Contents:

McGowan Virtual Prototyping

In any modern engineering business, there is immense pressure to produce better designs using faster and more cost effective processes than ever before.

Through the use of Virtual Prototyping, MVP can help customers meet these challenges. Virtual Prototyping is the ability to create, test, refine and optimise designs using a computer model. Thus reliance on physical prototypes can be reduced significantly, thereby saving time and money and improving design quality.

MVP

McGowan Virtual Prototyping Ltd.
7 Styvechale Avenue, Earlsdon, Coventry CV5 6DW. United Kingdom.

Tel: +44 (0) 2476 712389

Mobile: +44 (0) 7811 203727

email: neil.mcgowan@mvpro.co.uk

www.mvpro.co.uk

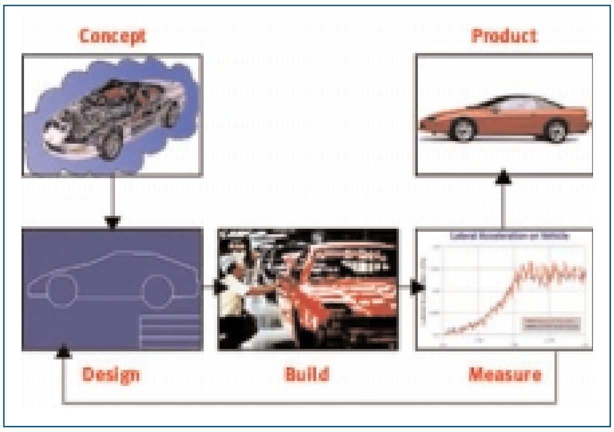
What is Virtual Prototyping?

In any modern engineering business, there is immense pressure to produce better designs using faster and more cost effective processes than ever before.

Through the use of Virtual Prototyping, MVP can help customers meet these challenges. Virtual Prototyping is the ability to create, test, refine and optimise designs using a computer model. Thus reliance on physical prototypes can be reduced significantly, thereby saving time and money and improving design quality.
MVP Ltd. has extensive experience of implementing virtual prototyping effectively within any existing design or test environment.

Traditionally, the approach to design has been a sequential process moving from concept to product with little room for design iteration.

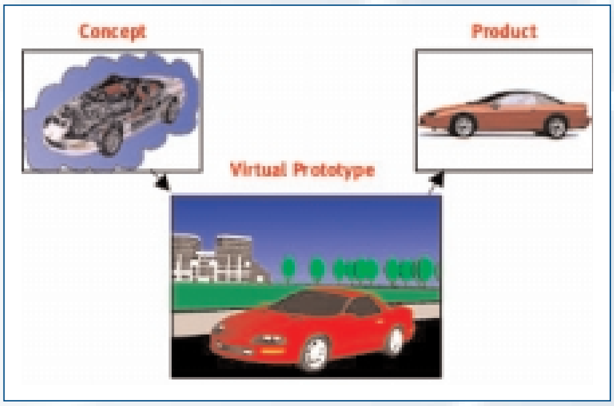
TRADITIONAL DESIGN PROCESS



The main disadvantage with this process is that problems with the design are never realised until the physical prototype or even the product is built. Modifying the design is then an expensive procedure in terms of both time and cost.

The vision of MVP is that virtual prototyping should become a major part of the design process. Thus many design iterations can be built and tested on the computer prior to building any physical prototype. The result is that better quality products can be delivered cheaper and faster.

VISION OF MVP



The virtual prototyping process is typically as follows:

- **Build Design:** A virtual prototype of the design is built and preliminary feasibility studies can be performed.

- **Design Investigation:** Parameter studies can be performed using techniques such as design studies, design of experiments and optimisation in order to predict the best operating configuration.

- **Design Validation:** Having selected a design from the investigation exercise, computer simulation results can be compared with those of test if test data is available.

- **Design Refinement:**
Having verified the performance of the virtual prototype against test data, modifications to the design can be made if further performance improvements are required.

