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Computer-aided Design

1. Introduction

In today's world, computers are used for all types of activities. All information has been or is currently being digitised or generated by information systems. Graphic media also use computers to generate designs, illustrations and graphic information in general.

This is done through the use of sophisticated CAD-CAM-CAE systems that integrate computer-aided design (CAD), management of manufacturing information or computer-aided manufacturing (CAM) and computer-aided engineering (CAE). Since the three systems jointly constitute a sound technological tool, it is important to be familiar with the possibilities that a computer-aided design system can offer in the context of a manufacturing and engineering system.

The activities proposed focus on using the resources offered by web tools to develop designs in different environments.

2. Objectives

The objectives of the activities included in this document are:
- to use particular computer-aided design programs for general purposes
- to be aware of specific tools developed for manufacturing technical objects
- to practise using perspective and different views of an object or group of objects
- to know about the practical use of design tools to switch the design from perspective to views
- to practise adding text and colours to enhance design.

3. Content blocks and competences

Content blocks
The aim of these activities focuses on the use of computer design tools as stipulated in the following content blocks of the curriculum:
- Block 1: Home installations
  Analysis of the elements involving domestic systems: electricity, sanitation, plumbing, heating systems, gas, air conditioning, domotics and other installations. Supply connections, components, regulations, symbology, analysis, team design and

assembly of simple installations. Analysis of household bills. Energy saving in domestic facilities. Bioclimatic architecture.

- **Block 6: Technology and society**
  Evaluation of the history of technological development. Analysis of the evolution of technical objects and the importance of standardisation of industrial products. Management of raw materials and natural resources. Acquisition of habitual behaviours that boost sustainable development.

In bilingual education settings, there is an additional specific block directly related to the acquisition of skills and knowledge of computer-aided design: *'Expression and communication techniques: Computer-aided design'*.

Key competences
The activities included here draw on the following basic competences as developed and defined by the European Commission:

- *Communication in foreign languages,* which involves, in addition to the main skill, dimensions of communication in the mother tongue, mediation and intercultural understanding. The level of proficiency depends on these factors as well as the capacity for listening, speaking, reading and writing;

- *Mathematical competence and basic competences in science and technology.* Mathematical competence is the ability to develop and apply mathematical thinking in order to solve a range of problems in everyday situations, with the emphasis being placed on process, activity and knowledge. Basic competences in science and technology refer to the mastery, use and application of knowledge and methodologies that explain the natural world. These involve an understanding of the changes caused by human activity and the responsibility of each individual as a citizen;

- *Digital competence,* which involves the confident and critical use of information society technology (IST) and thus basic skills in information and communication technology (ICT);

- *Learning to learn,* which relates to learning, the ability to pursue and organise one's own learning, either individually or in groups, in accordance with one's own needs, and awareness of methods and opportunities.

Linguistic competences

- *To understand general and specific information in oral texts in a variety of communication situations.*
- *To express themselves orally in everyday communication situations clearly and with autonomy.*
- *To communicate with enough spontaneity and fluency in English for conversation to flow effortlessly with native and non-native speakers.*
- *To understand texts of a historical and scientific nature, as well as other subjects likely to be taught in English. To reinforce writing and speaking skills and the related contents.*
- *To develop autonomous learning, reflecting on the process of learning and recognising the influence of the mother tongue in studying the English language.*
- *To use different learning strategies and all the media available to students, especially information and communication technology, to obtain, select, analyse and present both written and oral information.*
- *To appreciate the English language as an instrument to access information and as a tool for learning contents of a diverse nature.*
- *Use of different sources to extract information for an individual or group task, discriminating information from opinion and identifying trustworthy sources, especially coming from the Internet.*

The activities focus on the use of computer-aided design tools, and also include a series of exercises for grammar practice. The activities aim to work on:

- Contrasting developing actions with habitual actions.
- Requesting and transmitting information about habits, routines and lifestyles using the 'present simple', the 'present continuous' and 'frequency adverbs', as well as sentences with the expression *used to*.

4. Assessment criteria

The following criteria will apply in the sugggested activities:

- Use of computer-aided design to create views and perspectives of simple objects.
- Attempting to design new objects using a computer-aided design tool.
- Using proportion for measuring, and using the human body and its measurements as a reference.
- Awareness of the different CAD system infographic options that complement technical drawing, such as the application of textures and surfaces.

The following criteria should be taken into account when assessing use of English:

- The correct use of the present continuous and present simple in phrases and expressions.
- Production of written texts relating to daily life, with a particular focus on design tools. The texts can be wrtten by hand or on a computer.
- Knowledge of specific vocabulary relating to the regular tasks, instructions and commands involved with working with computer-aided design.

5. Activity development

Given the complexity of the subject and, particularly, of the professional tools used in computer-aided design, the activities aim to teach students how to apply basic design techniques, given easy access to user-friendly tools.

