# Process for By-Wire-Brakes

- Process to identify the optimal combination of processor, sensors, code and resources
- TargetLink's code profiling techniques aid in processor selection
- Quick turn around

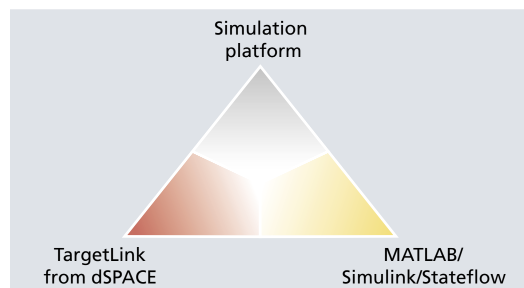
**Fast-tracking electronics development usually creates prototypes that are not representative of the final product. PBR and the Research Centre for Advanced By-Wire Technologies (RABiT) decided to transform this design approach. They integrated TargetLink into a product development cycle to accelerate development of PBR's new electric park brakes. They achieved the triple crown of enhancing features, functions and performance, added automatic production code generation to the process – while controlling product costs.**

## New Park Brakes

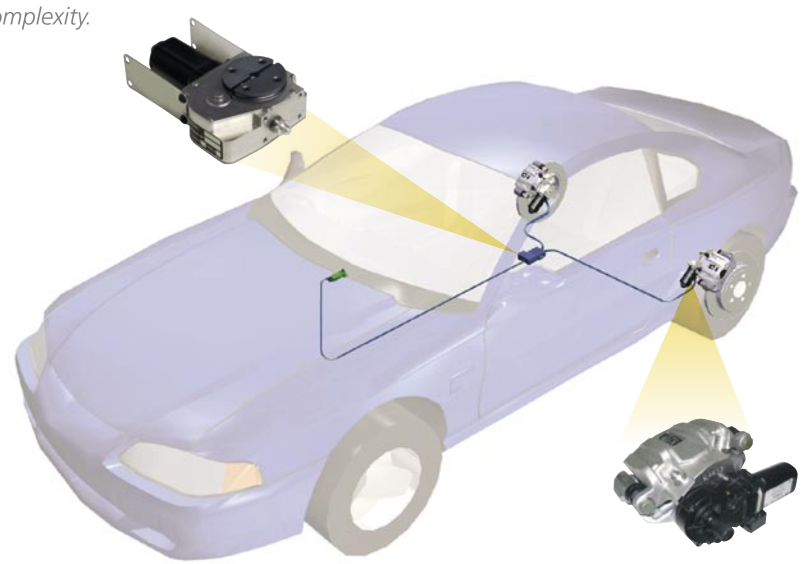
Developing automotive products that enhance the driver-vehicle relationship, increasing product performance and reduce costs would seem to be incompatible requirements. At PBR, we took on this challenge when we developed our range of ePark™ electric park brake solutions. The criteria to be met by the product include:

- End users' need for reliability, ease of use, convenience and advanced safety features
- The vehicle manufacturers' focus on reliability, reduced weight, cost, manufacturing flexibility, improved design freedom, performance, and packaging space

While developing our ePark product range including a cable puller and an innovative park brake mounted directly on the disc brake caliper, we bridged the development divide between software, sensor system and electronics using modern development techniques and processes primarily supported by the close integration of TargetLink from dSPACE and MATLAB®/Simulink® from The MathWorks.




▲ *Development triangle*



▼ *PBR's innovative electric park brake reduces vehicle weight and park brake complexity.*

## Development Bottleneck

Electronics is a significant part of the modern automobile. The software that supports electronic devices is intangible; for some period designers may not fully comprehend the optimum configuration of sensors, processors, electronics and software that achieves the lowest cost. This often initially sends prototype development in a direction that is not representative of the final product intent.

In the development of mechanical components, methods like stereo lithography are used to produce quick-turnaround prototype parts that we can evaluate for a number of criteria including fitment, clearance and appearance. However, there is no such family of techniques for electronics.

