

Technical Description

Manufacturing Team Challenge

Manufacturing and Engineering Technology



WorldSkills International, by a resolution of the Competitions Committee and in accordance with the Constitution, the Standing Orders and the Competition Rules, has adopted the following minimum requirements for this skill for the WorldSkills Competition.

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1 INTRODUCTION

1.1 NAME AND DESCRIPTION OF THE SKILL COMPETITION

1.1.1 The name of the skill competition is

Manufacturing Team Challenge

1.1.2 Description of the associated work role(s) or occupation(s).

The skill competition of Manufacturing Team Challenge is based on the design, manufacture assembly and testing of equipment by teams of complementary specialists. In either large or small manufacturing operations there is a strong demand for several specialists to come together to design, manufacture, assemble, and test new or improved equipment either as a one-off item or as the prototype for mass production.

Technicians skilled in project management, computer-aided design, programming, machining, welding, electrical/electronic, and fitting can combine to form efficient and effective teams covering design through to commissioning. While each specialism has value, each team member requires additional attributes. The capacity to work within and contribute to a team is vital, requiring both self-understanding and interpersonal skills. Team members also need the ability to think beyond their own specialisms and the boundaries of each skill, in order to make the most of the team's combined efforts.

This skill has exceptional value as an exemplar of modern manufacturing practices. Whatever the size or sector of the manufacturing organization, continuous improvement and innovation are key to its survival and prosperity. These features do not happen in isolation, but through the combined efforts of high level, insightful specialists. Where diverse manufacturing teams are most successful, this will also be due to the inclusion within the team of both broad and specific financial and organizational skills. These skills will strictly control time and cost while seeking at all times to go beyond the client's expectations for quality.

Whatever their specialism, members of successful manufacturing teams have the opportunity to generate the skills normally associated with accelerated promotion and management development. As the skills also associated with successful enterprise, they open up many positive career choices within the labour market and economy.

1.1.3 Number of Competitors per team

Manufacturing Team Challenge is a team skill with three Competitors per team.

1.1.4 Age limit of Competitors

The Competitors must not be older than 25 years in the year of the Competition.

1.2 THE RELEVANCE AND SIGNIFICANCE OF THIS DOCUMENT

This document contains information about the standards required to compete in this skill competition, and the assessment principles, methods and procedures that govern the competition.

Every Expert and Competitor must know and understand this Technical Description.

In the event of any conflict within the different languages of the Technical Descriptions, the English version takes precedence.

1.3 ASSOCIATED DOCUMENTS

Since this Technical Description contains only skill-specific information it must be used in association with the following:

- WSI – Competition Rules
- WSI – WorldSkills Standards Specification framework
- WSI – WorldSkills Assessment Strategy
- WSI Online resources as indicated in this document
- WorldSkills Health, Safety, and Environment Policy and Regulations

2 THE WORLDSKILLS STANDARDS SPECIFICATION (WSSS)

2.1 GENERAL NOTES ON THE WSSS

The WSSS specifies the knowledge, understanding and specific skills that underpin international best practice in technical and vocational performance. It should reflect a shared global understanding of what the associated work role(s) or occupation(s) represent for industry and business (www.worldskills.org/WSSS).

The skill competition is intended to reflect international best practice as described by the WSSS, and to the extent that it is able to. The Standards Specification is therefore a guide to the required training and preparation for the skill competition.

In the skill competition the assessment of knowledge and understanding will take place through the assessment of performance. There will only be separate tests of knowledge and understanding where there is an overwhelming reason for these.

The Standards Specification is divided into distinct sections with headings and reference numbers added.

Each section is assigned a percentage of the total marks to indicate its relative importance within the Standards Specification. This is often referred to as the “weighting”. The sum of all the percentage marks is 100.

The Marking Scheme and Test Project will assess only those skills that are set out in the Standards Specification. They will reflect the Standards Specification as comprehensively as possible within the constraints of the skill competition.

The Marking Scheme and Test Project will follow the allocation of marks within the Standards Specification to the extent practically possible. A variation of five percent is allowed, provided that this does not distort the weightings assigned by the Standards Specification.

2.2 WORLDSKILLS STANDARDS SPECIFICATION

SECTION		RELATIVE IMPORTANCE (%)
1	Work organization and management	5
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> Principles and applications of safe working generally and in relation to manufacturing The purposes, uses, care, and maintenance of all equipment and materials, together with their safety implications Environmental and safety principles and their application to good housekeeping in the work environment Principles of team working and their applications Personal skills, strengths and needs relative the roles, responsibilities, and duties of others individually and collectively The parameters within which activities need to be scheduled 	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> Prepare and maintain a safe, tidy, and efficient work area Prepare self for the tasks in hand, including full regard to health and safety Schedule work to maximize efficiency and minimize disruption Select and use all equipment and materials safely and in compliance with manufacturers' instructions Apply or exceed the health and safety standards applying to the environment, equipment, and materials Restore the work area to an appropriate state and condition Contribute to team performance both broadly and specifically Give and take feedback and support Manufacture components and assembly to meet cost constraints and record manufacturing costs and budgets Maximize material utilization in order to reduce waste 	
2	Communication and interpersonal skills	5
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> The range and purposes of documentation in both paper based and electronic forms The technical language associated with the skill and technology The standards required for routine and exception reporting in oral, written, and electronic form The required standards for communicating with clients, team members and others The purposes and techniques for maintaining and presenting records, including financial records 	

	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> • Read, interpret, and extract technical data and instructions from documentation in any available format • Communicate by oral, written and electronic means to ensure clarity, effectiveness, and efficiency • Use a standard range of communication technologies • Explain complex technical principles and applications to non-experts • Complete reports and respond to issues and questions arising • Respond to clients' needs face to face and indirectly • Arrange to gather information and prepare documentation as required by the client 	
3	Design and realization	10
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> • The principles and applications of project design • The nature and formats of project specifications • The bases on which the manufactured item will be appraised • Design parameters including: <ul style="list-style-type: none"> • Options appraisal • Selection of materials and work processes • Prototype development • Manufacture • Refinement • Commissioning • Principles and methods for work organization, control and management 	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> • Read and interrogate briefs or specifications for manufactured items • Identify and resolve areas of uncertainty within the briefs or specifications • Generate designs for the manufacture of a functioning item within given timescales • Generate innovative solutions to design challenges • Prepare and implement documentation for work management and control • Complete the design stage within the required limits of cost and time • Use of engineering measurement tools including rules, verniers, micrometres and digital measuring tools 	
4	Drawing	10
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> • How to interpret drawings that conform to ISO standards • How to create drawings that conform to ISO standards • The principles and uses of 2D and 3D modelling software • The principles and uses of CAM software 	

