From Concept to Creation:
CAD/CAM in Footwear Design

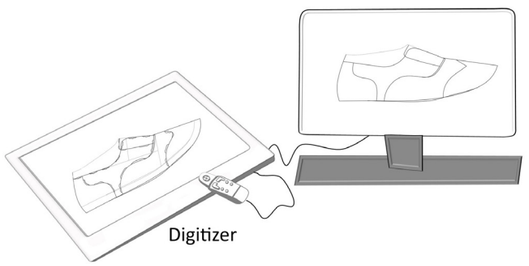
By Mr. Varun Gupta & Mr. A.V. Suresh

Computer Aided Design (CAD) has been used in footwear design since the 1970s and has gradually become an integral part of the footwear industry. With continuous improvements in computer technology, CAD systems have evolved from basic 2D drafting tools into advanced platforms capable of creating complete 3D virtual shoes. Along with CAD, the term Computer Aided Manufacturing (CAM) is commonly used in footwear product development.
In footwear, CAD refers to designing shoes in 2D or 3D digital environments, whereas CAM refers to generating manufacturing outputs from CAD data, such as pattern cutting, grading, nesting, CNC operations, and 3D printing. Traditionally, CAD in footwear was mainly associated with 2D pattern

This article is taken from the Book "ABC of Footwear Technology" written by Mr. Varun Gupta, Senior Faculty Geade-1, FDDI, Furstagnaj Campus and Mr. A. V. Suresh, Senior Technical Consultant, Romans CAD (Strategies, France)-Pune.
engineering. Today, 3D CAD software allows the creation of a full virtual shoe (digital twin), from which accurate 2D patterns can be developed for production.

Some of the advantages of using CAD in Footwear Designing are as below:

- Enables early concept development before physical shoe creation
- Allows creation of 3D virtual footwear models prior to manufacturing
- Facilitates quick material, colour, and accessory trials for faster decision-making
- Generates accurate 2D patterns directly from 2D/3D designs
- Supports rapid design modifications to accommodate changes
- Enables fast grading of patterns across size ranges
- Allows systematic storage and easy retrieval of digital design data
- Makes it easy to adapt designs in line with forecasted trends



DESIGNING IN 2D

Although 2D CAD software can be used for drawing design lines similar to manual methods, it is most commonly used for pattern engineering and grading. Traditionally, designers create the shoe shell manually and then digitize it into the CAD system using a digitizer. Digitization is a skilled process, and its major limitation is that the physical shell is not visible on the screen during tracing. This makes it difficult to verify accuracy and often requires cutting and comparing patterns with the original shell.

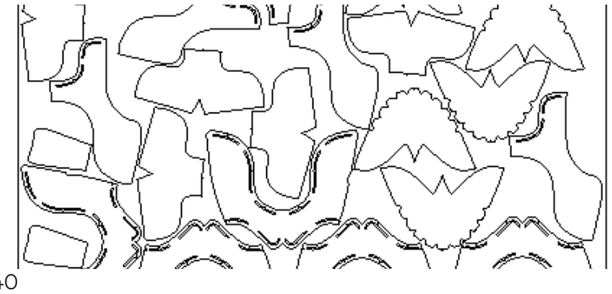
Modern 2D CAD systems overcome this limitation by allowing direct import of design images into the software. Designers can trace style lines directly on the image displayed on the screen, enabling easy verification and correction while eliminating the need for digitizer hardware.