Materials
A personal computer or laptop, with Internet connection and enough memory to run basic design tools, is required to carry out these activities.

Timing and implementation in the classroom
Two sessions will be required in order to put the activities into practice: the first will be used to present the two computer design tools and the second to work on and mark the CLIL activities suggested in each of the two activities in the Worksheets.

Since the design that students are asked to present is based on an open topic, focusing on using the program utilities with few technical restrictions, students are likely to need extra time to finish their designs. Activities will therefore tend to be carried out as part of the subject's 'homeschooling'.

The teacher will set a deadline of no longer than five days to finish the designs, which gives enough time for students to familiarise themselves with the tools.

6. Useful links

The following software must be installed on the computer in order to carry out the activities:
- the IKEA Kitchen Planner application:
  http://kitchenplanner.ikea.com/MY/UI/Pages/VPUI.htm
- the latest version of Google SketchUp:
  http://www.sketchup.com/

7. Extension activities

The computer tools presented for carrying out the suggested activities are not for professional use, but they do have enough capability for the creation of designs with a professional look. For the purposes of extension, students can be informed of the existence of professional tools such as AutoCAD. There are, in addition, a great number of free design tools available online:

- **Blender:** this is an open-source application for design and 3D animation. It is free and can be downloaded from the website (www.blender.org). Versions exist for Windows, Linux and Mac operating systems.

- **Drawspace** (http://dev.drawspace.com/): this is a community-based initiative created by designers and illustrators with the objective of teaching young people the main principles of illustration and design. It offers lessons that can be downloaded in PDF format or read online under the 'Creative Commons' license, and classified by skill levels.

- **Illuminations isometric drawing tool** (http://illuminations.nctm.org/): this is a website with online activities created by the National Council of Teachers of Mathematics, that offers an interactive tool to create simple designs on an isometric grid.

- **Librecad** (www.librecad.org): this is a CAD application for 2D drawing. It is an open-source application based on QCAD libraries and is available for Windows, MacOS and Linux.

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Activity 1: IKEA Kitchen Planner

IKEA Kitchen Planner is an online web tool, developed by the Swedish furniture company, that enables customers to design the layout of their own kitchen by arranging the furnishings and appliances of their choice to fit the exact measurements of the room.

The user web interface is shown full screen. The user is asked to determine the size and shape of the room in which the kitchen will be designed. For example, it could be a square room of 6000x4500x2700. Two icons allow you to switch between 2D and 3D view. After selecting the size of the room, you locate doors, windows and fixtures: plumbing, gas pipes, electricity switches and outlets, heating and ventilation devices such as radiators, air conditioners, vents, fireplaces and stoves. Finally, locate obstacles such as pillars, inner walls, bulkheads, partition walls, etc.

Now the available volume is ready to accommodate the following kitchen elements:

Built-in kitchens	Appliances	IKEA accessories
Base cabinets	Freestanding cooker	Wall panels
High cabinets	Dishwasher	Trolleys
Wall cabinets	Refrigerator	
Bench tops	The customer's own appliances	
Kitchen islands		

The designer views how the different elements fit in relation to the walls and floor in order to select the suitable furniture and appliances.

After equipping the kitchen with fixed furniture, dining objects such as tables, chairs, bar tables, stools and sets could be selected as well, to give the kitchen the final touches. The flooring, walls and ceiling may be decorated by selecting the appropriate materials from the menu.

An example of an ad-hoc design is shown in the picture:

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CLIL extension to Activity 1

a) In Activity 1, you have used several elements to equip a kitchen. All of the pieces of furniture and appliances are assembled and installed in your own kitchen. Select five of them in order to explain what activities you are used to doing with them and what objects you would like to have instead. For instance, in relation to a dining table, a possible sentence could be:

– *In my family we are **used to** having dinner in the living room, but I **would like** to find a suitable dining table to have dinner in the kitchen instead. I feel more comfortable talking with my parents in the kitchen.*

Now it's your turn. Write five more sentences similar to the example in order to explain something about your habits in your own kitchen, and what you would like to do instead.

1. .... used to............................ would like ....

2. .... used to............................ would like ....

3. .... used to............................ would like ....

4. .... used to............................ would like ....

5. .... used to............................ would like ....

b) Make a list of the elements that appear in the IKEA web tool which you had never seen before. Explain what you think they are used for, by looking at their position in the kitchen. If you're not sure, ask your teacher.

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Worksheet

Activity 2: Making buildings with Google SketchUp

Google SketchUp is a computer-aided design tool created as an added-value application from Google. The application has to be downloaded and set up on the computer so it can be used offline for drawing tasks, preparing designs, etc. After drawing a 3D design, the user can connect to the Internet to choose textures, materials and colours to complete the design.

