A cool ride
A LOOK AT MODERN AUTOMOTIVE CLIMATE CONTROL
Also, due to our landscape and hobbies, Australian vehicles not only need to keep occupants cool but also need to tow large loads at the same time. This means they must be robust to various climate conditions and surfaces while under load. This creates a unique challenge for balancing powertrain cooling, while maintaining adequate condensing to keep the air conditioning engaged and keep occupants comfortable.

"All Ford motor vehicles are designed to meet strict global specification requirements. Vehicles bound for the Australian market are required to be designed to meet the warm market classification.

I am the recently appointed Asia-Pacific climate attribute supervisor as part of Ford’s Body Interior team.

Our Program Attribute team is responsible for developing climate systems for various vehicles in the Asia-Pacific region, including current and future model Ranger, Everest, China Taurus, China Escort, Figo in Europe and India, to name just a few.

Occasionally, we also have opportunities to support our North American operations on future model vehicles such as the Bronco.

The basic components of air conditioning or climate control systems in Australian vehicles are similar, if not the same, to those for the northern hemisphere.

Various countries in the Gulf States can experience similar ambient and sun loads to Australia. Where we differ is in calibration to achieve a cooler cabin to other regions. Europeans typically like the cabin to be warmer than in our Asia-Pacific region.

Unsurprisingly, automotive HVAC is evolving just as fast as kit in the built environment.
requirements, which are more challenging in terms of air conditioning performance than those in a European region, for example.

For a vehicle to be sold in Australia, it is required to meet the specification relevant to our market.

**The largest environmental wind tunnel in the southern hemisphere is used for a wide range of climatic vehicle testing.**

The ACART (Advanced Centre for Automotive Research and Testing) facility is used to simulate any condition or location in the world.

It is capable of conducting heater performance testing down to an ambient of -20°C and air conditioning testing in a simulated ambient over 50°C, with high sun load simulation to over 1200W/m² and high humidity. This can represent a hot day in the middle of the desert with a clear sky and full sun load, or a humid day on the coast.

In addition to temperature testing, the ACART has a dynamometer that can simulate towing a trailer or driving up and down inclines. This facility is used to optimise our climate heater and air conditioning performance, as well as develop technical solutions and new technology for our vehicles.

A good automotive air conditioning system has sufficient capacity with appropriately sized heat exchangers, efficient compressor technology, and a superior airflow system to deliver the cold air to the cabin.

Vehicles can easily exceed twice the ambient temperature on a hot day, so it’s essential to purge this hot air as quickly as possible, with a smooth transition to the customer’s desired set-point temperature.

Optimised airflow volume and vent velocity balanced with NVH (noise, vibration and harshness) are also important factors when providing a comfortable cabin space. Good system stability once the cabin has been purged maintains comfort, and keeps the cabin fresh and glass areas clear.

The air-handling system is critical to achieving cabin comfort, and needs to be versatile enough to satisfy the wide range of customer preferences.

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**FORD’S ENVIRONMENTAL WIND TUNNEL**

The Advanced Centre for Automotive Research and Testing (ACART) is a collaborative undertaking between the Ford Motor Company of Australia and the University of Melbourne.

The Environmental Wind Tunnel facility provides a controlled and repeatable environment for development of products suitable for global markets. It is certified to ISO 9000 and ISO 14000, and is supported by a team of six technicians and one engineer.

**Specifications and capabilities**

**AIR CONDITIONING**

- Top speed: 250km/h
- Temperature: -40°C to +55°C
- Temperature stability: ±0.25°C

**Humidity control**

- 1-95% RH between +15°C and +55°C

**Humidity stability**

- ±2% RH

**Nozzle sizes**

- 4.0 and 2.7m²

**SOLAR SIMULATION**

- Operating range: 10 to 1200W/m²
- Irradiation area: 6 x 2.5m
- Irradiation uniformity: ±5% within irradiation area

**Spectrum**

- Full, with UV-B filters

**Directionality**

- Diurnal movement system

Source: www.acart.com.au

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Like in the built environment, automotive air conditioning systems are witnessing a change in the type of refrigerants being used.

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Ford’s ACART facility wind tunnel can simulate any climate condition or location in the world.
Airflow volume, air velocity/direction, and air-plume pattern are critical components when attempting to purge a warm cabin. These factors provide cool, relieving air to the occupants without over-chilling them, or disturbing their comfort by delivering too much or too little airflow.

The airflow path through the cabin space is also important. Body vents need to be specifically sized to allow adequate cabin purge, maintain a comfortable pressure, and resist external environment elements from entering the cabin.

Air from the vent outlets must be able to reach face level on tall occupants, as well as directing air to the waist region of the average-size person. Distribution of the airflow is also important to ensure the correct quantity of airflow reaches the occupants’ feet, face, and vehicle glass areas to keep them clear.

