchairs for babies and young children are amongst the most abused products in everyday use - they are 'bumped' up and down pavements and flights of stairs, they are jumped on and ridden in by children much older and heavier than the product was primarily designed for, yet by definition they must carry safely one of the most precious loads imaginable, namely a small human being.

Buggies and pushchairs are so commonplace that it is easy to fail to realise the range and ingenuity of design criteria that must be met if the product is operate reliably, and most importantly, safely. This case study looks at the design, manufacture and subsequent testing of these products.

Maclaren Ltd. is one of the leading manufacturers of wheeled transport for young children, with a 36% share of a world market that stretches from Australia to Scandinavia. This means that in practice the products they make must operate efficiently across a very wide range of temperatures and humidities, and in on surfaces that vary from sand to snow. In addition they must meet safety standards during their operation as laid down by each country.

In Great Britain, the British Standards Institute (BSI) is responsible for such safety legislation. There are two sets of rigorous BSI standards that must be followed:

BS7409 1991 and BS4792 1984

The scope of the standards embraces:

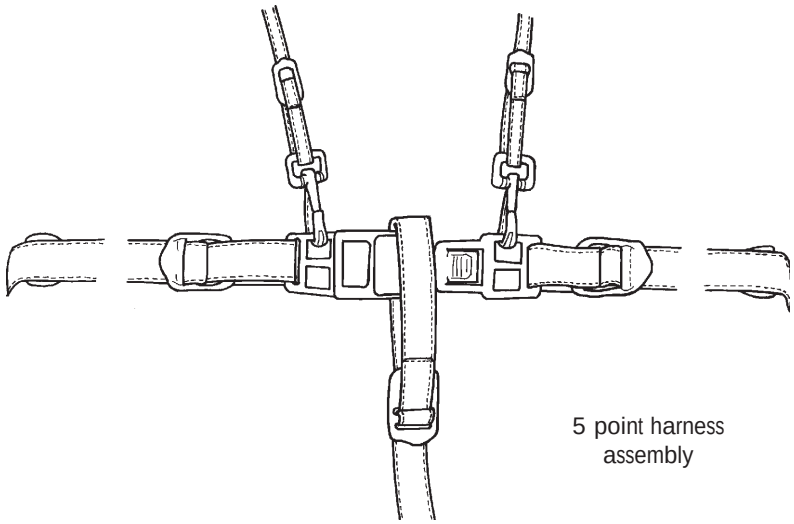
* the composition of materials (mainly plastics) to be used in the vehicle, limiting for example, the amounts of antimony, barium, cadmium. mercury etc. to be used.

* the composition of any coatings and finishes - paint, varnish, lacquer or similar substances

* the construction of the vehicle - it *"should not contain any open-ended tubes, loose washers, crevices or closing mechanisms in which a child's finger(s) or flesh are likely to be trapped".*

* parking devices

* safety harnesses. *"Seat and chassis assemblies shall be fitted with an integral 5 point harness assembly, comprising shoulder straps, waist strap and crotch strap"*



5 point harness assembly

* locking devices for folding vehicles - *"each folding chassis should have a least one primary locking device and at least one secondary locking device, all of which should act directly on the folding mechanism. The lever, or any other locking device, intended to operate a locking or parking mechanisms shall be positioned so that it is not possible, in normal use, to inadvertently operate more than one device in a single action"*

