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3D Modelling Hardware and Software Specification and its Introduction to the UK Valve Casting and Manufacturing Sectors

The prime objective of the ICT Carrier Programme was to assist industrial contributors to select the most appropriate 3D modelling package to meet the needs of their supplier/partner without prejudice to their own individual business requirements, applying the 'jump together' principle. In addition to assisting companies with the selection of 3D modelling software for the first time, a review was made of software and its use in those partnerships where one or both partners had previously made the investment in 3D modelling.

Prior to the commencement of the initiative in September 2001, the industrial contributors were benchmarked in terms of their Information and Communication Technology (ICT) competence, the results are shown in Figs 1 and 2.

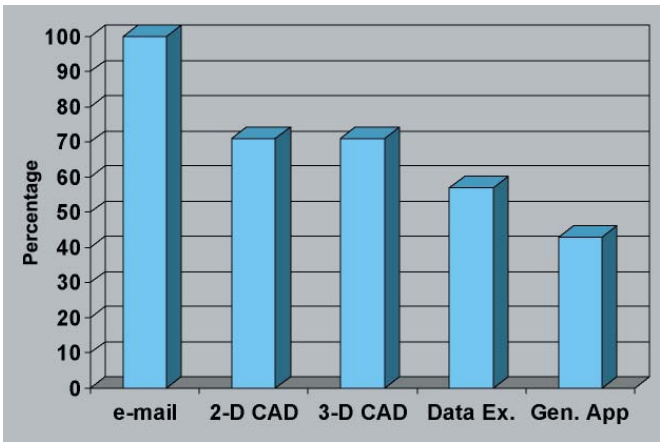

Figure 1. *Initial CAD Status : Valve Manufacturers – Sept. '01*

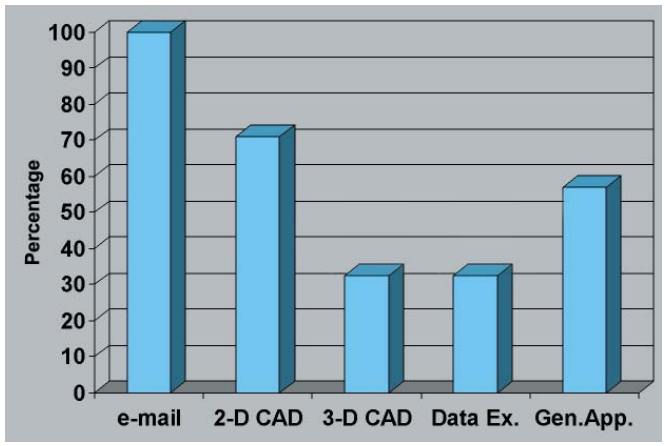

Figure 2. *Initial CAD Status: Casting Suppliers - Sept.'01*

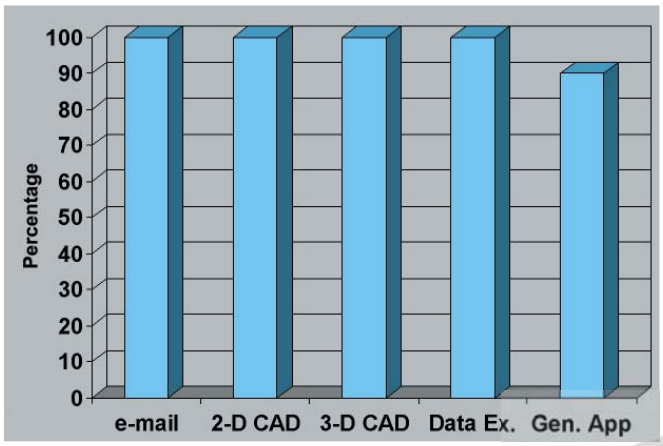

Figure 3. *Final CAD Status : Valve Manufacturers – Mar. '04*

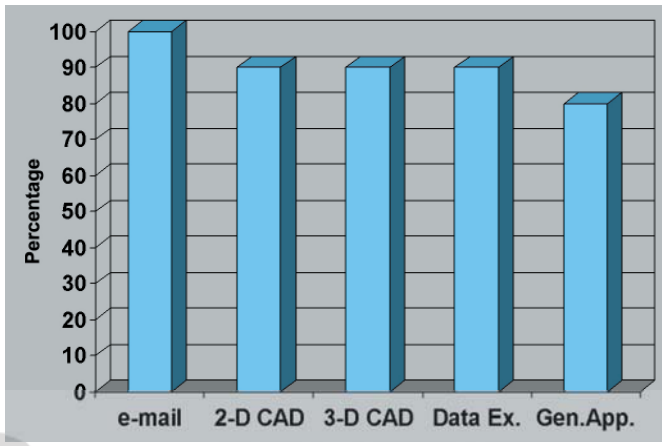

Figure 4. *Final CAD Status: Casting Suppliers - Mar. '04*

One conclusion of the benchmark study of the UK Valve Casting and Manufacturing sector showed that 70% of valve manufacturers were using 3D CAD software. The adoption of 3D within the valve-casting sector was much less at 33%. Many of the valve designers with 3D modelling had resorted back to 2D drawings, as they provided the only means of communicating with their supplying foundries. Interestingly, valve manufacturers who had made the investment in 3D modelling were reporting marked improvements in productivity within their manufacturing cells, far exceeding expectation. Discussions between industrial contributors, especially in the valve casting sector, revealed that the slow progress of adopting 3D modelling was attributed to a number of factors, which showed a degree of commonality:

- 3D was not relevant to their business and that 2D was adequate for their immediate needs
- marketing claims from software vendors were excessive and often unrealistic
- problems of data exchange especially between different non-compatible software packages needed resolution
- a lack of understanding of the technology at all levels of management
- a shortage of trained and skilled, design and engineering graduates with competences associated with ICT and/or 3D modelling
- the selection of a non-standard 3D modelling package leads to the company suffering from a small and shrinking pool of professionals who are proficient in the software
- a conservative manufacturing sector
- limited funds for investment into the intangible aspects of ICT especially as many companies in the UK valve supply chain are SMEs. Just 30% of sites with less than 100 staff are using 3D compared to 65% of companies employing more than 100 staff
- productivity gains are slow, especially where suppliers have underplayed the difficulties of mastering solid modelling
