CAM (Computer Aided Manufacturing)

The advent of computers and digital technologies is widely considered to have been the Third Industrial Revolution. Many think we're now on the verge of a Fourth Industrial Revolution that builds on digital innovations and incorporates elements such as automation, artificial intelligence (AI), biotechnology, the Internet of Things (IoT) and 3D printing.

Computer Aided Manufacturing, or CAM, is another important part of this new wave of technologies — and it's already starting to have an impact on manufacturing, construction, and other sectors.

What is CAM?

Siemens says: "Computer aided manufacturing (CAM) commonly refers to the use of numerical control (NC) computer software applications to create detailed instructions (G-code) that drive computer numerical control (CNC) machine tools for manufacturing parts. Manufacturers in a variety of industries depend on the capabilities of CAM to produce high-quality parts."

A broader and simpler definition would be: any manufacturing process that uses computer software to facilitate, assist or automate parts of the manufacturing process.

How does CAM work?

Computer aided manufacturing typically uses software to translate drawings and data into detailed instructions that can drive some sort of automated tool. As an example, a 2D digital drawing can be used to guide a laser or physical cutting tool to cut cladding or other components to fit an architect's design.

As the Siemens definition points out, the programming language generated from the drawing or other data set that is then used to control the machine tool is referred to within the industry as the G Code. This G-code tells the tool how to make something by telling the motors where to move, how fast to move, and what path to follow.

What is the relationship between CAM, CAD, and BIM?

CAM tends to go hand-in-hand with computer aided design (CAD) and building information modelling (BIM), at least as far as its application in the construction industry goes. CAD allows architects and members of the design team to make drawings in 2D or create entire 3D models using computer software. This has a number of advantages over traditional pen and paper drawings, including the ability to redraw and redesign easily, to save component parts in databases and (in the case of 3D CAD) the ability to rotate and fly into or through the model.

BIM utilizes CAD but allows for collaboration between different design and construction stakeholders, who can work on their own models while accessing and combining with other parties' models to create a central 'federated' BIM model. Additional data relating to elements such as cost and time can also be added.

The data from CAD and BIM drawings and models can be extracted and used to create the G Code used in computer aided manufacturing. That closes the gap existing between the design and manufacturing stages and allows for the accurate realisation of drawings, models and designs.

How is CAM being used in the construction industry?

CAM is being used onsite all around the world, although as of yet, it is still far from commonplace. CAM generally falls into two broad types: reductive and additive.

Reductive processes involve getting rid of material, and this includes the previous example of guiding a cutting tool to cut out a section of cladding. These cutting and shaping processes are currently the more commonly used types of CAM, and the laser cutting of sheet metal is certainly becoming more common. CNC (computer numerical control) routing uses a spinning component to carve materials into the desired shape while laser and water cutting can be used on relatively thin panels and pieces.

Additive processes involve adding material. They are far less common at present, but the arrival of 3D printers makes this a very exciting area. We could see walls and whole structures being ‘printed’, while robotics open up another avenue. Robot bricklayers and saws have already been trialled, and in some cases, deployed on construction sites.

Modular construction is another area where the potential for CAM is huge. In this method, buildings and other structures are assembled from components that are prefabricated offsite in manufacturing plants before being transported to the construction site for assembly. Sweden is a world leader in modular construction, with 84% of detached homes in the country using some prefabricated elements.

Modular construction is also taking off in Germany and, while it's not quite as popular in the UK and the USA, advances in CAM technology can be used to greatly enhance the efficiency of offsite modular building, speeding up and improving the accuracy of the component construction.

One example of modular building is GSK's 'factory in a box'. Created using CAD and BIM systems, this provides a colour-coded pharmaceutical factory that that can be shipped to developing areas in crates and put together like an altogether more impressive set of flat-pack furniture.

The benefits of CAM

Using CAM has a number of benefits when it comes to creating components used in building construction. Compared to manually operated machines, CAM generally offers:

- Greater speed in producing components
- Greater accuracy and consistency, with each component or finished product exactly the same
- Greater efficiency as computer controlled machines do not need to take breaks
- High sophistication in terms of following complex patterns like tracks on circuit boards

There are some limitations. CAM-enabled machines are generally designed for a particular task and are not incredibly versatile, although new systems and designs are emerging all the time.

They also need an upfront investment and skilled operators and programmers. Once in place, however, they could potentially bring large savings in time and efficiency, thereby reducing costs and saving companies thousands.