

Designing and Making a Ford in Australia

From Vision to Reality

It takes anything up to five years for a new vehicle to emerge as a final product.

Along the way, market guides shape, function and features. Feasibility and practicality is tested as well as safety and endurance. Designers are kept on their toes as they nurse vision to reality.

Computer simulation is used to determine everything from aerodynamics to crash testing. Then a working prototype is made. From that point a production car is still two or three years away.

While prototypes are tested at the Proving Ground, manufacturing and assembly processes are planned in enough detail to keep track of the 4,000+ components that go into a car. This stage of planning alone can take 18 months before a trial run is carried out.

Planning dominates every step from production to marketing, all the way through to spare parts and registration certification.

Phase One: The Designing Studio

The Dream Team

This is where the creative process for a new car starts. The clean sheet of paper.... Well, not quite...

Designers start work on a new product only after the Business Strategy Office has developed a case for investing in a new car, and the Programs Office has done groundwork in key areas including components, features and packaging.

Preliminary layouts of the passenger and engine package are given to designers who must then breathe

style, personality and innovation into the project.

Design covers all that drivers and passengers will experience – appearance, image or style, touch, feel, colour, ergonomics, communication through the car's graphics.

All this must be achieved within a certain price and marketing limits, and the final design then carefully nurtured through the long process that leads to a new model.

Colour and Trim

The colour and trim designers are influenced by fashion, furnishing and product trends as well as automotive, as they choose the colour palette and fabric range for every model.

Their brief covers every part of a vehicle that can be sensed by the customer, even the engine bay.

Trim design is one means of distinguishing models. For example, basic vehicles will have no-nonsense knits, or hardwearing, easy-clean

weave fabrics. At the prestige end, high quality velour and leathers create a luxurious ambience.

Achieving colour harmony throughout the car is a time consuming process. Colour and trim designers' work from trend forecasts, through image boards, fabric sketches and renderings, to sample runs, colour mastering and matching, trials and the eventual launch.

Trimming

Development trimmers have the all-important task of making prototype seats that are not only comfortable, but also functional and stylish. They work with engineers and designers to create ergonomically correct foam pads that are trimmed in pre-production fabrics for evaluation.

Trimmers sculpt the foam with knives and develop new patterns from which covers are made. They refine the sewing styles to improve quality and reduce cost.

Countless seats are made and tested before a new seat range and fabric collection is approved.

How is a car designed?

'Thinking on the end of a pencil'

Designer's personal sketches are the first steps towards the look of a new model. Some of these are followed through to become colour renderings that then go to management, engineering and marketing for their comments.

These all-important renderings are done in colour pencil, pastel, ball point and felt tips or on a 'paint box' computer.

Style is vital, but ideas will be

rejected or sent back for more work if they are not feasible and practical.

Designs themes are developed about four years before their launch, and then continued for four to eight years before a major facelift. A good designer has to be able to predict public tastes up to five years ahead.

Each design must complement previous models. It must also be compatible with Ford products sold around the world.

Tape drawing or ALIAS development

When design ideas have short-listed, full-size tape drawing are developed using adhesive tape over mylar film. Each conforms to package guidelines and is accurate to within 5 mm.

These tape drawings can be changed continually until everything is just right. Until recently they were used for the clay model to determine initial feasibility and to assess realistic

proportions.

Recent developments in 3D CAID (3-dimensional Computer Aided Industrial Design) now allows designers to use ALIAS software to produce three-dimensional electronic models, which are then used to produce a full-size clay model by milling the clay.

Clay models

Computers have changed the physical craft of modelling, but the same special 'clay' which has been used for more than 50 years is still being used, and is likely to for years to come.

This clay – a secret blend of waxes, fillers, and sulphur – is stable, safe, quick to block-in surfaces and flexible enough to allow changes to be made easily.

Clay is used for full-size exteriors, interiors, wheels, roof, boot, and engine bay trims in order to develop the shape and gain approval for production. Modellers use precision tools to sculpt intricate surfaces and shapes.

Every part and surface has to be true not only to the design, but to manufacturing, assembly, structural, cost and legal requirements.

Design model process

Models can be made by traditional methods or computer generation – they both start with the armature.

A full-size rigid steel frame is made, boxing in the basic form of the car. This is clad in custom board, and then rigid foam.

Clay is applied to models, by hand, while it is hot, to an approximate thickness of 40 – 80 mm.

Once it is roughed in, the clay surface is milled using either a high-speed axis mill or hand sculpted to shape.

At the start, modellers refer to concept sketches and the tape drawing, but as the shape progresses they work with designers to refine the form by eye.

From time to time the model is examined on an outdoor turntable, and viewed from a distance to check that the play of light and proportions on surfaces is as planned.