- the costs associated with marketing software to SMEs is high as each company has a diverse range of attitudes and behaviours, each of which are unique
- a lack of trust between the SME and the software vendor. Perhaps the biggest single factor in choosing an IT vendor is the quality of service at the point of sale
- the quality and quantity of training offered by the software vendor. Typically, software purchasers are buying on price, resulting in a limited training package.

The commonly held negative aspects of 2D and 3D were christened: ‘The myths of 2D & 3D’.

Myth 1: 3D costs too much based on the fact that 3D systems cost more than 2D to buy.

Truth: The difference in cost can be offset by the winning of a single contract or by gaining access to a customer who only provides 3D models.

Myth 2: People do not think in 3D.

Truth: Children think in 3D and as such this is a more natural process, however the continued use of 3D requires an unlocking rather than a learning process.

Myth 3: 3D is hard to learn.

Truth: This is a misnomer as the learning tools available for tuition based upon a step-by-step approach has been demonstrated to be the most effective approach to learning, with 2D users converting to 3D in weeks rather than years

Myth 4: 2D is faster than 3D at creating drawings.

Truth: This myth has a degree of truth. However, that has changed due to enhancements to the technology.

Despite these negatives, all partners recognised the benefits of introducing 3D modelling to the supply chain, the positive benefits being recognised as:

- improved communication of design intent throughout the organisation and the supply chain
- improved visualisation
- reduced errors
- reduced or eliminated prototypes or, where necessary, rapid solutions to prototype manufacture
- faster design changes
- increased design re-use
- accelerated downstream processing such as CAE analysis, tooling design, rapid prototyping and NC machining of samples.

The need to use 3D modelling was accelerated as a direct result of the Pressure Equipment Directive (PED). The legislation required that from May 2002 manufacturers of pressure equipment and assemblies supplied in the European Economic Area (EEA) must comply with new legislation. The legislation requires that pressure equipment must be designed, manufactured and checked, and if applicable, equipped and installed, in such a way as to ensure its safety when put into service in accordance with the manufacturer’s instructions, or in reasonably foreseen conditions. With respect to design, the pressure equipment must be properly designed taking all relevant factors into account in order to ensure that the equipment will be safe throughout its intended life. The valve design must incorporate appropriate safety coefficients calculated using comprehensive methods, which are known to incorporate adequate safety margins against all relevant failure modes and a consistent manner. The issue of design for adequate strength of the pressure equipment is critical and one where design by Finite Element Analysis has been recognised as a method to confirm the valve design. In addition to having a profound affect upon valve design, the PED required the casting user and his supplier to provide mechanical property data for the individual of batch of valves.