	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> • Create drawings to ISO standards • Create and modify 2D and 3D models • Create CNC programs using CAM packages and appropriate postprocessors • Interpret, construct, and modify engineering CAD drawings to work with 3D modelling and to convert both to CAM • Complete drawing activities within the planned timetable and to suit the project's overall requirements 	
5	Machining (conventional and CNC)	15
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> • The principles and applications of CNC machining • The routines of CNC machining • The use of general machining equipment used in activities such as central lathing and milling • The relationship between drawings and machining, including modifying the machining to meet specifications • The characteristics of metals and the potential impact on them of cutting tools and processes • The applications of machining to a range of metals and materials 	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> • Machine components to drawings on conventional machine tools and from CAM generated tool paths • Safely operate conventional machine tools such as lathes, mills, and drill presses • Safely operate a CNC machine centre • CNC programming • Address the issues caused by temperature during machining, including the use of coolants • Complete machining within the planned timetable and to suit the project's overall requirements • Manufacture components to industry finishes and tolerances • Measure and adjust manufacturing process to meet specifications 	
6	Sheet metal working and welding	10
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> • The specific safety principles and practices to be used with sheet metal • The principles and applications of working with sheet metal • The processes required for bending and cutting sheet metal • Specific safety principles and applications for welding • The principles and applications of a range of welding types, including TIG (for steel and aluminium) and MAG (for steel). 	

	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> • Apply safe working practices for sheet metal working • Bend and cut sheet metal components in accordance with drawings • Fit sheet metal components to an assembly • Complete the sheet metal work within the planned timetable and to suit the project's overall requirements • Use safe welding holding and welding techniques • Weld a variety of materials • Use a range of welding types • Complete the welding activities within the planned timetable and to suit the project's overall requirements 	
7	Electronics	12
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> • The principles and applications for working with electronics and related equipment • The principles and uses of PCBs • The principles and applications of electronic programming software • The principles and applications of robotics and mechatronics 	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> • Assemble and commission electronics from drawings • Design control circuits • Generate programs for automated sections of the manufacturing process, including those for CNC machining, robots, PCs, and PLCs • Complete the electronics activities within the planned timetable and to suit the project's overall requirements • Generate programmes for automated sections of the manufacturing process, including CNC machining, robots, PC, and PLCs 	
8	Fitting	10
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> • Principles and methods for manufacturing parts such as jigs, fixtures, adaptors and process attachments • Principles and methods for assembly and fastening of manufactured parts such as jigs, fixtures, adaptors, and process attachments 	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> • Design a range of jigs, fixtures, and accessories • Manufacture jigs, fixtures, and accessories in accordance with drawings and specifications • Assemble and commission items in accordance with drawings and specifications • Assemble items using fasteners such as glues, screws, bolts, etc. • Complete the fitting activity within the planned timetable and to suit the project's overall requirements 	

9	Testing and commissioning	20
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> • The criteria and methods for operating test runs • The scope and limits of the technologies and methods employed • Strategies for thinking creatively and generating innovation • The possibilities and options for making incremental and/or radical changes 	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> • Test run the assembled item • Review each part of the manufacturing and assembly process against established criteria, including quality, functionality, time, and cost • Modify, test, and appraise each part of the process, including: <ul style="list-style-type: none"> • Design • Tool paths • Assembly procedures • Jigs • Fixtures • Machining • Undertake a final test run to commission the item • Present the item to the client with explanations and responses to questions • Generate and present a portfolio including all essential documentation such as: <ul style="list-style-type: none"> • 2D mechanical drawings • Electronic solid models • Electrical drawings • Manufacturing plans • Design calculations • Manufacturing costs • Generate support documents such as: <ul style="list-style-type: none"> • the Operating Manual • the Maintenance Manual 	
10	Additive manufacturing	3
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> • Principles and methods to design parts; • Principles and methods to design parts in special software; • Principles and methods to make postprocessing for 3D printers (FDM, SLS, DLP and SLM); • Principles and methods to design parts considering variety of materials used; • Principles and methods to reduce production time keeping with quality in resistance and durability. 	

	The individual shall be able to: <ul style="list-style-type: none"> • Design parts in the special software; (www.autodesk.com/solutions/generative-design); • Calculate the variety of materials used; • Postprocess jobs of 3D printers; • Start and control the process; • Operate a 3D printer; • Adjust and set up parameters for 3D printing; interpret drawings. 	
	Total	100

3 THE ASSESSMENT STRATEGY AND SPECIFICATION

3.1 GENERAL GUIDANCE

Assessment is governed by the WorldSkills Assessment Strategy. The Strategy establishes the principles and techniques to which WorldSkills assessment and marking must conform.

Expert assessment practice lies at the heart of the WorldSkills Competition. For this reason, it is the subject of continuing professional development and scrutiny. The growth of expertise in assessment will inform the future use and direction of the main assessment instruments used by the WorldSkills Competition: the Marking Scheme, Test Project, and Competition Information System (CIS).

Assessment at the WorldSkills Competition falls into two broad types: measurement and judgement. For both types of assessment the use of explicit benchmarks against which to assess each Aspect is essential to guarantee quality.

The Marking Scheme must follow the weightings within the Standards Specification. The Test Project is the assessment vehicle for the skill competition, and also follows the Standards Specification. The CIS enables the timely and accurate recording of marks and has expanding supportive capacity.

The Marking Scheme, in outline, will lead the process of Test Project design. After this, the Marking Scheme and Test Project will be designed and developed through an iterative process, to ensure that both together optimize their relationship with the Standards Specification and the Assessment Strategy. They will be agreed by the Experts and submitted to WSI for approval together, in order to demonstrate their quality and conformity with the Standards Specification.