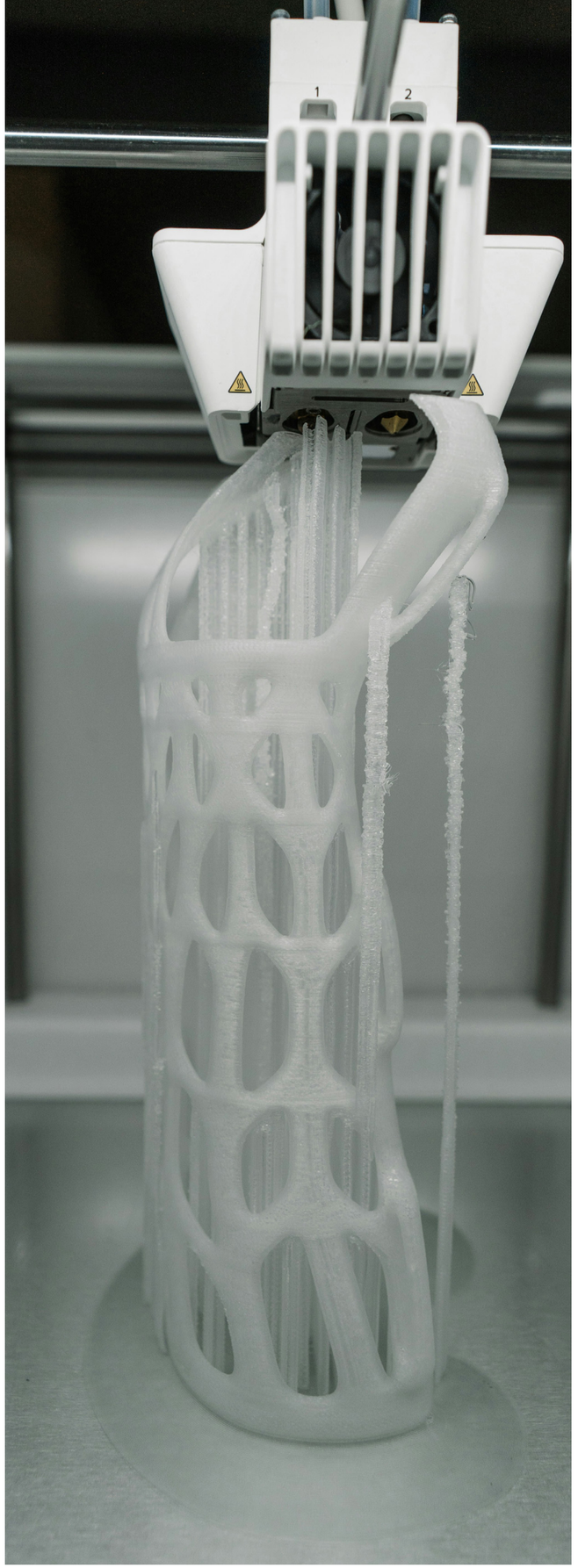
COMMON 2D CAD WORKING METHODS

- Digitizing only the mean form and completing the design digitally
- Digitizing the complete shell and then creating and grading patterns
- Digitizing manually created patterns only for grading

PATTERN CUTTING

After grading, the patterns are prepared for physical cutting. The digital patterns are nested in the software on a predefined pattern sheet size to optimize material usage. The nested data is then sent to a pattern cutting machine. During cutting, the pattern sheet is fixed to the machine table using tape or a vacuum system to prevent movement. Cutting machines typically use pens for marking pattern information and knives for cutting pattern boundaries and stencils. This CAM process ensures higher accuracy, consistency, and speed compared to manual cutting.





DESIGNING IN 3D

In recent years, many footwear companies have adopted full 3D shoe design to reduce development time and minimize the number of physical samples. 3D CAD allows designers to work directly on the digital last, visualize the complete shoe, and make design decisions at an early stage.
Some advanced software allows simultaneous modification of 3D designs and 2D patterns, further reducing engineering effort.

SHOE CONFIGURATOR

One limitation of physical prototypes and 3D printed models is the difficulty in visualizing the materials and color combinations. Shoe configurators provide an effective solution to this problem. Once the 3D CAD shoe model is completed, it is uploaded to a web-based configurator along with material options. Designers, marketing teams, or customers can interact with the virtual shoe, experiment with different materials, colors, and logos, and generate multiple variants without producing physical samples. Many brands now use shoe configurators to offer personalized footwear, which is manufactured and delivered based on customer selections

3D PRINTING

After completing the 3D design in CAD software, the model can be printed using a 3D printer. The design is processed in 3D printing software, where it is sliced into thin horizontal layers. The printer builds the object layer by layer, forming the complete volume. This process is known as additive manufacturing and is widely used for rapid prototyping in footwear development.

Common 3D Printing Technologies

- FDM (Fused Deposition Modeling): Economical, limited color options
- PolyJet: supports multiple colors and textures, produces more realistic prototypes but at higher cost
- SLA (Stereolithography): Uses UV laser to cure liquid resin; offers high detail and smooth surface finish.
- SLS (Selective Laser Sintering): Fuses powdered material using a laser; ideal for strong, functional parts.
- DLP (Digital Light Processing): Cures resin using projected light; faster printing with fine accuracy.