With the PED requirement impacting on all of the industrial collaborators, it became critical that support be provided from Cti’s IT experts and design engineers and would be required at all levels to aid the supply chain. Cti’s design

team were involved in all aspects of valve design optimisation, the underpinning support provided included:

- software selection process, ensuring that the most appropriate 3D modelling software was selected based upon need (best long term solution) rather than how much software they get for their money.
- defining the quantity and quality of training, provided as part of the software package as the investment in training is proportional to the rate of productivity improvement
- the development of valve modelling strategies to reduce the time and accuracy of valve design

Having made the conscious decision to improve the design process, the associated challenges were numerous and complicated by the array of software available. The simple message emanating from this initiative is for companies to speak to their customers, as they are the prime reason for change. The need to achieve more accurate and efficient flow of communication to speed up the design and manufacturing process will only occur if there is data compatibility. Equally, it has to be recognised that the customer also drives the method of data exchange since all data is proprietary and needs to be secure.

As part of the 3D modelling software selection process, key criteria for both the casting user and producers were developed.

For **Casting Users**, the software should be able to:

- create non-analytical shapes
- build valve and actuator assemblies for interference checking
- generate bills of materials
- generate requests for quotations and cost models
- conduct finite element analysis and/or computational flow dynamics
- communicate electronically, 'face to face', with their casting supplier
- develop of marketing literature
- prove cost effective
- exhibit low maintenance cost
- come with quality operator training and on-going technical support

For the **Casting Producers**, the software was required to be:

- capable of creating non-analytical surfaces
- able to model complex parts both as solids and surfaces
- used with a wide range of user friendly data transfer interfaces
- cost effective
- low cost to maintain
- provided with quality operator training and on-going technical support
- able to cope with e-drawing capability

During the initiative, industrial collaborators were introduced to a variety of suitable 3D modelling options, including:

- Pro/ENGINEER
- Solid Edge
- SolidWorks
- Autodesk Inventor

Having introduced and assisted the industrial partners to 3D modelling, it was imperative to ensure that the partnerships created had a sufficient data exchange capability in terms of efficiency, security, reliability and speed. The initial benchmarking of the industrial contributors highlighted a general lack of awareness within the UK casting and valve manufacturing sector in terms of data transfer and electronic communication. It was apparent that key personnel within both the valve manufacturers and casting producers had a limited knowledge of the issues of ICT and how ICT can improve the effectiveness of the supply chain. In response to the challenge, Cti, as the 'technology carrier', developed a comprehensive suite of workshops to present and discuss the key factors associated with ICT.

A series of four workshops were held during the initiative. These were well attended, with a total of 62 delegates. Each of the workshops had a theme:

Workshop 1: Basic Information and Communication Issues

Workshop 2: Model Viewing, File Types and Data Transfer

Workshop 3: Modelling Strategies for Casting

Workshop 4: Audio Visual and Telecommunications Options - Strengths and Weaknesses

The presentational material presented at these seminars is available in pdf format on the e-valve web site (www.evalve.org.uk). Alternatively, companies wishing to gain greater awareness of any ICT subject should contact Steve France at Cti (s.france@castingstechnology.com).

The success of delivering 3D modelling to the highly conservative UK casting and valve manufacturing sector is best described by the results of the benchmarking exercise, conducted during April 2004, of the industrial contributors (see Figs 3 and 4) and comments made by industrial partners. Simon Alexander, Managing Director of Norton Cast Products stated "the workshops were useful, primarily in the selection of a suitable 3D CAD package. The networking opportunity allowed us to understand the pros and cons of each of the software packages on the market and draw on other's experience".

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For more details about these 3D modelling packages potential users are advised to make the initial contact with the software suppliers:

- **Pro/ENGINEER:** Further information associated with the Pro/ENGINEER software can be obtained from:

  Rand Worldwide
  Unit 3,
  Interchange 25 Business Park,
  Bostocks Lane
  Sandiacre
  Nottingham
  NG10 5QG
  Telephone No: 0115 9210000
  E-Mail: enquiries.uk@rand.com

- **Solid Edge:** Further information associated with the Solid Edge software can be obtained from:

  Solid Applications Ltd
  Sandwell Business and Technology Centre
  Pound Road
  Oldbury
  West Midlands
  B68 8NA
  Telephone: 0121 5441400
  E-Mail: info@solidapps.co.uk

- **SolidWorks®:** Further information associated with the SolidWorks software can be obtained from:

  Solid Solutions
  Innovation Centre
  Warwick Technical Park
  Warwick
  Warwickshire
  CV34 6UW
  Telephone No: 01926 623160
  E-Mail: info@solidsolutions.co.uk

- **Autodesk Inventor:** Further information associated with the Autodesk Inventor software can be obtained from:

  INCAT House
  Prospect Way
  London Luton Airport
  Luton
  Bedfordshire LU2 9QH
  Telephone: 01582 878750
  E-Mail: salesdesk@uk.incat.com