The final step is to produce a fine surface, after which it is electronically digitised for production engineering. It is then covered in a film called dynoc and painted to look exactly like the car when it will be in production.

Interior and exterior

Designers put equal effort into the interior and exterior of every car – after all, both are equally important to the customer.

The exterior design is all about moving sculpture – proportion, stance, the way light and reflection play on the surface, identity from 50 metres, and the look of glass, lights and grille.

However, the designer's hand is guided by the requirements for

ventilation, safety, ergonomics, visibility and often international regulations. Having to use pressed steel and glass, and consider things like cooling and aerodynamics, repairability and product improvements also imposes limitations.

The interior design must deliver a feeling of comfort and safety, vehicle contours that are easy to use, all in a blend of form, colour and texture that appeal to the occupants.

Ergonomics and packaging

Have you ever thought about the way people fit into cars?

Ford 'packages' people in cars.

One of the first steps toward the development of every new model is by analysing the best position for the occupants of a vehicle of the type and size being proposed.

The position of the primary controls, engine, floor, firewall, wheel arches and interior roof are all part of the

equation.

Packaging engineers work with designers to meet strict regulations and specifications, which ensure maximum safety, vision and ergonomic quality while maintaining the spirit of the new vehicle.

The 'package buck' is a mock up of the seat and interior volume. This allows Ford to use real people to check the interior space for comfort, control and entry.

Computers in design

In the late 1970s, a revolution hit the car design – CAD (computer aided design). Traditional drafting (done with pen on tracing paper or mylar film) could now be computer generated.

This speeded up the draftsman's job, enabled greater accuracy. It also aided engineering development. Lead times tumbled from five to three years.

It spawned a new job – the CAD designer.

Through a digitised scan of the clay model's surface, a mathematical model of the exterior and interior surfaces is created.

These powerful computer systems

reproduce the clay's surfaces to ensure accurate body shape when manufactured. All structural, working, and assembly systems are evaluated and engineered using CAD.

If CAD revolutionised the 1980s, CAID (computer aided industrial design) is revolutionising the late 1990s.

This powerful system enables the designer to create in three dimensions.

In the future, cars will be developed digitally and go directly to manufacture. New technologies such as holograms and virtual reality will allow assessment of designs.

It's an exciting future!

Phase Two: Engineering and Testing

Before manufacturing a new design, every part is engineered and tested for safety, durability and customer satisfaction.

The Proving Ground

Before secluded facilities were set up in 1965, Ford engineers used to test drive prototypes on public roads – to the great delight of spy photographers. That changed with the establishment of the Proving Ground northwest of Geelong in the foothills of the 'You Yangs' range.

Cars are tested on a variety of surfaces and terrain simulating the best and worst of possible road conditions.

Test cars sometimes circle Geelong's Proving Ground tracks 24 hours a day.

Ford engineers have developed a number of techniques that compress 'lifetime' testing into a short period. Accelerated testing is done by replicating a range of road surfaces, terrain and environmental conditions. Test cars go through more in six months than most vehicles do in a lifetime.

Specific Tests

The Proving Ground has a circuit for durability and constant speed. It also has 55 km of test tracks, which replicate conditions ranging from country roads and wet weather, to broken and patched surfaces, cobblestones and square edged potholes.

Several laboratories assess every aspect of the car from the customer's perspective:

The Noise Vibration and Harshness Laboratory analyses vehicle noise and vibration.

The Salt Spray and Humidity

Chambers conduct accelerated corrosion tests.

The Environmental Laboratory performs climatic tests at temperatures between -20 and +50 degrees Celsius with relative humidity up to 95%. The vehicle is driven on a chassis dynamometer which also simulates road and wind conditions up to 160 kph.

The Emissions Laboratory measures passenger vehicle exhausts and evaporative emissions, as well as testing fuel consumption.

There are also Vehicle Fire test and Barrier Crash facilities.

Test, test, then test again

In order to design each part of a car properly, measurements must be taken to establish the number of operations each component will have to perform during its lifetime, and the forces working on a vehicle. Strength, durability and performance are tested under every conceivable condition.

New ideas are considered and virtual 'parts' are created for computer modelling. Prototype parts are made and assembled into full prototype vehicles.

The simplest form of testing is to

drive these prototypes at the Proving Ground. However, this only covers a small proportion of customer extremes. The majority of testing is performed on individual parts on test rigs that reproduce field conditions quickly and repeatedly in the laboratory.

Represented here are some of the hundreds of individual tests performed on car parts. So that you can see what's happening, the test rigs in this exhibition have been simplified and forces reduced to minimise noise.

Crash testing

The crash test is over in the blink of an eye.

Every car sold in Australia must conform to Australian Design Rule Standards that require crash test dummies to 'survive' a 48-kph full frontal impact into a solid barrier. The vehicle must absorb the energy of impact in a way that minimises forces measured at the dummy's head, neck, chest and legs.

