CAD Techniques Helping To Enhance NDT Workflow

Steve McCarley

Eclipse Sientific Products Inc.

www.eclipsescientific.com

This document will show you some applied techniques and uses of CAD to solve some of today's challenges within the NDT industry. With this knowledge Eclipse Scientific hopes to help the NDT industry recognize the need and applications for CAD and set the pace for future NDT technology.

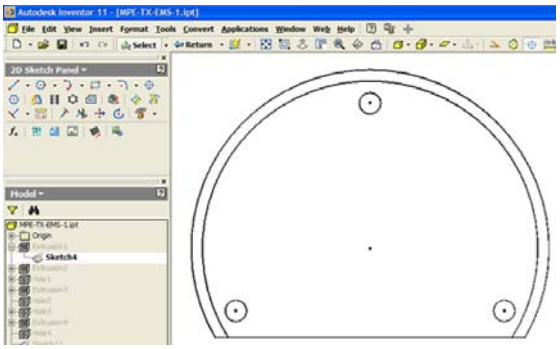
The acronyms CAD (computer aided design), CADD (computer aided design and drafting) and CAM (computer aided manufacturing) are all derived from the use of computers running sophisticated design software to aid in solving certain challenges faced by industry today. For the sake of simplicity we will use the term CAD within this document to represent the use of design software for the NDT industry.

Everyone knows that the industrial revolution, which began in the late 18th and early 19th centuries, changed the world and the way we work. It set the pace for modern developments that we enjoy today.

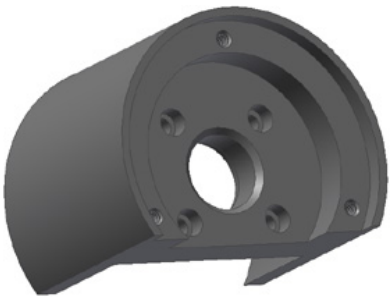
In the late 1980's and early 1990's another revolution took place with the advent of CAD. Industries that embraced CAD were able to develop products far superior and at a rate never before achieved with conventional design and drafting methods. Those companies went on to become successful while companies still employing old ways of designing products struggled to keep up. Today the use of CAD within industry is commonplace and has become tightly entwined with the systems and methods of management, development, manufacturing and services.

CAD in Product Development for NDT

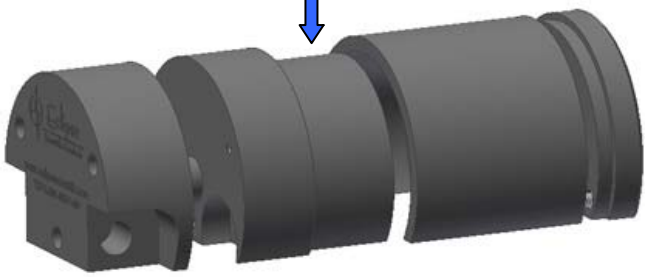
Product development means taking a concept and turning it into a physical device that solves a problem or fills a need for a specific consumer or industry. An idea, as formed in the human mind, is usually conveyed to someone else by means of verbal communications first and then for clarity by means of a sketch. Over time the sketch has evolved from the cave wall, to paper, and now to CAD.



2D CAD Sketch for Part Concept



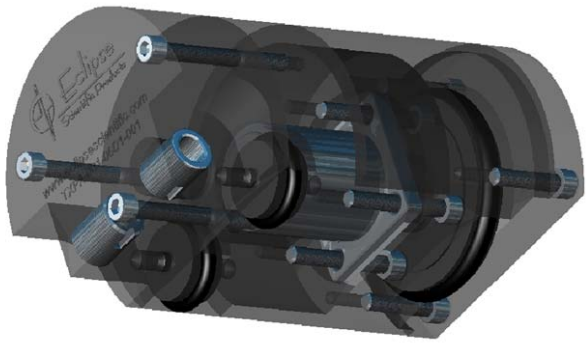
3D CAD Part Model Created from Sketch



Other Parts are Created for the Assembly

3D CAD Model of Completed Product

Why create a 3D CAD model?