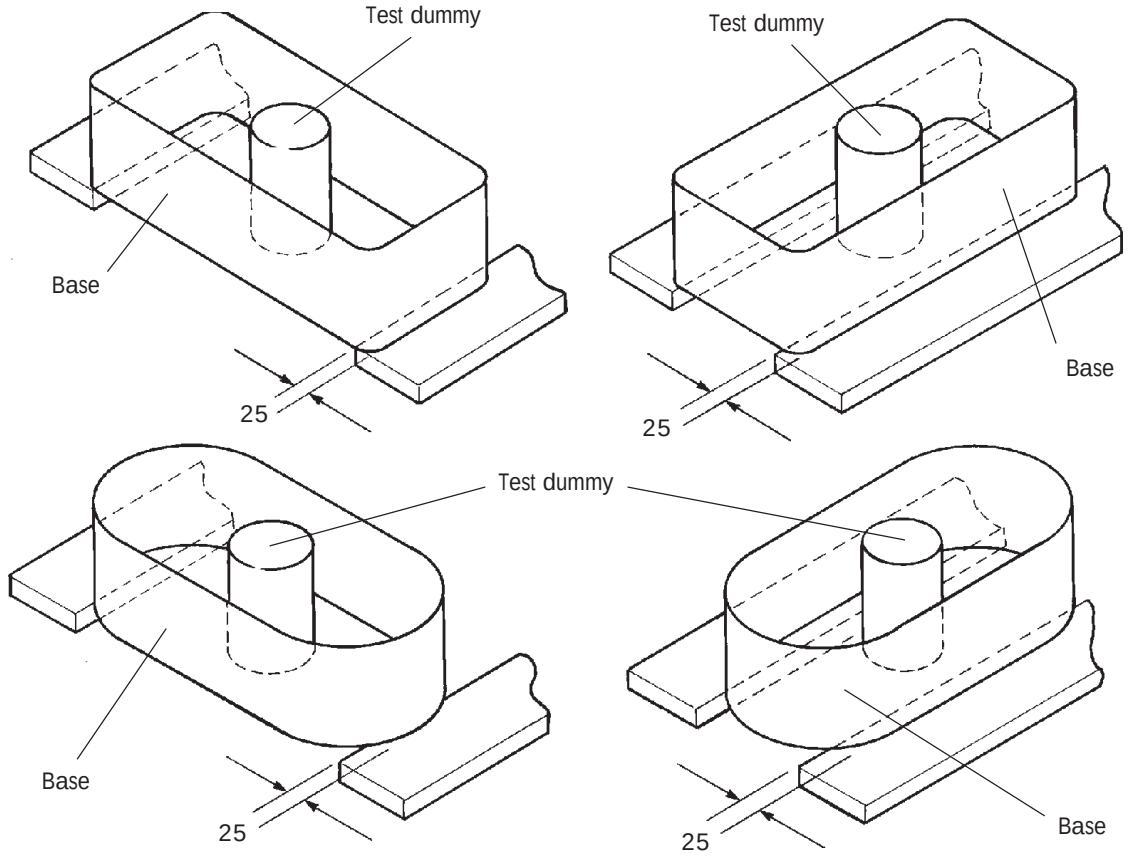
* performance of the vehicle in terms of stability and rigidity.

* instructions on the use and maintenance of the vehicle

The BSI documents give very detailed descriptions of tests to be undertaken by manufacturers to ensure that their vehicles meet the necessary safety criteria. The tests use two sizes of dummies - the details of which are very clearly detailed. For example:

Appendix B. Details of test dummies

B.1 A solid cylinder 200 +/- 5 mm in diameter and 300 +/- 5 mm in height, having a mass of 15 +0.01, -0kg and with its centre of gravity in the centre of the cylinder. All edges shall have a radius of 5mm. Two anchorage points shall be provided 150 +/- 2.5mm from the base and at 180 degrees to each other around the circumference.



Before Maclaren's, or any other manufacturer, embark upon the design and manufacture of a new product, they will conduct extensive market research. They will:

* *survey their competitors' products,* - for their construction, ease of use, features that are part of the pushchair, selling price and so on. Part of this information may be collated in tabular form.