Prior to submission for approval to WSI, the Marking Scheme and Test Project will liaise with the WSI Skill Advisors in order to benefit from the capabilities of the CIS.

4 THE MARKING SCHEME

4.1 GENERAL GUIDANCE

This section describes the role and place of the Marking Scheme, how the Experts will assess Competitors' work as demonstrated through the Test Project, and the procedures and requirements for marking.

The Marking Scheme is the pivotal instrument of the WorldSkills Competition, in that it ties assessment to the standards that represent the skill. It is designed to allocate marks for each assessed aspect of performance in accordance with the weightings in the Standards Specification.

By reflecting the weightings in the Standards Specification, the Marking Scheme establishes the parameters for the design of the Test Project. Depending on the nature of the skill and its assessment needs, it may initially be appropriate to develop the Marking Scheme in more detail as a guide for Test Project design. Alternatively, initial Test Project design can be based on the outline Marking Scheme. From this point onwards the Marking Scheme and Test Project should be developed together.

Section 2.1 above indicates the extent to which the Marking Scheme and Test Project may diverge from the weightings given in the Standards Specification, if there is no practicable alternative.

The Marking Scheme and Test Project may be developed by one person, or several, or by all Experts. The detailed and final Marking Scheme and Test Project must be approved by the whole Expert Jury prior to submission for independent quality assurance. The exception to this process is for those skill competitions which use an independent designer for the development of the Marking Scheme and Test Project. Please see the Rules for further details.

Experts and independent designers are required to submit their Marking Schemes and Test Projects for comment and provisional approval well in advance of completion, in order to avoid disappointment or setbacks at a late stage. They are also advised to work with the CIS Team at this intermediate stage, in order to take full advantage of the possibilities of the CIS.

In all cases a draft Marking Scheme must be entered into the CIS at least eight weeks prior to the Competition using the CIS standard spreadsheet or other agreed methods.

4.2 ASSESSMENT CRITERIA

The main headings of the Marking Scheme are the Assessment Criteria. These headings are derived in conjunction with the Test Project. In some skill competitions the Assessment Criteria may be similar to the section headings in the Standards Specification; in others they may be totally different. There will normally be between five and nine Assessment Criteria. Whether or not the headings match, the Marking Scheme as a whole must reflect the weightings in the Standards Specification.

Assessment Criteria are created by the person(s) developing the Marking Scheme, who are free to define criteria that they consider most suited to the assessment and marking of the Test Project. Each Assessment Criterion is defined by a letter (A-I). It is advisable not to specify either the Assessment Criteria, or the allocation of marks, or the assessment methods, within this Technical Description.

The Mark Summary Form generated by the CIS will comprise a list of the Assessment Criteria.

The marks allocated to each Criterion will be calculated by the CIS. These will be the cumulative sum of marks given to each Aspect within that Assessment Criterion.

4.3 SUB CRITERIA

Each Assessment Criterion is divided into one or more Sub Criteria. Each Sub Criterion becomes the heading for a WorldSkills marking form. Each marking form (Sub Criterion) contains Aspects to be assessed and marked by measurement or judgement, or both measurement and judgement.

Each marking form (Sub Criterion) specified both the day on which it will be marked, and the identity of the marking team.

4.4 ASPECTS

Each Aspect defines, in detail, a single item to be assessed and marked together with the marks, or instructions for how the marks are to be awarded. Aspects are assessed either by measurement or judgement.

The marking form lists, in detail, every Aspect to be marked together with the mark allocated to it.

The sum of the marks allocated to each Aspect must fall within the range of marks specified for that section of the skill in the Standards Specification. This will be displayed in the Mark Allocation Table of the CIS, in the following format, when the Marking Scheme is reviewed from C-8 weeks. (Section 4.1)

	CRITERIA								TOTAL MARKS PER SECTION	WSSS MARKS PER SECTION	VARIANCE	
	A	B	C	D	E	F	G	H				
STANDARDS SPECIFICATION SECTION	1	5.00								5.00	5.00	0.00
	2		2.00					7.50		9.50	10.00	0.50
	3								11.00	11.00	10.00	1.00
	4			5.00						5.00	5.00	0.00
	5				10.00	10.00	10.00			30.00	30.00	0.00
	6		8.00	5.00				2.50	9.00	24.50	25.00	0.50
	7			10.00				5.00		15.00	15.00	0.00
TOTAL MARKS	5.00	10.00	20.00	10.00	10.00	10.00	15.00	20.00	100.00	100.00	2.00	

4.5 ASSESSMENT AND MARKING

There is to be one marking team for each Sub Criterion, whether it is assessed and marked by judgement, measurement, or both. The same marking team must assess and mark all competitors, in all circumstances. The marking teams must be organized to ensure that there is no compatriot marking in any circumstances. (See 4.6.)

4.6 ASSESSMENT AND MARKING USING JUDGEMENT

Judgement uses a scale of 0-3. To apply the scale with rigour and consistency, judgement must be conducted using:

- benchmarks (criteria) for detailed guidance for each Aspect (in words, images, artefacts or separate guidance notes)
- the 0-3 scale to indicate:
 - 0: performance below industry standard
 - 1: performance meets industry standard
 - 2: performance meets and, in specific respects, exceeds industry standard
 - 3: performance wholly exceeds industry standard and is judged as excellent

Three Experts will judge each Aspect, with a fourth to coordinate the marking and acting as a judge to prevent compatriot marking.

4.7 ASSESSMENT AND MARKING USING MEASUREMENT

Three Experts will be used to assess each aspect. Unless otherwise stated only the maximum mark or zero will be awarded. Where they are used, the benchmarks for awarding partial marks will be clearly defined within the Aspect.

4.8 THE USE OF MEASUREMENT AND JUDGEMENT

Decisions regarding the selection of criteria and assessment methods will be made during the design of the competition through the Marking Scheme and Test Project.

4.9 COMPLETION OF SKILL ASSESSMENT SPECIFICATION

Recording and calculation of all marks for the test project shall be done in the Competition Information System (CIS) however it must first be verified by the Marking Systems Advisor three months prior to the Competition.

The test project marks will be calculated by comparing team's build cost and compliance to project specifications. Marking will be on the basis of product cost and will include such things as Competitors' work time, materials used, components used, any consulting fees, and machine tool and tooling costs.