Like in the built environment, today’s automotive climate control systems rely on field data to deliver conditioned airflow to the cabin space.

Ambient temperature, humidity, heat load, sunlight, air quality, set-point temperature, and the cabin temperature are all inputs into a climate control system which use this data to define the appropriate course of action.

The inputs need to be calibrated to deliver the best outcome based on what the customer is requesting their climate system to deliver. In vehicles, smart strategies manage these sensor inputs to not only provide a safe and comfortable environment, but also optimise fuel efficiency, reduce heat loads on other vehicle systems, and keep glass areas clear of fog and ice.

Components such as the compressor, condenser, expansion valve or orifice tube device, evaporator, refrigerant, temperature and pressure sensors are all common components to climate control in both vehicles and the built environment.

But the above mentioned items are similar in type only and differ considerably in design.

A vehicle’s HVAC system must be compact and contain various internal doors and flaps for mixing hot and cold airflow. These doors and flaps also work to change outlet modes to allow air to different outlets in the vehicle, either by request or by a software component.

The conditions a vehicle will experience are far more dynamic, diverse, and extreme than in the built environment. Built systems don’t need to react as quickly to dynamic conditions experienced in a vehicle, as the environment is more stable and less likely to experience a rapid change in condition.

Like in the built environment, automotive air conditioning systems are witnessing a change in the type of refrigerants being used.

R1234yf has been slowly phased in since 2014 to replace R134a, which is being phased out because of its global warming potential (GWP) of 1430. This is important, given it can leak into the atmosphere in the event a vehicle is crashed or is poorly repaired.

The European Union (EU) will require a refrigerant with a GWP of less than 150, and will eventually mandate this on all new future vehicle models. R1234yf is being marketed as being a refrigerant with a GWP of 4 or less. Switching to R1234yf industry-wide, including in Australia, is forecast to eliminate millions of cars’ worth of greenhouse gas emissions.

The main downside we see is higher cost and some equipment upgrades.

CO2-based air conditioning systems have also been developed, and have a GWP of 1. These aren’t as common, as they need to operate at slightly higher pressures to be effective, which means the compressor draws more power, which could affect fuel economy and tailpipe emissions.
As with all automotive components, HVAC components are constantly advancing to become smaller, more efficient, lighter, multipurpose and smarter.

Many HVAC components now have brushless blower motors that use less current and run much quieter. Heat exchangers are constantly shrinking and achieving higher outputs as more modern materials become cheaper to use. Thinner evaporators have fine fin pitch and pass configurations. Water-shedding coatings reduce surface tension in condensate, making components more efficient and eliminating odours by shedding liquid immediately.

Energy efficiency is always a focus. Technological advances are allowing us to downsize a major component like a compressor by adding technology such as internal heat exchangers that make use of lost heat to improve the quality of refrigerant to the thermal expansion (TX) valve.

Any technology than can reduce load, minimise fuel consumption, and reduce tailpipe emissions is always a focus for our team.

Smart strategies that also minimise loads, like recirculation mode and engine programs to help warm up coolant faster and improve driveline efficiency, are also widely implemented.

As engine capacities reduce to improve fuel consumption, we are constantly challenged to invent new strategies and controls to deliver outcomes with reduced engine torque and capacity.

Strategies to open/close windows and turn systems on/off while the vehicle is parked reduce heat load and purge the cabin space in preparation for occupant return – features like this are now being included in most new models.

Electric vehicles present some new challenges to conventionally designed HVAC, but also present new opportunities to make improvements.

Electric compressors are not dependent on engine RPM (revolutions per minute), and hence this provides us with new control opportunities because we can request the compressor speed independent of the engine speed.

A vehicle’s HVAC system must be compact and contain various internal doors and flaps for mixing hot and cold airflow.

We can also locate components in new areas previously not possible, by simply running an electric supply to it. Peltier-type devices that produce heat and cold from a voltage source rather than heat exchange are also becoming more common.

With the shift to mobility design in automotive systems, driverless cars and new ways of moving around, we are expecting conventional thinking around how HVAC systems maintain comfort to also evolve.

New ways of identifying a person’s state of comfort are surfacing. As a result, how we deliver the environment that provides comfort is also changing.

Solar glass, built-in interior blinds, solar-powered air-purge systems and more clever control systems that analyse air quality, quantity and temperature before delivering a solution are just some technologies that will become commonplace.

Along with these technologies, we will also see improvements in reduced noise during operation.

There is no limit to the opportunities for climate technology in the future as new ideas become more affordable. It’s an exciting time to be involved in automotive climate control as the concept of the motor car evolves to the next phase.