MVP can provide its customers with consulting, training and support to help make this vision become reality.

www.mvpro.co.uk

Company Capabilities

McGowan Virtual Prototyping (MVP) was founded in 2001 with the vision of reducing physical prototyping in the engineering process. The focus of the company is to support customers by providing complete engineering solutions in the fields of:

- Project Management
- Mechanical System Simulation
- Controls and Hydraulics System Simulation
- Design of Experiments and Optimisation
- Hardware in the Loop
- Vehicle Ride and Handling Testing
- CAD and Finite Element Analysis
- Training
- Assisted Consulting

The company has extensive experience of applying these capabilities in the following industrial sectors:

- Automotive
- Aerospace
- Military
- General Engineering

In summary, the goal of MVP is to help customers reduce physical prototyping and improve profitability, productivity and performance.

Company Capabilities - Project Management

In addition to performing Virtual prototyping, MVP also offers a project management service from initial proposal writing through to final results delivery. MVP has the ability to coordinate different fields of CAE and test in order to deliver large turnkey projects. The projects can range from full vehicle analysis and test programs through to software interface development projects. An example of such a project is given below: MVP director Neil McGowan (formerly of MDI) was the project manager:

- ADAMS/Car was sold to Toyota Motor Company in Japan.
- Customer specific suspension and full vehicle analyses together with corresponding output were required.
- The project was managed from the UK MDI office (now MSC) and was staffed with fifteen engineers from MDI's international pool of resource.
- Neil McGowan spent one week in Japan interviewing Toyota chassis engineers in order to obtain their requirements for ADAMS/Car - Toyota.
- An extensive proposal was prepared based on input from the interviews.
- A custom version of ADAMS/Car was created in a six-month project.
- During the project, Neil McGowan made further visits to Japan in order to present completed work and finalise project details.
- A similar exercise was performed for Rover Cars in the UK.

MVP has the capability to project manage large vehicle design, test and analysis projects. Vehicle ride and handling development, CAD and Finite Element analysis capabilities are realised through close liaisons with Richard Hurdwell Engineering, SJO Engineering Services and KJ Analysis.

Company Capabilities - continued

Company Capabilities - Mechanical System Simulation

Mechanical System Simulation involves computer modelling of mechanisms which consist of lumped mass parts, connected together via joints or stiffness elements. The system is resolved into a sequence of algebraic and differential equations using Lagrangian Dynamics. Numerical integration is applied and results are returned in the form of, displacements, velocities, accelerations, forces and graphical animations.

A mechanism can be any system from a small breath actuated inhaler device to a large passenger airbus or heavy-duty crane.

The lumped mass parts in MSS models can be replaced by flexible bodies generated from FE packages in order to investigate the effects of component flexibility.

At present, the MSS software packages used by MVP are ADAMS (Automatic Dynamic Analysis of Mechanical Systems) and SIMPACK. Neil McGowan was former Technical Director of Mechanical Dynamics International Ltd and has 17 years experience of using ADAMS and all its modules in the industry sectors of Automotive, Aerospace, Military and General Machinery. SIMPACK is similar to ADAMS but has more extensive frequency domain and Noise and Vibration Harshness (NVH) analysis capabilities.

Company Capabilities - Controls and Hydraulics System Simulation

Modern mechanical engineering frequently employs hydraulic systems as a means of powering actuators and control systems for improving the overall system response or defining safety margins. On a modern car for example, such systems are used for, Driver Stability Control (DSC), Active Braking System (ABS), Active Roll Control (ARC), Engine Idle Speed Control ISC), to name but a few.

Simulation of control and hydraulics systems can be performed using the software packages ADAMS/Hydraulics, SIMPACK or MATLAB. It is also possible to integrate the control or hydraulic system design in MATLAB, with the MSS model. This process is known as cosimulation where the motion responses from the MSS model are continuously fed into the MATLAB control system, whereby the required control signal is then generated and fed back to the actuators in the ADAMS model.

Company Capabilities - Design of Experiments and Optimization

Design of Experiments (DOE) is a methodology employed for performing extensive parameter studies on a machine or process where a resulting problem is known, but the cause of the problem is not. A number of parameters or factors are thought to contribute to the problem and a single factor may be considered to have two or more levels. For example, a factor could be a vehicle suspension bush rate whose levels may be defined by a tolerance of minus 15%, the intended value and plus 15%.