Required tolerances must be met for a result to be valid.

Each team member must make sure to record the time they start and finish each shift and clearly indicate what activity they are working on (for machine costs). Competitors not working must remain in a central position. Lunch time is an exception.

Main Project labour hours and machine usage hours will be costed at an hourly rate. This hourly rate will be in the currency of the Host Country. Typical hourly rates are:

- Each Competitor's work time @ €30.00/person/hour;
- CNC machine @ €35.00/hour;
- Consultant and training @ €40.00/hour

Sections of the portfolio must be done during the Competition and will be costed.

Standard documents for portfolio A applicable for competition are provided in appendix.

There may be other forms of assessment for sub-categories of the Main Project such as cycle time where applicable which may also translate to cost per product item made and inclusion of specific items of documentation.

Multiple awards may be made.

4.10 SKILL ASSESSMENT PROCEDURES

Time-keeping system

Machines are to be allocated in 15 minutes increments. Standard machine booking sheets to be used during competition are provided in appendix. Working hours and actual machine usage hours are calculated to the accuracy of the handwritten time-keeping system. The minimum increment for consultant is 15 minutes. Time keeping is handwritten by the Experts. The time keeping is done with three-minute tolerances. Standard time sheets to be used during competition are provided in appendix.

After a machine usage, the Competitor must clean it. This is done during booked time and it will be costed. Expert will check the cleanliness before the Competitor can leave the machine. Standard machine cleanliness applicable during competition is provided in appendix.

For the main project, raw materials such as steel and aluminium in pipe, sheet, and bar form will be costed on a price per kilogram rate. Rate to be decided by Experts prior to the Competition.

All specific profile will be priced by length. Cost must be verified by Experts to reflect commercial cost.

All other allowed raw materials and components of the main project will require current catalogue prices – a printout of a current e-catalogue is acceptable as long as the printout has the website and date printed on it. The accuracy of these catalogues will be checked by Experts. Prices quoted must indicate whether or not they are inclusive of taxes.

Standard list with cost of material to be used for competition is provided in the Test Project description.

Currency conversion rates will be set by Experts at the pre-Competition meeting.

Pre-competition coloured poster

The teams need to provide a pre-made coloured poster (size: 600x1000) with 3D assembly view of the designed product, names and photographs of the competitors, description of main project and designed product. This poster must be displayed to the public before the start of first competition (C1).

Documentation

Portfolio A is to be submitted in paper during Familiarization Day, during toolbox check.

During the toolbox check the material brought by the teams for manufacturing their Test Projects needs to be spread on the floor. A photo needs to be taken of all and put with the sketches that must be submitted for checking material.

All portfolio documents are to be in English.

Sketches must be available at toolbox check and should be referenced to materials, parts etc. (e.g. a number).

Sketches for the drawings to be made during competition need to be hand-drawn. Only text generated by computer can be brought at the competition.

The list of jigs with drawing or photo of each one must be included in the portfolio A. This will also be used during toolbox check

The Surprise Project is to be released during Familiarization Day (C-2)

Security/safety

Each team's toolboxes will be checked prior to competition start. If any suspect items are identified during the toolbox check, the compatriot Expert is to be informed immediately. At no time should an Expert dismantle any components. The compatriot Expert and a team member must be present during this process.

Material size

All material is to be cut in lengths at least 50 mm larger than sketch size. To ensure this, five random parts will be measured during the toolbox check and compared with the sketch in the team's portfolio. Each piece must be 50 mm larger than sketch size to be able to be used (cut down sheet material must be cut 50mm larger in two directions). A photocopy of this sketch is then taken and kept and will be compared throughout the competition to ensure same dimensions are used in the final drawings.

Progressive marking for all sections of the Competition.

MARKING SECTION	WHEN
Main project performance	C4 (day four of Competition)
Main project cost	C4 (day four of Competition)
Portfolio - section A Portfolio - section B	C1 (day one of Competition) C2 (day two of Competition)
Surprise Project	C3 (day three of Competition)

5 THE TEST PROJECT

5.1 GENERAL NOTES

Sections 3 and 4 govern the development of the Test Project. These notes are supplementary.

Whether it is a single entity, or a series of stand-alone or connected modules, the Test Project will enable the assessment of the skills in each section of the WSSS.

The purpose of the Test Project is to provide full, balanced and authentic opportunities for assessment and marking across the Standards Specification, in conjunction with the Marking Scheme. The relationship between the Test Project, Marking Scheme and Standards Specification will be a key indicator of quality, as will be its relationship with actual work performance.

The Test Project will not cover areas outside the Standards Specification, or affect the balance of marks within the Standards Specification other than in the circumstances indicated by Section 2.

The Test Project will enable knowledge and understanding to be assessed solely through their applications within practical work.

The Test Project will not assess knowledge of WorldSkills rules and regulations.

This Technical Description will note any issues that affect the Test Project's capacity to support the full range of assessment relative to the Standards Specification. Section 2.1 refers.

5.2 FORMAT/STRUCTURE OF THE TEST PROJECT

The Test Project includes a main project, a surprise project which represents the 30% change and a Portfolio.

Main Test Project

The Main Test Project involves the manufacture of a team's solution to a manufacturing challenge and would include skill areas such as design, planning, manufacturing, and documenting the manufacturing process.

The manufacturing challenge will detail the Test Project brief and the evaluation procedure and will be made freely available to MTC teams prior to the Competition.

Surprise project

The surprise project represents the 30% change. See paragraph 5.9 Test Project change at the Competition. The surprise project can relate to the main project and must demand work on all equipment listed on the Infrastructure List. The surprise project will be independently designed, and must cover all the following activities:

- CNC milling;
- Conventional milling;
- Conventional lathe;
- Sheet metal work and welding;
- Electronic;
- Additive manufacturing

Assessment of the surprise project is completely done by an independent assessor.

Portfolio

The portfolio will include the documentation involving the main project and will include:

- Video to display to the public during competition;
- 3D assembly drawings;
- 2D mechanical drawings;
- Electrical/electronic diagrams;
- Design calculations;
- List with cost of items used to manufacture the product of main project (raw materials, components);
- Forecasted manufacturing costs;
- Project documentation such as user and maintenance manuals;
- List of jigs provided by the team in toolbox

Some sections of portfolio documentation may be done prior to the Competition.

