## Unit 14: Computer-aided Machining

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<th>Unit code:</th>
<th>J/601/1501</th>
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<td>QCF level:</td>
<td>4</td>
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<td>Credit value:</td>
<td>15</td>
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### Aim
This unit will develop learners’ understanding of computer-aided machining (CAM) systems and the related skills found in manufacturing and engineering companies.

### Unit abstract
It is essential that engineering technicians involved in the planning, operation and management of manufacturing systems should have a broad underpinning knowledge of computer-aided machining processes. The first learning outcome focuses on the hardware and software of CAM systems. The second and third learning outcomes deal with manual and computer-assisted part programming, giving learners the opportunity to derive and prove part-programs for engineered components. The final outcome is concerned with quality control in CAM systems, particularly the various levels of inspection and the capture, transmission and analysis of quality control data. It is intended that the learner will gain both a detailed knowledge of programming methods and the practical skills necessary for programming industry standard CAM systems.

Due to the rapid growth in this area of technology it is expected that delivery centres may need to review and update aspects of the indicative content of the unit as required to keep pace with and also meet the needs of their local industries.

### Learning outcomes
On successful completion of this unit a learner will:

1. Understand the operational characteristics of CAM systems
2. Be able to produce and prove manual part programs
3. Be able to produce and prove computer-assisted part programs
4. Understand inspection and quality control in CAM systems.
Unit content

1 **Understand the operational characteristics of CAM systems**

*Hardware elements:* computer eg mainframe, mini, micro; computer power and memory; printer; mouse; digitiser; digital and screen data displays; disc drives; axes of CNC machines; parametric settings eg zero datum setting and transfer, manual modes, program overrides

*Software elements:* operating system; CAM software; CAM database management systems; program editing facilities; diagnostic testing techniques

*Inputs:* geometry data; material specifications; CAD data

*Outputs:* manufacturing data; tool data; cutter path; component profile; CAM file

*Component location, work-piece clamping and tool holding:* methods eg jigging devices, holding techniques, punch tooling, formers for bending

2 **Be able to produce and prove manual part programs**

*Elements and structures:* investigation of system initialisation; tooling information and data; positional control and sequence

*ISO standards:* use of blocks, word and letter addresses; system management; positional data and coded data transfer

*Programming techniques:* macro routines; sub-routines; rotation; zero shifts; scaling and minor imaging

3 **Be able to produce and prove computer-assisted part programs**

*Functions:* generation of graphics eg use of third party software in design or draughting mode (EdgeCam, SmartCam); component profile definition eg simple 2D profile with internal circular and square pockets and holes on a pitch circle diameter suitable for fixed/canned cycle manipulation; geometry manipulation; tooling and machinery sequences; cutter path simulation; post-processing

*Databases:* CAD profile and attribute data; material files; tool data; cutter location files; report generators; Bill of Materials (BOM)

*Macro routines:* macro routines eg continuous operations, automatic tooling sequences, standard components

4 **Understand inspection and quality control in CAM systems**

*Levels of inspection:* inspection eg tooling verification, datum and location checks, in-process measurement, post-process inspection, qualitative data and attributes, statistical analysis, technical and management information

*Data capture:* tactile sensing; non-tactile sensing; data transmission features
# Learning outcomes and assessment criteria

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<tr>
<th>Learning outcomes</th>
<th>Assessment criteria for pass</th>
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<td><strong>On successful completion of this unit a learner will:</strong></td>
<td><strong>The learner can:</strong></td>
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| **LO1 Understand the operational characteristics of CAM systems** | 1.1 explain the function of the hardware and software elements of a CAM system  
1.2 identify the inputs and outputs of a CAM system  
1.3 explain the methods of component location, clamping and tool holding in CNC machines |
| **LO2 Be able to produce and prove manual part programs** | 2.1 utilise elements and structures of a CNC part program when producing and proving a manual part program  
2.2 use appropriate ISO standards with respect to codes and program format when producing and proving a manual part program  
2.3 use programming techniques to promote enhanced system performance  
2.4 produce manually written part programs for engineered components  
2.5 input manually written part programs to a CNC machine and prove their accuracy |
| **LO3 Be able to produce and prove computer-assisted part programs** | 3.1 use an appropriate range of functions when producing and proving computer-assisted part programs  
3.2 use a database in support of computer-assisted part programming  
3.3 use macro routines in support of computer-assisted part programming  
3.4 produce computer-assisted part programs for engineered components  
3.5 pass computer-assisted part programs to a CNC machine and prove their accuracy |
| **LO4 Understand inspection and quality control in CAM systems** | 4.1 review the various levels of inspection in CAM systems  
4.2 assess the techniques used for data capture in automated inspection systems  
4.3 explain the significance of adaptive control methods in CAM systems. |
Guidance

Links
This unit may be linked with Unit 22: Programmable Logic Controllers.

Essential requirements
Centres delivering this unit will need to have access to industrial-standard CNC machining centres and programming hardware and software.

Employer engagement and vocational contexts
Visits to industrial installations will be of value to supplement learning activities and provide learners with a wider appreciation of the range of possible CAM applications.