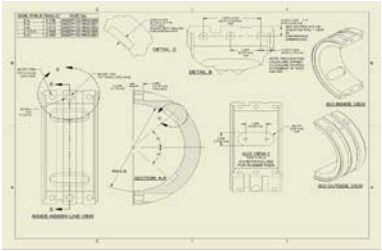


- People from marketing through to the end consumer can now visualize, from every angle, exactly how the product will look when produced. 3D allows the product to be virtually rotated, magnified and every part scrutinized, all in real time, within hours or even minutes of concept. With the advent of the internet the 3D model can be viewed by anyone in any part of the world instantly.
- Changes and enhancements to the original concept can be introduced rapidly and effectively.
- Parts fit and interferences can be checked before production, ensuring functionality without costly, time consuming production delays or remakes. In some cases the need for a prototype may be eliminated altogether.
- Interactions with other products, peripheral attachments or elements in the field can be modeled and tested within the CAD environment. This ensures the product lives up to expected performance levels without costly redesign and time delays.

CAD in Product Manufacturing for NDT

Product manufacturing means producing a physical model, prototype or product. It is at the manufacturing stage that the implementation of CAD has made the greatest advances. Computer Numerical Control (CNC), and Rapid Prototyping and Engineering are at the cutting edge of today's manufacturing processes. Both are based directly on the input of CAD data to have parts manufactured automatically and to precision levels not possible with conventional machining processes.

Early 20th Century (time from concept to creation = 2 to 6 months)

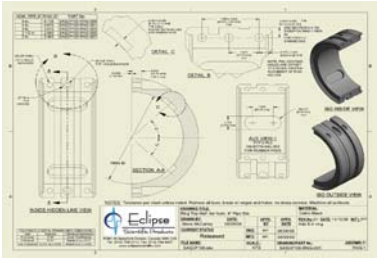


Machine shop tradesman interprets drawing and sets up machinery → Part is machined with conventional machinery

Hand Drafted Specifications 2D

- Most time was spent at the drafting stage. Master draftsmen turned 3D ideas into 2D specifications that had to be perfect before time and materials were spent to machine the part.

Late 20th Century (time from concept to creation = 2 to 4 weeks)



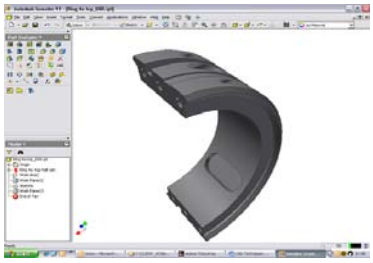
CNC Programmer interprets drawing and programs machinery → OR → Special postprocessor software makes machine code directly from the CAD file → Part is machined with CNC or conventional machinery

*AutoCAD® Creates Specifications 2D

- 2D CAD, still used today, is much like traditional drafting but uses the computer software as a set of drafting tools. Skilled CAD people help engineers and designers visualize products.

- Some leverage is obtained with the use of CNC machinery and post-processing software that can read certain types of CAD files directly and make machine "G" code. However this proprietary software, that only works with certain CNC machines, is costly and somewhat inflexible.

21st Century (time from concept to creation = 3 to 4 Days)



The CAD STL file is e-mailed to a Rapid Engineering firm → **SLS Process creates the part directly from STL file with no machining

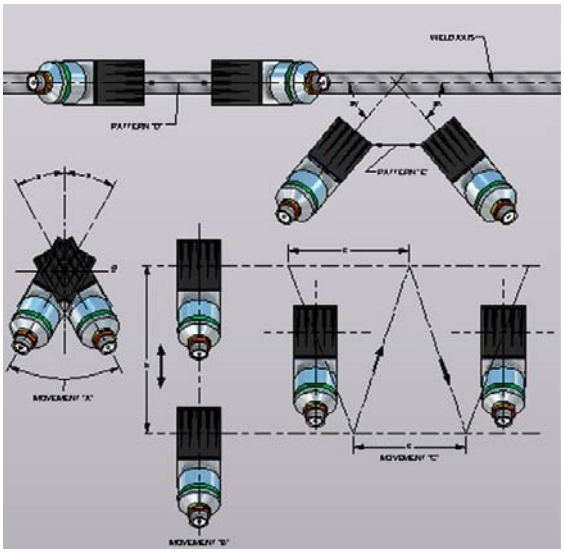
3D CAD Creates a Model

- The 3D CAD model is also used to create a 2D dimensioned drawing which is linked to and controlled directly from the 3D model. This can be used for conventional methods as above.