5.3 TEST PROJECT DESIGN REQUIREMENTS

The total working time for the Test Project will be between 18 and 22 hours.

The Test Project proposals must fit with the following activities/guidelines:

Design

The task is to have all design work including process parts, jigs, and fixtures carried out in accordance with the instructions, specifications, drawings, parts, and samples provided by the project designer(s).

Programme generation

Generate all programmes required for the automated sections of the task including those for any CNC machines, robots, PCs, and PLCs.

Manufacture

Make any parts nominated by the Experts as well as those needed for the working of those manufactured parts such as jigs, fixtures, adaptors, and process attachments to the required tolerances.

Assembly

Assemble the various components either manufactured previously or supplied as part of the task by outside sources using automated methods where nominated as part of the task.

Optimization

Revise the manufacturing and assembly process to optimize cycle times and reduce the process cost.

Documentation

Document the process including header page, index, and descriptive overview of the task, hard copy of any programs, instructions for setting up and assembly, and any relevant drawings.

Surprise project

The design of the Surprise Test Project must fit in the constraints of the following materials provided:

- 100 x 100 x 50mm aluminium – two per team;
- 150 x 100 x 50mm aluminium – two per team;
- 100 x 25mm aluminium flat – 300 mm per team;
- 100 x 10 aluminium flat – 250mm per team;
- 50 dia aluminium round – 150mm per team;
- 50 dia mild bright steel round – 150mm per team;
- 25 dia mild bright steel round – 150mm per team;
- 50 x 5 mild steel flat – 250mm per team;
- 1.6mm thick flat MS sheet – 400 x 400mm per team.

Note: The tolerance gap of dimensions for CNC milling parts cannot be under 0.05mm.

The inside measurement of part by digital machine can be only between 10 and 30mm.

5.4 TEST PROJECT DEVELOPMENT

The Test Project MUST be submitted using the templates provided by WorldSkills International (www.worldskills.org/expertcentre). Use the Word template for text documents and DWG template for drawings.

5.4.1 Who develops the Test Project or modules

The Test Project/modules are developed independently by each Expert.

5.4.2 How and where is the Test Project or modules developed

MTC has two projects. The Main Project is circulated prior to the Competition. The second project is the Surprise Project which represents the required 30% change and is selected at the current Competition and therefore is not circulated prior to the Competition.

Main project proposals are prepared by Experts before the previous Competition where one selected is made, see 5.6 Test Project selection.

Schedule for preparation and development of main Test Project

Experts prepare at least one project proposal which will include an assessment scheme.

One month prior to the previous Competition – all Main Test Project proposals are submitted on the MTC Discussion Forum.

At the previous Competition

The MTC Main Test Project is selected for the following Competition. See paragraph 5.6 Test Project selection.

After the previous Competition

- Three months after the previous Competition the complete specifications of project development is put on the MTC Discussion Forum. The CE or nominated Expert/s facilitates this.
- Four months after the previous Competition the Marking Scheme is developed. The CE or nominated Expert/s facilitates this.
- Eight months after the previous Competition the complete assessment procedures including assessment check lists and testing equipment is developed.

Before the Competition

Twelve months prior to the Competition the MTC Information Pack is compiled with discussion on the MTC Discussion Forum. This is submitted to the Director of Skills Competition who circulates it on the WSI website.

5.4.3 When is the Test Project developed

The Test Project is developed according to the following timeline:

TIME	ACTIVITY
Before the previous Competition	Test Project proposals are developed by the Experts.
One (1) month prior to the previous Competition	Test Project proposals are submitted on the Discussion Forum.
At the previous Competition	The Test Project for is selected for the following Competition.
Three (3) months after the previous Competition	The complete specifications of the Test Project are put on the Discussion Forum.
Four (4) months after the previous Competition	The Marking Scheme is developed.
Eight (8) months after the previous Competition	The assessment procedures including assessment check lists and testing equipment is developed.
Twelve (12) months before the Competition	Test Project Information Pack is supplied to the Technical Director and circulates it on the WorldSkills website.
At the Competition	The Experts propose surprise Test Projects. One is selected by vote of the Experts and given to the Competitors.

5.5 TEST PROJECT VALIDATION

The Test Projects are validated as follows:

- Main Project – specifications to be developed with performance outcomes – explanations and clarifications including assessment procedure to be available in current Competition MTC Information Pack – skills must be outlined in MTC Technical Description.
- Surprise Project – sample project to be supplied as well as all required documentation to be examined by Experts to conform to skills outlined in MTC Technical Description.

The detailed and final marking scheme is developed and agreed by all Experts using the MTC Discussion Forum.

5.6 TEST PROJECT SELECTION

Test Project is selected as follows:

- Before the previous Competition Test Project proposals submitted to the MTC Discussion Forum. The proposal should contain a proposed Marking Scheme with allocation of marks.
- The main Test Project proposals will be presented by each Expert with discussion between Experts. The proposals should be in hard copy form with a copy for each Expert.
- Previous proposals that were not selected may also be considered for selection.
- The proposals will be checked for completeness and compliance with the project design criteria during selection of the Test Project.
- The main Test Project will be considered on the basis of the design criteria in paragraph 3.2 with consideration of the MTC Infrastructure List and competition time.
- Proposals may be edited or altered by the Experts before the selection process.
- Several proposals may be combined to make up the Main Test Project to meet competition time requirements.
- Proposals that do not meet the design requirements under paragraph 5.3 will be excluded.
- The main Test Project is then selected from the proposals by the standard WorldSkills ballot process.

The selected main Test Project or projects will then be prepared as a detailed set of specifications and assessment criteria and procedures and will be referred to as the MTC Information Pack.

5.7 TEST PROJECT CIRCULATION

The Test Project is circulated via the website as follows:

The main Test Project is circulated via the website twelve months before the current Competition.

The surprise project is released on Familiarization Day (C-2). All related documentation is available to the Competitors for 30 minutes.

5.8 TEST PROJECT COORDINATION (PREPARATION FOR COMPETITION)

Coordination of the Test Project will be undertaken by the Skill Competition Manager.