The test vehicle has instruments to measure dummy and vehicle forces.

High-speed cameras record the interactions between components – coloured for film clarity – and movements can be tracked by target reference markers. These records allow precise analysis of very rapid events.

Today, computer simulated crash tests are dramatically reducing costs. While it is estimated that a real crash of a prototype vehicle can cost more than \$300,000, a 'virtual' crash that yields comparable information may cost only \$15.

Safety testing

Safety is a top priority for Ford. The focus is on to key areas – reducing the risk of injury in a collision, and helping drivers avoid accidents in the first place.

Cars today are designed to protect their occupants with safety features including anti-lock brakes, air bags,

reinforcement bars and navigation systems.

In the near future, cars are likely to include features such as impact sensors, adaptive sensor cruise control, road guidance systems, lane change sensors and enhanced night vision.

Phase Three: The making on the car

A 4,000 piece jigsaw puzzle

The modern car is made of over four thousand separate components. Sourcing, manufacturing and assembling these parts into a finished

car requires precision planning and organisation. Ford Australia uses a Just in Time production and inventory system...

Geelong Operations

Press Operations

The manufacture of vehicle body components requires special tools called dies. A die is a mould made from a large block of steel.

Dies are made in the Toolroom, then used in the Press Plant to make everything from doors to boots. Each type of car panel has a particular metal thickness, grade and surface finish and requires a unique set of dies.

Steel arrives in flat sheet or coils and

is fed into presses that cut it into 'blanks' – the shapes and sizes needed for each panel. Presses of up to 3000 tonnes stamp these blanks into recognisable shapes as bonnets and roofs.

After being stamped into shape, the metal is removed and transported along conveyors to the next set of press operations. Each of the nineteen lines of five or six presses produce about 350 panel an hour.

Earth, wind, and fire – aluminium casting

The casting plant is where engine manufacture begins. The process is often called 'earth, wind and fire' due to the sand, cool air and hot furnaces used in casting an engine.

Moulds are made from green sand and impacted into a moulded pattern. Furnaces are used to heat the raw metals to the melting point of 1440 degrees C. cores made of sand

bonded with resin are added and the molten metal is poured in.

Robots place the hot components on a conveyor. The castings cool as they move along to the end where they are cleaned.

'Grinding the flash' removes the burrs and lumps, and from here the castings are sent to the Engine Plant.

The Engine Plant

The cast components are machined to exact specifications. All other components from supplies and stamping operations are then added

along an assembly line. The completed engines are then tested and sent to the Assembly Plant at Broadmeadows.

Suppliers

There are 2,300 suppliers to Ford Australia.

Components such as seats, headlamps, fuel tanks and instrument panels, ABS braking systems, paints, and instruments and clusters all come from external suppliers such as

Hendersons, Hella, Venture, Bosch, Dulux, VDO and many more.

70% of the car is purchased from suppliers. Ford spends \$2 billion dollars each year with them. \$500 million is spent on non-production parts from pens to electricity.

Broadmeadows Operations

Assembly

The whole assembly process is extremely well organised. Controlled by a master computer, orders from dealers all over Australia are programmed into a production sequence.

For instance, two Fairmonts may be followed on the assembly line by a Fairlane, then a utility, all in different colours. Each different model is made of different components.

Each vehicle has its own 'identity card', which specifies the exact component to be fitted. With more than 4,000 individual parts in each car there is no room for mistakes.

Ford uses a 'Just in Time' supply system to deliver components to the assembly line just before they are needed. The delay of one part can hold up the whole process.

Body construction

The car underbody consists of three sections: engine box, front and rear floors. These are welded together by production robots and placed on a simple frame called a skid. The side parts of the body are welded to the

floor. The roof is then welded to the sides. Doors, bonnets and boots are added as the car moves along the line. The completed body is now ready to be painted.

Painting

The car body is first moved through a series of large dip tanks, rinse baths and high-pressure spray rinses. An undercoat of paint is applied by immersing the body in a tank of water-based paint.

The body then passes through an

oven and is baked. Primer coats are added using several spray booths. The body is then transferred to where the final colour coats are added. ClearCoat finish is applied, then the body receives its final oven baking.

Trim Assembly

The interior trim, instrument panels and wiring are fitted as the car moves along the 110 stations on the trim line.

Coded computer printouts attached to each car ensure that the right parts and options are fitted to each model.

Final Assembly

At the end of the trim line the body is lifted from its skids and transferred to the elevated clamshell conveyor and finally lowered onto the engine/transmission section and rear

axle unit. This is called the 'body drop'. Then radiators, air conditioning and other engine components are installed.

