Case Study with Bentley Motors
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Designing is more than just creating a product...

...it is also about creating an emotional experience!
VIRTUAL ENGINEERING CENTRE

BENTLEY MOTORS

OPTIS + VEC = HIGH FIDELITY VIRTUAL PROTOTYPES
VE - integration of product and process modelling using digital technologies

VE impacts product development performance

- Rapid response to customer requirements
- More comprehensive exploration of the solution space
- Higher quality products to market quicker
- Reduce the risk and cost of development
- Enabling the supply chain to collaborate
VIRTUAL PROTOTYPE - a product model embedded within a synthetic environment of the relevant life cycle phase enabled to simulate a task

TS = Technical System  
Hu = Human System  
En = Active Environment

Virtual Prototypes

Theory of Technical Systems: V Hubka
Virtual Prototypes
VIRTUAL ENGINEERING enables integration across the product life cycle

VE across the Product Lifecycle
High fidelity VIRTUAL PROTOTYPES support early decision making in NPD

VPs across the Product Lifecycle
A Centre of Excellence in Virtual Engineering...

- VE best practice demonstration
- VE business development and research
- VE education and skills development

... providing VE support to the aerospace supply chain and other high valued added manufacturing sectors
Located in North West region of UK

- Largest manufacturing region in the UK by GVA
- Manufacturing generates 20% of the region’s GVA
- Employs 400,000 people in the region
Project Partners
- University of Liverpool
- STFC Daresbury Laboratory
- NWAA
- Morson Projects
- BAE Systems
- Airbus (Associate)

Funding
- NWDA
- ERDF
VEC Technology Suppliers
VEC Technical Facilities
Virtual Reality Workgroup

Computer Network
4 x DELL T5500 64-bit

LAN
100 Mbps

HPC Link

Projection System
2 x WUXGA Active Stereo projectors
6.0m x 2.1m screen
3390 x 1200 resolution single image
3.6 million pixels in total

“Virtual Touch” System
Haption Virtuose Haptic Device

Head Mounted Display
NVIS nVisor SX111 HMD
2 x 1280 x 1024 eye displays
102° Horizontal Field of View

Tracking System
12 x Vicon Bonita Infrared Cameras

License Server
DS Virtuols
PTC Division

CATIA V6 Server

10 Gbps via Fibre Optic

12 x
Vicon Bonita Infrared Cameras

Computer Network

"Virtual Touch" System

Tracker System

102° Horizontal Field of View
Virtual Reality & Visualisation

Projection Screen
6.0m x 2.1m screen
3390 x 1200 resolution single image
3.6 million pixels in total

Tracking System
12 x Vicon Bonita Infrared Cameras

“Virtual Touch” System
Haption Virtuose Haptic Device
Founded by W.O. Bentley in 1919

Located in Crewe, England since 1946

Owned by Volkswagen AG since 1998

Bentley Motors
“To build a good car, a fast car, the best in class”

W.O. Bentley
Design Development
Concept
Virtual Models
THE JOURNEY OF A CONCEPT

PR1 DESIGN DIRECTION: 2 FULL-SIZE CLAY MODELS
50% FEASIBILITY - 1 CHOSEN

PR1 DESIGN DIRECTION: 2 FULL-SIZED CLAY MODELS
50% FEASIBILITY - 1 CHOSEN

PR1 Gateway
PR2 Gateway
THE JOURNEY OF A CONCEPT

INTERIOR

IDKM - PRODUCTION READY DATA CONTROL MODEL

EXTERIOR

EDKM - PRODUCTION READY DATA CONTROL MODEL

IDKM & EDKM
Production
Objectives

- Improve the quality of the design solution
- Reduce time and cost of new vehicle design
- Replace physical mock-ups with virtual prototypes

Surface and Build

- Virtual surface validation

Ergonomics

- Ergonomic Validation – vision/reflections
- Lighting Development – illumination

Priorities for Bentley Motors
Demonstration Project

- Vehicle CAD data of Mulsanne: Bentley Motors
- Virtual Reality technologies: VEC
- Optical behaviour: Optis

Common technology challenges include:

- Immersion and auditor tracking
- Physics based real-time visualisation
- Realistic exterior environments
- Augmented physical reality
- Actual visibility of variation
Health Warning – Everything you are about to see is a simulation

VEC + OPTIS = HIGH FIDELITY VPS
Step 1: CAD Geometry

Start with Basic Geometry.....Catia, Alias, ICEM.....IGES
Step 2: Material Properties

- Materials
- Light emitting sources
Add measured information using SPEOS for CATIA

- Light sources
- Materials
- Sensors
- Environments (any location and time)

Step 3: Integrate into One Model
Step 4: Physics-based Simulation

Run simulation and post-process data
Step 5: Evaluate in CAD (Speos)

**SPEOS**
- Photometric studies

**Used to design lighting solutions**
- Waterfall lights, Reading lights, Switches, Gauges, Needles, Headlamps

Review VE results with Human vision
Step 5: Optis SPEOS
Step 5: Optis SPEOS
RT Lab

- Interactive (real time) assessment of components and assemblies, modify viewpoint, change lighting conditions, change materials, evaluate glare, reflections, ergonomics in a real time environment.
- Not pre-calculated

Used for early design review to assess lights, materials, positioning, reflections & glare

Step 6: Evaluate in RT Lab
Step 6: Evaluate in RT Lab
Step 7: Evaluate in VRLab

VR Lab,
- Full 3xDOF assessment of reflections, lighting conditions, spectrum changes, from a
- Hi-fidelity full physics based rendering
- Pre-calculated view point

Used for design review, communication and decision making on lighting levels, sunlight impact, veiling glare, and reflections
Step 7: Evaluate in VRLab
**Step 8: Evaluate in VR (Virtools)**

**VIRTOOLS**
- Real time immersive tool to enable interaction between ‘designers/engineers’ with virtual products models and virtual environments.
- Uses CAD data from CATIA (3DXML)
- Material properties
- Real time tracking
- Physics-based behaviour
- Programmable capabilities
Step 8: Evaluate in VR (Virtools)
Capability to perform full vehicle reviews (physics based) before physical prototypes have been built

Real time, dynamic design review with the flexibility to accommodate different user viewpoints

Full physics based analysis of vehicle interiors and exteriors

Inspection capability for exterior examination

A facility with technical partners to develop a process that can be used within Bentley Motors

Demonstrator Outcomes
Future plan to create an augmented seating & steering column module to interact and enhance the immersive environment

Reduce rendering calculation time by use of CPU & GPU clusters
Virtual Prototypes have an important role to play in NPD

Immersive, user experiences require hi-fidelity physics-based models of the product and the active environment

Interaction with VPs must be intuitive and non-invasive

Exploration of the total design space will be expensive

Concluding Remarks
Thank You