5.9 TEST PROJECT CHANGE AT THE COMPETITION

The Surprise Project represents the 30% change and the contents of this project will not be released to the teams prior to the Competition.

Editing of the surprise project is permitted by Experts if there are conflicts in the execution regarding the infrastructure.

Selection of the Surprise Project

The Surprise Project should be challenging and involve as many skills as possible identified in this Technical Description. The surprise project is made by addition of several proposals in order to cover all the following activities:

- CNC milling;
- Conventional milling;
- Conventional lathe;
- Sheet metal work and Welding;
- Electronic;
- Additive manufacturing

Each of them cannot be greater than 30% of marks allowed for the total surprise project.

The duration of the surprise Project should take 30% of competition time. The project designer must remember that we have three Competitors per team, so the surprise project can reach up to 18 hours to execute. Competition time is 20 hours, however 30% is 6 hours per Competitor.

Ideally, the surprise project can relate to the main Test Project, be developed and evaluated the surprise project completely done by the independent assessor.

5.10 MATERIAL OR MANUFACTURER SPECIFICATIONS

Specific material and/or manufacturer specifications required to allow the Competitor to complete the Test Project will be supplied by the Competition Organizer and are available from www.worldskills.org/infrastructure located in the Expert Centre.

All software including that required for CNC and Robotics must be available to each team at least six months prior to the Competition in the version in which it will be used at the Competition.

PIC software shall also be available at the same time.

6 SKILL MANAGEMENT AND COMMUNICATION

6.1 DISCUSSION FORUM

Prior to the Competition, all discussion, communication, collaboration, and decision making regarding the skill competition must take place on the skill specific Discussion Forum (<http://forums.worldskills.org>). Skill related decisions and communication are only valid if they take place on the forum. The Chief Expert (or an Expert nominated by the Chief Expert) will be the moderator for this Forum. Refer to Competition Rules for the timeline of communication and competition development requirements.

6.2 COMPETITOR INFORMATION

All information for registered Competitors is available from the Competitor Centre (www.worldskills.org/competitorcentre).

This information includes:

- Competition Rules
- Technical Descriptions
- Marking Schemes
- Test Projects
- Infrastructure List
- WorldSkills Health, Safety, and Environment Policy and Regulations
- Other Competition-related information

6.3 TEST PROJECTS [AND MARKING SCHEMES]

Circulated Test Projects will be available from www.worldskills.org/testprojects and the Competitor Centre (www.worldskills.org/competitorcentre).

6.4 DAY-TO-DAY MANAGEMENT

The day-to-day management of the skill during the Competition is defined in the Skill Management Plan that is created by the Skill Management Team led by the Skill Competition Manager. The Skill Management Team comprises the Skill Competition Manager, Chief Expert and Deputy Chief Expert. The Skill Management Plan is progressively developed in the six months prior to the Competition and finalized at the Competition by agreement of the Experts. The Skill Management Plan can be viewed in the Expert Centre (www.worldskills.org/expertcentre).

7 SKILL-SPECIFIC SAFETY REQUIREMENTS

Refer to WorldSkills Health, Safety, and Environment Policy and Regulations for Host country or region regulations.

Competitors must carefully familiarize themselves with the safety instructions concerning general electrical safety, machine safety, welding and hot work, machining and requirements for Personal Protective Equipment.

Chemical Substances

- Safe handling instructions must accompany all substances used. Familiarize yourself carefully with these instructions before using hazardous chemical substances. Wear the necessary protective equipment, for example gloves, eye protection, and respirators.

Personal Protective Equipment (PPE)

- Protective clothing (long pants and a long-sleeved shirt) must be made of non-flammable materials;
- The long-sleeved shirt must be firmly fastened at the wrist. Long pants must reach shoes/boots. Pants must be worn on waist;
- Wrist, finger and hand jewellery and any loose neck jewellery or clothing must be removed;
- Safety glasses to be worn at all times. Preferably a face shield should be worn when using machine tools, grinders and hand tools;
- Safety footwear with protective toe caps must be of approved safety standard;
- Hearing protection must be worn when using offhand grinding machines and angle grinders;
- Protective clothing, safety glasses and safety footwear must be worn at all times when in Competition area. This includes computer use as machine tools may be in adjacent area.

Working areas

- All offhand grinding must be done in the welding bays with the shields closed;
- Welding gloves and welding helmet must also be worn when welding in the welding bay. (Note: welding helmet and gloves not required for grinding);
- When welding, the welding bay shields must be fully closed;
- All people in the welding bay must be fully equipped with welding gloves and welding helmet for welding. (If grinding suitable Personal Protective Equipment (PPE) should be worn.);
- Persons not properly equipped may enter the workshop but must move directly to and must remain within Expert's room and will not be permitted to enter the competition area.

Machine Safety

- When using a grinding machine or machine tool any sparks or swarf must not endanger other people;
- Machines must be cleaned after use;
- Clean up any coolant or oil or liquid spilt on floor;

Housekeeping

- When working in your own competition area, make sure that no working material interferes with the adjacent Competitor's area, and that your actions do not hinder his or her work;
- When sharing machines, leave ample space for the person working on the machine;
- Floor and passages must be kept free of unnecessary clutter, wires and trash.

8 MATERIALS AND EQUIPMENT

8.1 INFRASTRUCTURE LIST

The Infrastructure List details all equipment, materials and facilities provided by the Competition Organizer.

The Infrastructure List is available at www.worldskills.org/infrastructure.

The Infrastructure List specifies the items and quantities requested by the Experts for the next Competition. The Competition Organizer will progressively update the Infrastructure List specifying the actual quantity, type, brand, and model of the items. Items supplied by the Competition Organizer are shown in a separate column.

At each Competition, the Experts must review and update the Infrastructure List in preparation for the next Competition. Experts must advise the Director of Skills Competitions of any increases in space and/or equipment.

At each Competition, the Technical Observer must audit the Infrastructure List that was used at that Competition.

The Infrastructure List does not include items that Competitors and/or Experts are required to bring and items that Competitors are not allowed to bring – they are specified below.