Testing

Fuel, water and brake fluid are now added and the vehicle is started for the first time. Wheel alignment and headlights are adjusted, and the vehicle is driven through a high-pressure spray booth to test for water leaks.

electrical systems are checked on a vehicle dynamometer as part of the final inspection.

Engine, transmission, brakes and

New vehicles are then driven to a holding area. They are then transported to more than 250 Ford dealers throughout Australia.

Phase Four: Marketing and Distribution

Shaping the cars of tomorrow

Marketing and sales is the final yet critical phase in the birth of a car – it

involves selling the right product at the right price to the right person.

Marketing and sales

Marketing and sales are all about selling the right car, at the right price, to the right person. Market research guides everything from product development to advertising campaigns.

Ford's customers include people of all ages and interests, as well as businesses, major fleet companies and government departments. Ford knows what they are looking for, and where they are looking for it.

As an example, the XR series is mainly aimed at men between 30 and

45, who would describe themselves as 'living life to the fullest'. Ford knows they love the excitement of power. They know the best place to advertise to them is at major sporting events, and on television during sports shows.

When Ford develops an advertising campaign they look at the lifestyles of the people in their target market. Advertising will reflect their interests and ideas, and allow them to know more about the vehicle, and identify with it.

How and why 'Live it' developed?

Ford wants people to feel good when they think about Ford.

They want people to see their corporate brands as inspirational, in touch with the times, and approachable. The 'Live it' campaign meets all those objectives. It shows Ford employees as passionate about their jobs and the product. They have a zest for life and a pride in their work. The campaign shows a company that produces stylish,

reliable and safe vehicles that allow their customers to get the most out of life and share the passion that goes into them.

The advertising campaign featuring Suspension Engineer, Chris Yates is a perfect example. In the television commercial he examines the spring on the hotel bed before getting into it. It's fun, but also reflects Ford employees' constant quest for the highest possible standards.

Phase Five: The Future

What the smart car will be doing in 2010

- The car will be talking to you and you'll be talking right back to it. Ford-owned companies already have the technology for you to tell your car to start, turn on the air-conditioning or change the CD.
- Satellite navigation will be helping with everything from steering to finding a parking spot.
- The Satnav system will communicate with sensors on the road to establish likely traffic conditions as you travel. Traffic jams will be reduced as your intelligent car processes information and act on it.
- Satnav will eventually integrate with the Internet to search out details on the restaurant or shop, or whatever you want to visit.
- If your car is in an accident, satnav can not only send out the alert, but also pinpoint the location.
- Satellite tracking also will make life hard for thieves – communicating your vehicle's location if stolen.
- 'Virtual bumpers' will prevent you getting too close to the car in front.
- Intelligent safety systems will include airbags that assess how quickly inflation is needed – reducing the risk of injury.
- A sensing system will monitor driver alertness via eye movement and warn against the danger of falling asleep at the wheel.
- Children will be watching television in the back seat.
- Computers will tell you when your car needs repairs, and then report the fault to your nearest dealer and arrange for service.
- Petrol will no longer burn, but be broken down chemically to create electricity for engine power – with particularly low levels of toxic emissions.
- Ford's Synergy 2010 concept car demonstrates the hybrid car of the future where small engines work alongside an electric motor.
- Another Ford concept car, the P-2000 – which looks like a Ford Mondeo – uses a hybrid power plant capable of travelling 100 km on just 3.5 litres of petrol.
- Parts will be lighter and stronger through greater use of aluminium and magnesium along with the efficiencies of computer aided design.
- Infrared sensors that see in the dark or in bad weather will reduce accidents caused by poor visibility.
- The Lifestyle Demonstration Vehicle shows some features of the future, such as voice-activated email, a personalised news service and a portable notebook computer linked to a small printer in the glove box.

Imagine 2050

People will be working, dating, shopping on-line from home. Downtown areas of cities will be car-free, serviced instead by electric trams and trains... but private car ownership will survive, with some major differences.

The driver will be merely the occupant by 2050. There will be no need to steer, brake or accelerate – that will all be taken care of by the automatic guidance system.

The 'driver' will command the destination and the car will plot the route, give an estimated time of arrival and do all the rest.

The engine will be electric, charged whenever it is parked. Insulation will block out external sounds, except for the basketball match, which might be on the monitor which, will be where the steering wheel used to be.

There will be no need for headlight or brake lights. Cars will detect each other by radar, and an electronic pulse will warn other cars of a vehicle slowing down.

Solar power will be common, which will lead to big cars with large upper surfaces to capture and store the sun's energy.

Perhaps they will be carbon fibre boxes with wheels. They will certainly be more attuned to issues of the environment and access than the cars of today.

Smaller engines will mean more lounging room inside. Occupants will have time to take advantage of optional extras such as coffee percolators, intergalactic television or an intranet video link.