	Push chair A	**Push chair B**	**Push Chair C**	**Push Chair D**	**Push Chair E**	**Push Chair F**	**Push Chair G**	**Push chair H**	**Push chair I**	**Push chair J**
Approx trade (£)	20.85	25.00	18.00	N/A	N/A	24.00	19.00	19.44	29.22	25.00
Approx Retail (£)	33.00	44.00	30.00	N/A	N/A	43.00	33.00	32.00	47.00	40.00
Fixed wheel	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Swivel wheel				yes (option)						
Foam tyres	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Foot rest	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Non padded seat	yes		yes				yes	yes		
Padded seat		yes		yes		yes			yes	yes
Fixed seat	yes	yes	yes		yes		yes	yes		yes
Lie back seat				yes		yes			yes	
Painted frame	yes	yes	yes	yes		yes	yes	yes	yes	yes
Othe frame finish					chrome					
Linked brakes	yes	yes	yes	yes 5 point	yes	yes	yes	yes	yes	yes
3 point harness	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Shopping tray					yes				yes	yes

From this review of products made by their competitors, the company will:

* *assess whether customers will buy the proposed product, and what they are prepared to pay.* (From the figures given in the table, Maclaren will need to produce the pushchair, Pushchair J, for no more than £25, to retail at around £40)

* *identify unique selling points.* The proposed product will have a padded seat, a feature of the more expensive pushchairs, and the provision of a shopping tray - again only available in a minority of products, at the more expensive end of the market.

* *check that the current and projected market for this product* (that is, the number of babies being born and likely to be born) is sufficiently large enough for another pushchair to be added to the range already available in the shops. The company will obtain figures produced by the Office for Population and Census Studies (OPCS) for the UK birth rate.
A sample of these indicates:

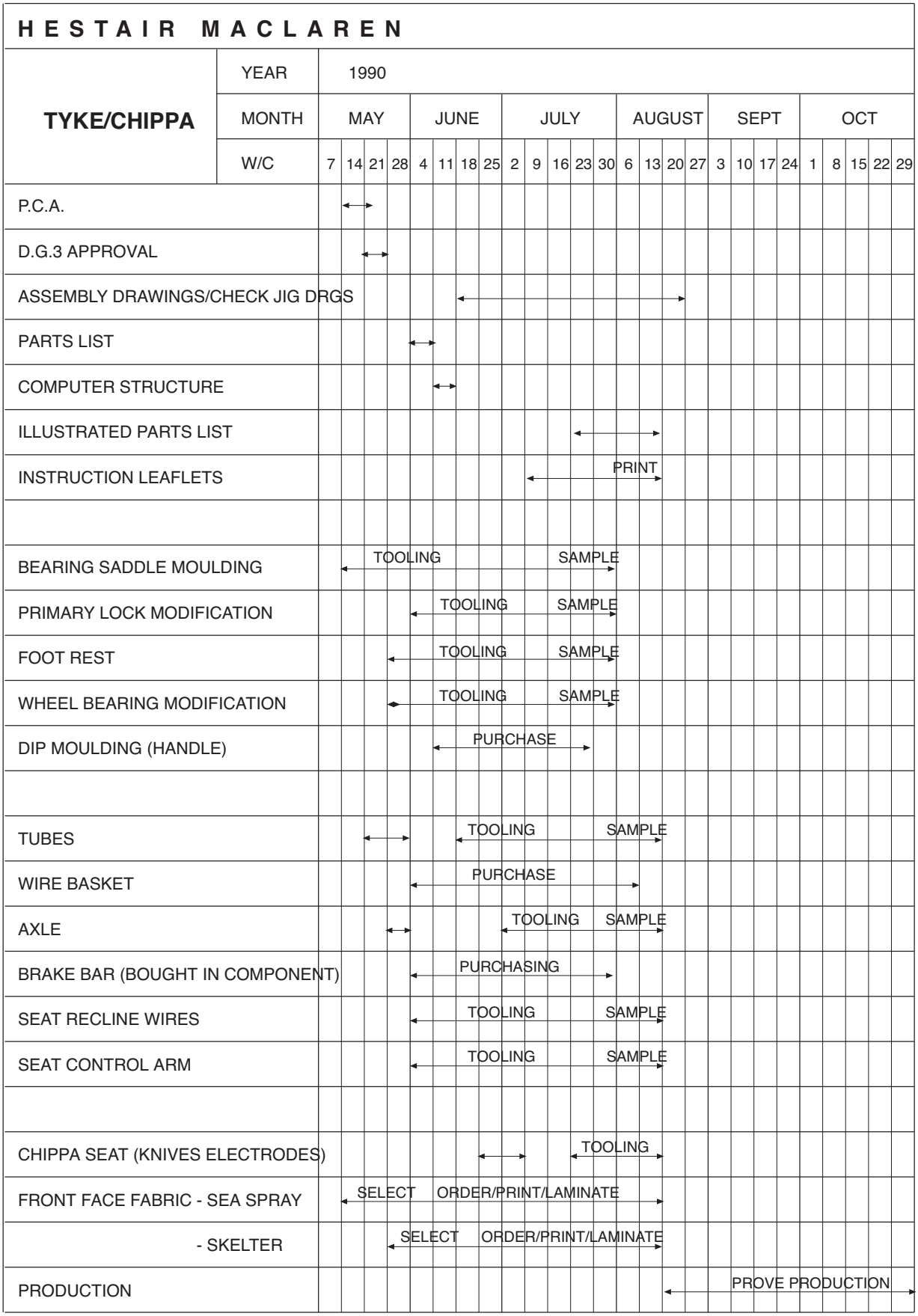
'000s' of births

	Actual (Jan - Dec)	**Latest Projection** (Mid year)	**Previous Projection** (Mid year)
1989	780.7		802
1990		796	823
1991		805	829
1992		809	835
1993		812	838
1994		812	858
1995		810	
1996		805	
1997		799	
1998		791	
1999		783	
2000		774	

How would you account for the differences between the original projections and the latest revisions? It would seem that the birth rate has now reached its peak - and will now decline slowly. Why do you think this is?

PLANNING FOR PRODUCTION

Although this is a new product, Maclaren will attempt to use as many existing components as possible - to keep production costs low . The company, as with the vast majority of all manufacturers, will already have a lot of experience and expertise gained as a result making similar products. As they produce the first prototype, the allocation of resources necessary to go into full scale production, together with a timescale will be made.


HESTAIR MACLAREN
TYKE/CHIPPA
YEAR
1990
MONTH
MAY
JUNE
JULY
AUGUST
SEPT
OCT
W/C
7 14 21 28 4 11 18 25 2 9 16 23 30 6 13 20 27 3 10 17 24 1 8 15 22 29
P.C.A.
D.G.3 APPROVAL
ASSEMBLY DRAWINGS/CHECK JIG DRGS
PARTS LIST
COMPUTER STRUCTURE
ILLUSTRATED PARTS LIST
INSTRUCTION LEAFLETS
PRINT
BEARING SADDLE MOULDING
TOOLING
SAMPLE
PRIMARY LOCK MODIFICATION
TOOLING
SAMPLE
FOOT REST
TOOLING
SAMPLE
WHEEL BEARING MODIFICATION
TOOLING
SAMPLE
DIP MOULDING (HANDLE)
PURCHASE
TUBES
TOOLING
SAMPLE
WIRE BASKET
PURCHASE
AXLE
TOOLING
SAMPLE
BRAKE BAR (BOUGHT IN COMPONENT)
PURCHASING
SEAT RECLINE WIRES
TOOLING
SAMPLE
SEAT CONTROL ARM
TOOLING
SAMPLE
CHIPPA SEAT (KNIVES ELECTRODES)
TOOLING
FRONT FACE FABRIC - SEA SPRAY
SELECT
ORDER/PRINT/LAMINATE
- SKELTER
SELECT
ORDER/PRINT/LAMINATE
PRODUCTION
PROVE PRODUCTION