8.2 COMPETITOR'S TOOLBOX

To minimize tools and materials shipped to the competition, toolbox weight will be measured, and marks will be awarded proportionally (the maximum of allocated mark will be for the lightest toolbox). Measurement will be done with pallet truck equipped with weight scale. Pallet truck will be specified to infrastructure list. Before the opening of the toolboxes mass of the tool box/boxes will be measured by the Experts. The mass of the empty outside packing will then be measured to be excluded of the assessment for marking.

8.3 MATERIALS, EQUIPMENT, AND TOOLS SUPPLIED BY COMPETITORS IN THEIR TOOLBOX

Teams must submit a list of the items (materials and components) that they will bring to the Competition and present these parts for inspection to the Experts before the commencement of the Competition. The Expert will then determine what security/safety arrangements will apply for these items.

- It is the responsibility of the team to supply all the tooling, allowed components and raw materials to manufacture the main Test Project including consumables (LEDs, resistors, circuit boards, sheet metal, screws, nuts, pipe flat bar, etc.);
- All electric and electronic components;
- Electric cables, connectors, and couplings;
- All mechanical components (sprocket, chain, gear, etc.);
- Jigs, fixtures, formers and clamping devices. (Jigs must be clearly identified by being painted in red colour and registered in a list included in the portfolio A);
- Lathe and mill tools, machining centre, consumable tooling required for manufacturing components for the main Test Project;
- All hand tools, cutting tools and measuring equipment for the main Test Project;
- Other required manufacturing equipment that is not listed in the MTC Infrastructure List.

Standard tool items for the Surprise Test Project to be provided by Competitors:

Surprise Test Project design will be able to be manufactured with these tools plus items listed in the Infrastructure List.

Attention:

The following items are excluded of the supply from Competitors if related to surprise project (provided by the Competition Organizer in that case):

- All tools for machining (fitting, lathe, mill, CNC);
- Holders of cutting tools for machining;
- Independent metrology and measuring tools for the dimensional measurement of parts/components.
- Screwdriver set;
- Precision screwdriver set;
- cordless drill driver;
- Mechanic tools sets;
- Hand Tap (M3 – M12);
- Tap Wrench (M3-M12);
- Drill set (1,0 – 13,0mm in 0,5mm increments);
- Drills for Tap (M3-M12);
- Drill (16 and 20mm)
- Spanner set;
- Hacksaw;
- Allen key set – metric;
- Snips;
- Hammer;
- Centre punch;
- Combination Square & angle gauge for Welding;
- Combination pliers (for Electronics and Mechanical);
- Soldering station to suit electronics;
- Dial Bore Gauge (10 – 35mm) (accuracy 0,001mm at least);
- External Digital Micrometers (0 – 100mm) (accuracy 0,001mm at least);
- Dial test indicator (accuracy 0,01mm at least);
- Dial indicator (accuracy 0,001mm at least);
- Magnetic hydraulic stand;
- Digital Caliper (0-200mm) (accuracy 0,01mm at least);
- Digital Depth Micrometer (0-150mm) (accuracy 0,001mm at least);
- Multimeter;
- Oscilloscope;
- Adjustable digital DC power supply precision, at least 30V 5A;
- All accessories and consumables for welding machine;
- 3D printers and all accessories and consumables.

Note:

1. More details in the infrastructure list;
2. Tools and instruments similar or having the same function carried out by the competitors, which has in the infrastructure list, will not be allowed to use.

8.4 MATERIALS, EQUIPMENT, AND TOOLS SUPPLIED BY EXPERTS

A sample of the surprise project proposal is provided by the related Expert if applicable.

Electronic components of surprise project are provided for all Competitors by the related Expert if applicable.

8.5 MATERIALS AND EQUIPMENT PROHIBITED IN THE SKILL AREA

- Digital storage devices including;
- Laptop or portable computers;
- PDAs such as Palm, IPAQ etc.;
- Mobile phones;
- Digital or film cameras;
- Memory sticks/MP3 players;
- Walkman radio/CD players;
- Electronic organizers/diaries;
- Wireless communication devices;
- Non-approved CDs or floppy discs – approval by Chief Expert or delegate;
- Any additional software not supplied by Competition Organizers unless approved by majority of Experts;
- Purchased items are not to be modified in any way prior to the Competition;

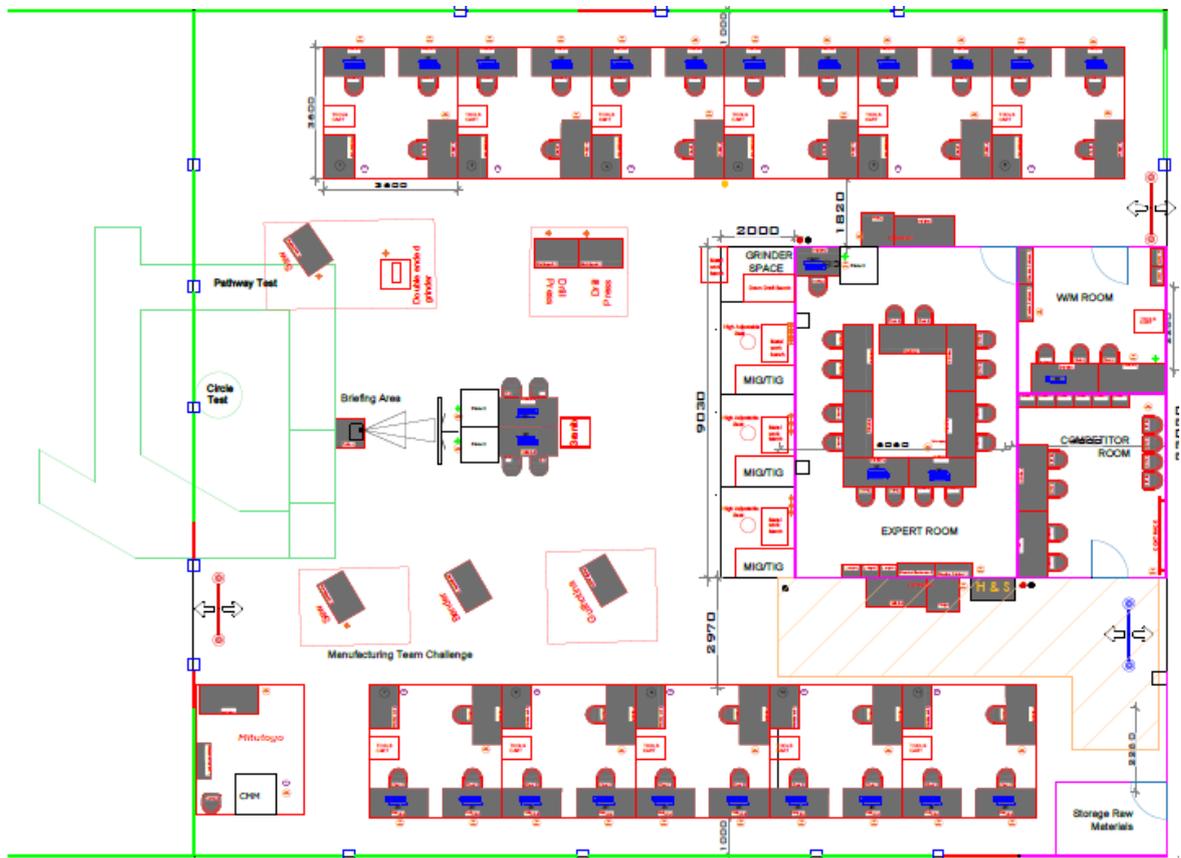
Teams will be controlled for components of the unit that they are not allowed to bring into the Competition. In other words, bringing purchased and self-made items that must be made at the Competition will be banned. A toolbox inspection will be conducted before the Competition and any suspect components will be quarantined and banned from use during the Competition;