## Changing of the Guard

Working closely with RABiT, we challenged ourselves to find a workable solution and opted to use Simulink to deploy a zero-distance, virtual development environment that simulates the park brake control structures. TargetLink was used to generate code and perform processor-in-the-loop (PIL) simulations. To evaluate the functional prototypes, we developed a simulation platform to execute the code on each selected processor and to connect the sensors. This proved to be an efficient development triangle, where at any stage activities can be monitored, evaluated, compared and tested for attributes such as performance and functionality using TargetLink's PIL simulation and code profiling features.

This process enabled us to determine the viability of a concept or optimization strategy. The result of this method was an integrated solution that mirrors the final product.

### Stage 1 – Control Design

Development of the control structures included modelling the system sensitivity and response times against target hardware requirements. This step enhances early stages of product development as the requirements are assessed by other divisions e.g. product test for:

- Clarity
- Completeness
- Consistency
- Functionality
- Performance
- Testability

### Stage 2 – Model Simulation

Simulation of the models was conducted and the results used to evaluate performance and establish if the product goals were attainable, providing a benchmark for each solution. This step ensured that any changes made did not have a negative impact.

### Stage 3 – Development of Test Harnesses

Simulation test harnesses that enabled over 20 test cases to be performed were created. This allowed collection of maximum and minimum values and studies of sensors' cost, performance and resolution to be conducted. The results of this were fed back into the control design. This step allowed us to quickly evaluate the impact of sensitivity and refine the requirements of supporting sections to suit the selected sensor.

### Stage 4 – Fixed-Point Implementation

The target code was converted into fixed-point, and integration simulation was performed again to establish the scaling errors. Any scaling errors identified were fed back into the control design.

### Stage 5 – Simulating the Target

Using PIL simulation, TargetLink code was executed on the simulation platform, effectively creating functional prototypes. The recorded signals from stage 3 were used to excite the simulation.

### Stage 6 – Performance Feedback

The results of the tests, including sensor results, processor performance, code size and RAM size were analyzed with the aim of optimizing the control design for the selected processor and electronics platform and the desired functionality.

### Step 7 – Target Deployment/ Testing

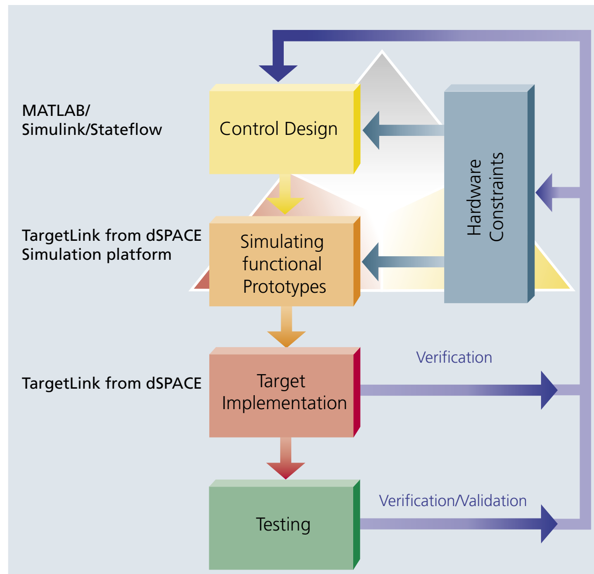
The resultant code was deployed on the target and tested in both an HIL- and a vehicle-based environment.

## Answers in No Time

Simulation did more than just simulate, linking in the development variables, it also enabled us to evaluate different variants of processors, electronics and sensors. This was not done against standard test routines, but rather each solution was individually optimized for the specific target elements. Any assumption of cost conflicting with performance, features or functionality was quickly swept away, enabling the right design decision to be made.

*Dennis Plunkett,*
*System Engineer*
*PBR Australia*

▼ *Performance and resource measurements were conducted to select the best-suited combination of processor and sensors for the control design.*




PBR is a subsidiary of Pacifica Group Ltd. and Australia's leading supplier of brake system technology. SAE Australasia's Gold Award for Automotive Engineering Excellence was awarded in 2004 for the design and development of the ePark electric park brake.
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