Once the application starts running, the program asks the user to select a template. There is a wide range of available templates to develop the proper design according to the specifications of the proposed job. The templates permit the user to draw directly using perspectives such as 2-points perspective, 3-points perspective, isometric projection, etc. The zoom-in, zoom-out, rotation and displacement options allow the user to view details of the design. In this exercise, the Engineering template will be chosen.

A human body will appear aligned to three orthogonal axes in order to determine by comparison the size and measurements of the building to be designed. Human body height will be used as a first approach, but later metres will be used to draw the length of magnitudes.

Students will create their own design following these steps:
1. Draw a simple sketch to define the occupied surfaces for the buildings.
2. Use the push/pull tool to create volumes based on the previous surfaces.
3. Determine the number and position of the windows and doors.
4. Add detail to roofs and surrounding pavements.
5. Apply textures and colours to walls, windows, doors and roofs, as well as to the surrounding area, such as tiles for pedestrian areas, grass textures for gardens, etc.

An example of the result can be seen in the following picture:

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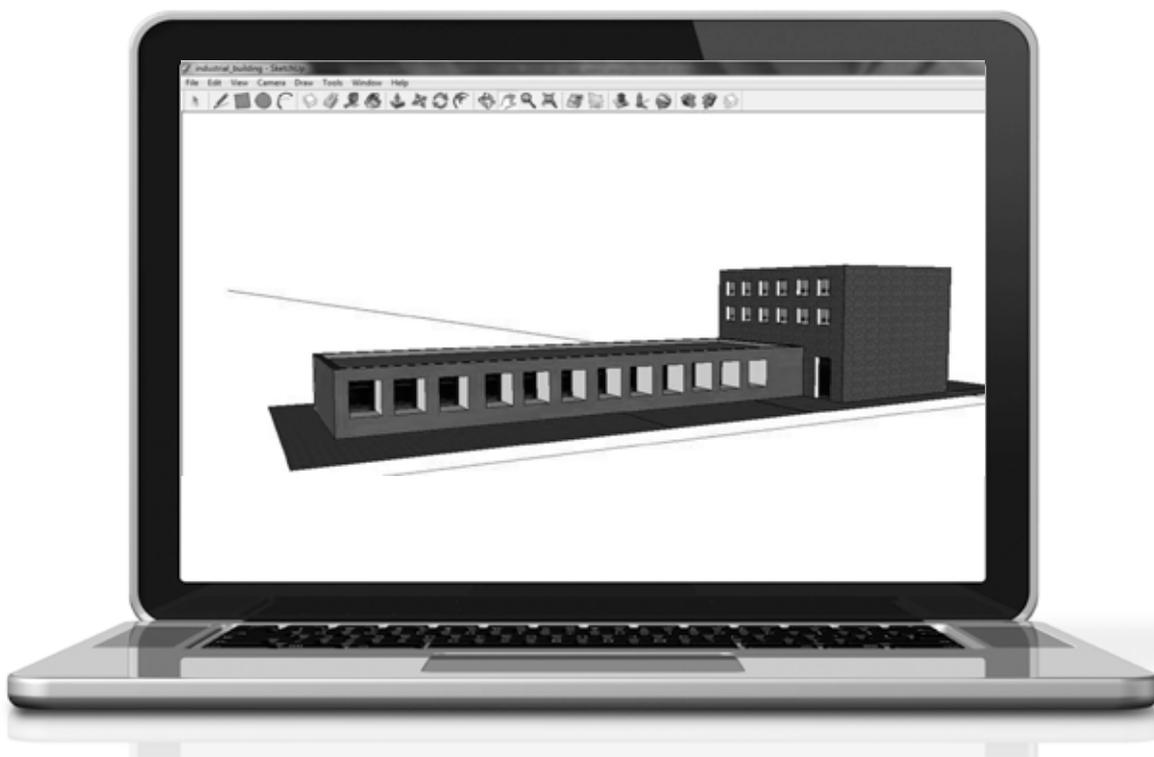
Worksheet

CLIL extension to Activity 2

a) Describe, using the present simple tense, the buildings designed in the example. Describe the shape of the buildings, the texture of the walls, the position and number of windows, and the approximate size of the buildings in comparison with the size of the human body represented on the right side of the drawing.

b) Imagine that you are working in the building. Write a document explaining who you are and what kind of work you do daily. Once you've finished, highlight in a different way the verbs in the present simple tense, from those in the present continuous tense. For example, your personal history could be:

I'm Peter McGregor. I work for an engineering company near Leicester in the north of England. In my company, we develop many electronic products and I'm in charge of the design department. Now it's early in the morning and I'm driving to my office. I've just remembered that I have to call a transistor provider to solve a problem with some invoices. They sent us a couple of invoices for the wrong amount. I don't feel very comfortable when I have to call somebody to tell him he's doing a bad job. But I have to do it. I wonder if there's anybody who enjoys telling others what to do. I remember when I was a simple designer. My life was easier then but I am making more money now …

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