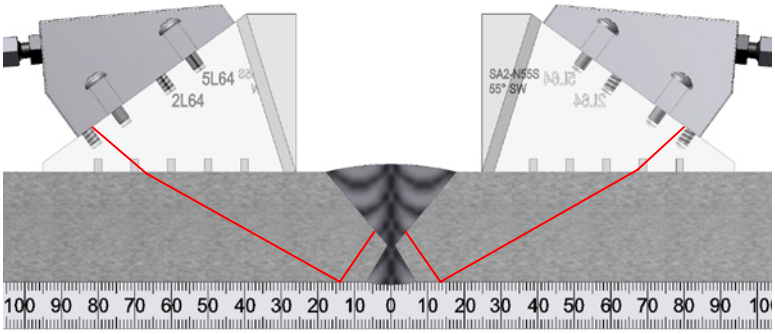
- Stereo Lithography (STL) also called "Rapid Prototyping" has now developed into "Rapid Engineering" with the advent of new materials that can produce the finished product immediately.

CAD in NDT Training

Illustration of the complexities of NDT theory is a daunting task at best. Here CAD can help to demonstrate how equipment is used and what the expected wave paths should be using actual scale models of wedges and transducers and the media they are to test.



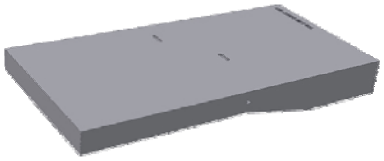
The geometry of proper wedge motion is illustrated here using scale models of the actual wedge and transducer used for the training course.



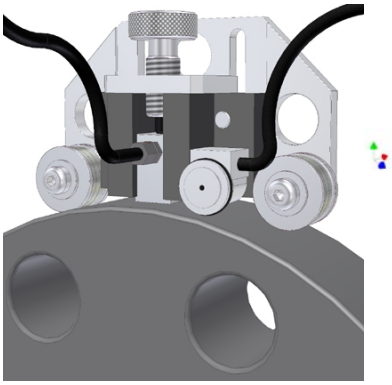
Here a phased array setup is demonstrated showing proper wedge alignment with the weld and expected wave patterns.

CAD in NDT Services

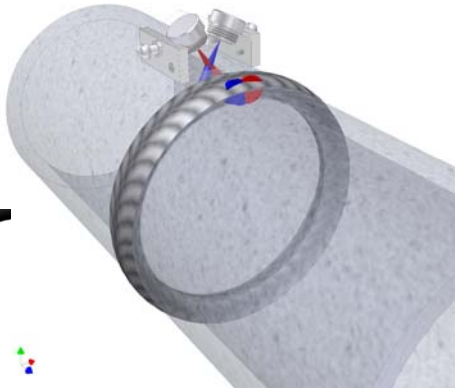
When NDT jobs require specialized equipment CAD helps prepare for the job with 3D models and specifications. Calibration blocks, wedge and transducer arrangements, transducer holders and jigs can all be designed to fit material and geometric constraints. This allows the client to visualize and confirm a special procedure ahead of time, instilling confidence that the job will be performed correctly and without costly surprises on site.



Complex calibration blocks are modeled in 3D and approved for use before being manufactured.