If all factors and levels are considered, then the number of permutations may be too many to be analysed. DOE employs techniques such as fractional factorial analysis, where a realistic proportion of the full permutations is analysed in order to better understand the system behaviour. The information obtained from such analysis is:

- Which of the factors or interactions between the factors are most significant with respect to the problem.
- What should the factor levels be in order to minimise the problem.

Further analysis can then be employed on a reduced number of factors using methods such as DOE response surface techniques or optimisation in order to make detailed predictions of what optimum factor levels should be in order for the objective to be achieved.Software employed to perform the DOE and optimisation analysis is Minitab, MATLAB, ADAMS, ADAMS/Insight and SIMPACK.

Company Capabilities - continued

Company Capabilities - Hardware in the loop

Electronic control systems play a significant part in the performance enhancement and safety of modern machinery. On the modern passenger car, for example, such systems include ABS (Active Braking System), TCS (Traction Control System), DSC (Driver Stability Control), ARC (Active Roll Control) to name but few. Development and testing of these controls systems, particularly under extreme conditions (cold climate), can be expensive, time consuming and often seasonal.

Hardware in the Loop (HIL) offers a cheaper, faster and more efficient means of testing such systems. This is achieved by connecting the actual onboard electronics inline with a real time computer model. In the case of the passenger car, the computer model would be of the car and the actual electronics could be the DSC system, for example. The model would then be made to simulate required performance and safety manoeuvres in order that the DSC system can be developed and tuned. The process can be performed at any time, in any location, in any climate. Thus long lead times and associated costs caused by winter testing, for example, can be avoided or significantly reduced.

MVP currently offers an HIL solution through the German company IPG. IPG has twenty years of experience in offering automotive HIL solutions to companies such as Ford, Volkswagen, TRW, GM and PSA Peugot Citroen.

Company Capabilities - Vehicle Ride and Handling Testing

MVP also has a ride and handling test and development capability through a close liaison with Richard Hurdwell Engineering Ltd. Richard is one of the country's top vehicle dynamics engineers who has extensive experience with Prodrive, Lotus and MIRA.

Company Capabilities - CAD and Finite Element Handling

MVP Ltd. also has a CAD capability using CATIA and SDRC Master Series and a Finite element analysis capability using NASTRAN, SDRC Master Series, ANSYS, LS-Dyna, and ABAQUS.
These are achieved via close liaisons with the engineering consultancies SJO Engineering Services and KJ Analysis Ltd in order that large turnkey projects involving CAD, FE, MSS and validation to test can be accommodated.

Company Capabilities - Training

Training in all ADAMS and SIMPACK modules is offered via a close liaison with MSC in the UK and INTEC in Germany. MVP also works closely with IPG in Germany to provide Hardware in the Loop training. Specialist training in Design of Experiments is also offered.

Engineering Solutions

Examples of the project experience of MVP include:

Engineering Solutions - Automotive

Vehicle Handling – On Centre Handling of a Passenger Vehicle

- An 'on-centre' handling problem was reported on a passenger vehicle. A design of experiments (DOE) analysis on an ADAMS model was proposed.
- Prior to any computer simulation, tests on the vehicle were planned purely for model correlation.
- The test handwheel angle and vehicle speed were used as input for the ADAMS model.
- Test output data such as lateral acceleration, yaw velocity and roll angle was compared with that of the simulation results.
- Once confidence in the ADAMS model was obtained, the DOE analysis was performed.

Vehicle Ride – Driveline Vibration Analysis

- Driveline vibration problems were reported on a vehicle.
- Hooke joint excitations from the driveline were exaggerated by the tolerances on propeller shaft manufacture, engine and differential installation position and mounting strategy.
- An ADAMS model with driveline was built of the vehicle. The vehicle was powered via the crankshaft to enable the driveline excitations to be invoked.
- Design of experiments was used to identify which of the effects was most significant with respect to the objective, namely the acceleration response at the driver seat rail.