- During the Competition, no tools, equipment, stationary, components, manuals, drawings or digital storage devices may be removed from the Competition venue, unless approved by Chief Expert;
- Wood material in the main project;
- Extrusion profiles with related fittings;
- Any pre-made parts except the ones specified in the Test Project description;
- All software (always provided and installed by Competition Organizer);
- If suitable equipment is provided by the Competition Organizer, Competitors are not permitted to use substitute equipment provided by them.

8.6 PROPOSED WORKSHOP AND WORKSTATION LAYOUTS

Workshop layouts from previous competitions are available at www.worldskills.org/sitelayout.

Example workshop layout:



9 SKILL-SPECIFIC RULES

Skill-specific rules cannot contradict or take priority over the Competition Rules. They do provide specific details and clarity in areas that may vary from skill competition to skill competition. This includes but is not limited to personal IT equipment, data storage devices, internet access, procedures, and work flow, and documentation management and distribution.

TOPIC/TASK	SKILL-SPECIFIC RULE
Use of technology – USB, memory sticks	<ul style="list-style-type: none"> • Competitors are only allowed to use memory sticks provided by the Competition Organizer. • Memory sticks or any other portable memory devices cannot be taken outside the workshop. • Memory sticks or other portable memory devices are to be submitted to the Chief Expert at the end of each day for safe keeping.
Use of technology – personal laptops, tablets and mobile phones	<ul style="list-style-type: none"> • Competitors, Experts, and Interpreters are not allowed to bring personal laptops, tablets or mobile phones into the workshop. Exceptions for Experts may be granted by Chief Expert if requested.
Use of technology – personal photo and video taking devices	<ul style="list-style-type: none"> • Competitors, Experts, and Interpreters are not allowed to bring personal photo and video taking devices into the workshop. Exceptions for Experts may be granted by Chief Expert if requested.
Tools/infrastructure/materials/equipment	<ul style="list-style-type: none"> • Refer to the Test Project and Technical Description for a detailed list of equipment and materials that are prohibited in the workshop. • After toolbox check and during the Competition duration, no tools, equipment, stationery, components, manuals, drawings or digital storage devices may be removed from or brought into the workshop, unless approved by the Chief Expert.
Templates, aids, etc.	<ul style="list-style-type: none"> • Refer to Test Project and Technical Description
Drawings, recording information	<ul style="list-style-type: none"> • Sketches for the drawings to be made during the competition need to be hand-drawn. Text can be computer generated. See Technical Description.
Health, Safety, and Environment	<ul style="list-style-type: none"> • Refer to the WorldSkills Health, Safety, and Environment policy and guidelines document.

10 VISITOR AND MEDIA ENGAGEMENT

To maximize visitor and media engagement for MTC the following ideas will be considered:

- Utilize MTC Media Liaison Person (previous Competitor is ideal) at Competition site to explain MTC concept and escort media on site;
- Display screens with head cam showing live images;
- Test Project descriptions;
- Enhanced understanding of Competitor activity;
- Site layout to enable public and media to get close to Competitors – have access bays;
- Display screen with Competitor profiles;
- Daily reporting of competition status including marks, costs and times;
- Active assessment involving timed and active tasks – use announcer to inform public of what is happening.

11 SUSTAINABILITY

- Selection of projects to be related to sustainability and energy conservation e.g. wind generator, solar powered water pump and inner city rechargeable electric vehicle;
- Main project ideally be of benefit to developing countries;
- Use of 'green' materials;
- All swarf and scrap materials to be collected for recycling;
- Use of completed Test Projects after the Competition.

12 REFERENCES FOR INDUSTRY CONSULTATION

WorldSkills is committed to ensuring that the WorldSkills Standards Specifications fully reflect the dynamism of internationally recognized best practice in industry and business. To do this WorldSkills approaches a number of organizations across the world that can offer feedback on the draft Description of the Associated Role and WorldSkills Standards Specification on a two-yearly cycle.

In parallel to this, WSI consults three international occupational classifications and databases:

- ISCO-08: (<http://www.ilo.org/public/english/bureau/stat/isco/isco08/>)
- ESCO: (<https://ec.europa.eu/esco/portal/home>)
- O*NET OnLine (www.onetonline.org/).

This WSSS (Section 2) appears to be a junior version of a *Mechanical Engineer*:
<https://www.onetonline.org/link/summary/17-2141.00>

and to relate to a *Mechanical Engineering Technician*:

<http://data.europa.eu/esco/occupation/b31e404e-9af6-457d-a58a-208f612eeba3>

Adjacent occupations can also be explored through these links.

The following table indicates which organizations were approached and provided valuable feedback for the Description of the Associated Role and WorldSkills Standards Specification in place for WorldSkills Kazan 2017.

ORGANIZATION	CONTACT NAME
Autodesk	Mike Westlake, UK & CEE Manager