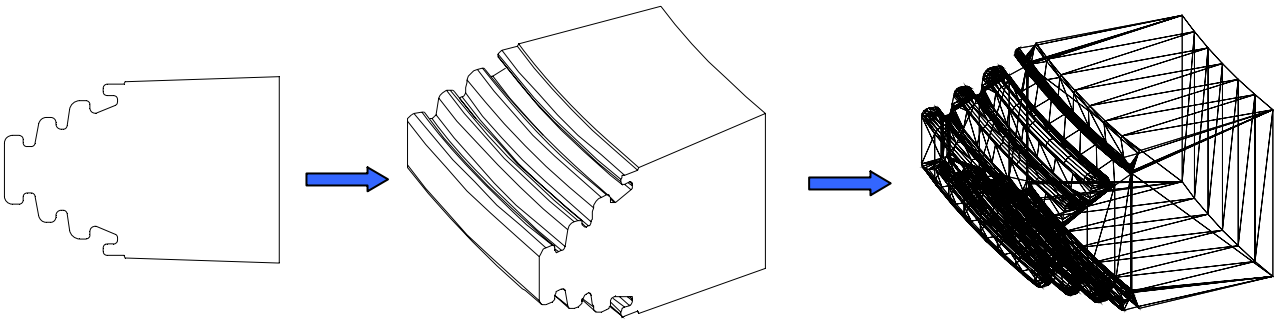
Transducer holders and jigs for custom pipes and flanges are modeled in 3D to fit an exact replica of the item to be inspected.



Wedges and transducers can be designed for specialized applications and beam patterns and angles honed to material and weld attributes.

CAD with Specialized NDT Software Development

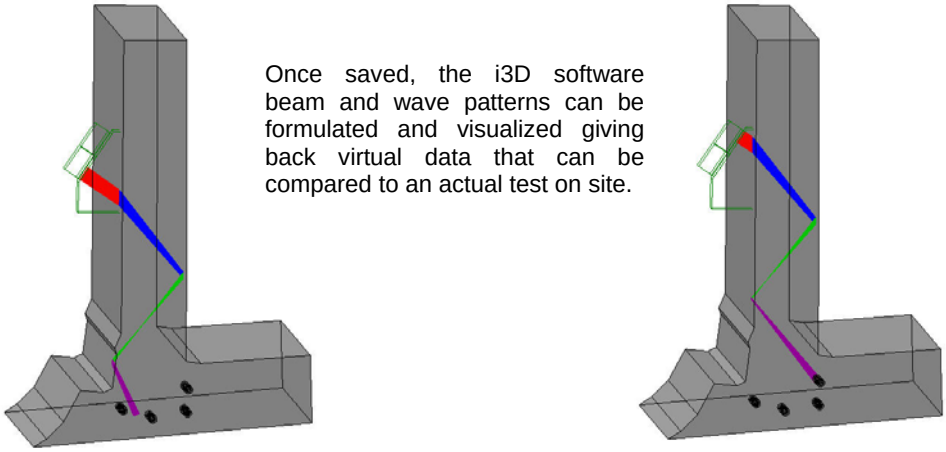
Specialized software created for the NDT industry sometimes uses files generated directly from CAD. The geometric data generated from the CAD program can be read into the NDT software and used for an application, such as computer generated wave patterns, within a given set of material properties. Parts to be tested are first modeled in CAD then saved in a file type that is compatible with the NDT software. Individual parts or multiple parts can be assembled inside the NDT software and virtually tested.



A 2D CAD image of the part to be tested is received from the client.

The 2D image is transformed into a 3D model with geometry matching the part to be tested.

The 3D model is transformed into a surface model and saved in a file format readable by Imagine3D® (i3d) software.



Once saved, the i3D software beam and wave patterns can be formulated and visualized giving back virtual data that can be compared to an actual test on site.

Proper communication between multiple software applications must be achieved to be effective. CAD professionals can create procedures that ensure the proper data is translated between the CAD software and 3rd party applications.

Footnotes

*Eclipse Scientific Products uses Autodesk Inventor Series® software for product design which consists of AutoCAD® for 2D drawing and Inventor® for 3D modeling. Illustrations within this document were created with AutoCAD® and Inventor®.

**Selective Laser Sintering (SLS) is a new cutting edge technology that uses a high powered laser to bind together a powdered thermoplastic nylon in layers, creating an actual 3D part directly from a CAD file. New materials available for the SLS process now allow these parts to be made durable and robust enough for everyday usage in many applications.

References

1. Benjamin W. Niebel, Motion and Time Study, Seventh Edition, Irwin
2. Autodesk Inventor Series software is a registered product of Autodesk Inc. www.autodesk.com
3. Imagine3D software is a registered product distributed by Utex Scientific Instruments Inc. www.utex.com
4. Information about SLS and materials was obtained from, Forecast Product Development www.forecast3d.com