Active Roll Control Design

- An active roll control system was proposed on a passenger car.
- Prior to production of a prototype, an ADAMS model of the car with an active anti-roll bar was built. The hydraulic system was incorporated into the vehicle using ADAMS/Hydraulics.
- The control strategy was modelled in MATLAB.
- Using cosimulation, ADAMS and MATLAB were run simultaneously thus enabling investigation of the mechanism, hydraulics system and controls strategy within the same model.

Engineering Solutions - continued

Engineering Solutions - Automotive continued

Engine Idle Speed Control Design

- A passenger car engine idle speed control system required improvement.
- A series of engine tests were performed in order to obtain constants for a computer model.
- Using the software package ACSL, a computer model of the engine was built.
- The test parameters enabled the relationship between model inputs and outputs to be defined.
- The idle speed control system was designed around the model using MATLAB.
- Linear control design techniques were employed to optimise the controller.

Interface Development – ADAMS/Car

- ADAMS/Car was sold to Toyota Motor Company in Japan.
- Customer specific suspension and full vehicle analyses together with corresponding output were required.
- The project was managed from the UK office of MDI (now MSc) and was staffed with fifteen engineers from MDI's international pool of resource.
- Neil McGowan spent one week in Japan interviewing Toyota chassis engineers in order to obtain their requirements for ADAMS/Car - Toyota.
- An extensive proposal was prepared based on input from the interviews.
- A custom version of ADAMS/Car was created in a six-month project.
- A similar exercise was performed for Rover Cars.

Engineering Solutions

Engineering Solutions - Aerospace

Aircraft Landing and Handling Analysis

- The loading conditions on the landing gear of a large passenger aircraft needed to be investigated.
- A model of the aircraft was built and the required landing manoeuvres simulated.
- The dynamic landing gear forces were then obtained from the model.
- The same model was also used for aircraft ride and handling studies given different steering inputs and varying runway surface profiles.

Aircraft Landing Gear Retraction Analysis

- Prior to building of a test rig and prototype landing gear, an ADAMS model of the mechanism was built.
- Forces or motions were applied at the actuator locations.
- The operational mechanism forces and motion were investigated.

Engineering Solutions

Engineering Solutions - Aerospace

Field Gun Recoil Track Design

- A field gun light enough to be suspended beneath a helicopter was designed
- A 'down-hill' firing load case caused the gun to lift off the ground.
- The ADAMS model of the gun included flexibility and a soil hysteresis model.
- The shape of the barrel recoil track was varied in order to minimise the lift-off response during the 'down-hill' firing condition.

Submarine Missile Launch

- Submerged vertical launch of ballistic missiles was required.
- Given that the submarine may be moving, jamming of the missile in the launch tube due to hydrodynamic forces was a possibility.
- An ADAMS model of the missile and tube was created.
- The contacts between the missile and tube were modelled together with the hydrodynamic forces as the missile emerged into the flow.
- Parameter studies were conducted to investigate the force required to launch successfully in varying operating conditions.

www.mvpro.co.uk

Engineering Solutions

Engineering Solutions - General Machinery

Robot Design

- The purpose of the robot was the transportation of nuclear fuel rods.
- The robot had to operate within a specified natural frequency range.
- Pre-defined cartesian tests had to be performed to test the electric motor capacities.
- An ADAMS model of the robot was built incorporating full flexibility and motor compliance.
- Model analysis was performed on the robot to obtain the mode shapes and eigenvalues.
- The motion output of the robot was known.
- Inverse kinematic analysis was performed on the robot to determine the required electric motor input motions and torques.

Overhead Crane Design

- A crane was designed to position and remove a nuclear reactor head relative to the reactor main body.
- The failure modes of the crane had to be analysed.
- An ADAMS model of the crane was built and simulations of the lifting process performed. The motion of the reactor head was investigated under various crane cable failure conditions.
- The motion of the reactor head was investigated under various crane cable failure conditions.

Inhaler Mechanism Design

- A breath actuated in haler was designed to coordinate the application of the inhaler gas with the ‘breathing in’ process.
- The small mechanism had to be designed for very efficient operation to ensure robustness throughout its life and also to prevent jamming occurrences.
- An ADAMS model of the mechanism was built and positional and friction parameter studies were performed in order to establish the operational tolerances of the device.