









User Centred Design

A Practical Guide for Teachers of Design & Technology

Chartered Institute of Ergonomics & Human Factors

Design 4 Real People
The Campaign for Teaching User-centred Design

About this Guide

The Design for Real People Action Group, in collaboration with the Chartered Institute of Ergonomics & Human Factors (CIEHF), has been working to support the introduction of User Centred Design (UCD) into Design and Technology teaching in schools. This guide is intended as an introduction to the teaching of UCD under the new syllabus. It provides a set of signposts to resources that the group is compiling to support you and your students from September 2017 onwards.

Section 1 Introduction	...is an outline of UCD and its relevance to good design
Section 2 UCD basics	...fleshes out the philosophy of UCD and the iterative design process at its centre
Section 3 Teaching UCD	...deals with how to teach UCD and shows how it fits in with both new and existing D&T topics
Section 4 Planning your teaching	...suggests a strategy for planning your teaching, and how to adapt some of your existing Schemes of Work so that they clearly include UCD elements
Section 5 Further resources	...signposts further resources if you and your pupils want to delve more deeply into UCD
A note about UCD terminology	We have not included a glossary of new terms, opting instead to include sidenotes that explain new ideas on the pages where the terms first occur, so you can see the terms being used in context. Where the term first appears, we have shown it in *red italics*. Let us know if this is the best way to handle this.
Contact us	We look forward to getting feedback from you and your pupils in the coming months. Please email your thoughts to info@designingforpeople.org.uk

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Section 1

Introduction

Part of the excitement of teaching Design and Technology (D&T) derives from the way in which the curriculum is continually evolving to reflect changes in the real world of design practice. So, in the Government's 2016 changes to the D&T curriculum, terms such as *biomimicry*, *iterative design* and *user-centred design* (UCD) have made an appearance for the first time, and there is an increased emphasis on a systems approach and a need for cross-curricular links between D&T, Maths and Science.

Changes in D&T subject content

The introduction of UCD is the main subject of this guide. From a teaching point of view, there is considerable overlap between UCD and, in particular, iterative design and systems thinking. This overlap is likely to ease the introduction of the extra topics, and some of the 'new' material will actually be in part taught already. Nevertheless, change can be challenging, and although you may have already attended DATA events introducing the new D&T curriculum, we believe many teachers will welcome specific guidance on UCD, as well as ideas and materials to help in teaching it.

Biomimicry is the imitation of the models, systems, and elements of nature for the purpose of solving complex human problems. Like ergonomics, it is an example of the application of science to the problem of design (in this case, biological sciences such as comparative anatomy). However other than this tenuous link, it is unrelated to UCD and will not be considered further in this guide.

The exam boards have now revised their D&T specifications to reflect the new curriculum, which you can see through links from the DATA website. These have all now been approved by OFQUAL. We have studied the specifications from OCR, Eduqas (WJEB), AQA and Pearson (Edexcel), and from these drawn out some key learning objectives specific to UCD. These have been the starting point to develop learning materials to support you and your students in the transition, but which will also become a permanent set of resources for D&T teachers in the long term.

What is UCD?

In broad terms, UCD is both a design philosophy and a design process. As a philosophy, it makes the needs, wants, and limitations of the *end user* of a product the priority focus, and as a process it offers designers a range of methods and techniques to ensure this focus is sustained through the various stages of design.

The UCD process not only helps designers to analyse and foresee how users are likely to use a product, but also to assess their assumptions about peoples' behaviour in realistic tests with actual users. Such testing is necessary as it is often very difficult for designers to understand intuitively what a first-time user of their design will experience, and what each user's learning curve may look like. The chief difference from other design philosophies is that UCD tries to optimise the design around how users can, want, or need to use the product, rather than forcing them to change their behaviour to accommodate the product. This is explored in more detail in Section 2.

Iterative design is an approach that involves the refinement of the design of a product, system or process through cycles of building, testing and analysing a sequence of prototypes. It is very compatible with UCD, as prototypes are excellent for communicating a developing design idea to users and may also be tested out with the users themselves. The UCD process is therefore based on iterative design (see Section 2.2).



To encourage a less ego-centric approach

One of the most fundamental mistakes that some professional designers still make is to assume that end users are very similar to themselves. Such designers tend to understand the end user in terms of their own abilities and physical and mental characteristics. This makes it simpler to come up with a design, and he or she can easily try out their ideas on themselves without having to bother to talk to anyone else! Sometimes this approach will work, but students only have to look around their classroom to see that people are not all alike – there are *individual differences*. Furthermore, if students choose a career in professional design, they will have to start thinking about accommodating the needs of a wide range of users, so starting to understand the full range of users from the beginning will improve their chances of later success.

To improve product safety

Badly designed products can injure and even kill people. A hand tool such as a knife or a chisel can slip or break with dire consequences if it has not been designed for the way that a human hand will hold it in use, and apply forces through it. Conversely, a well-designed product can nudge users towards safe operation. Students will be aware of risks in the context of their own safety in the classroom and workshop, but the importance of good design expands if the product is a building, a motor vehicle, an aircraft, an air traffic control system or a nuclear power station to be used by other people whose awareness of risk may vary a lot. Modern health and safety legislation places responsibility on designers to ensure that products they develop are safe to use, and this can only be done by carefully analysing how users will interact with the product. UCD provides a vehicle for ensuring that user risks are assessed sufficiently early in the design process, and periodically at each iterative design cycle, so that they can be properly accommodated in the final product.

To improve product effectiveness

Obviously a product must 'do what it says on the tin' – it must have the functionality to address the need that was set out in the design brief. However, needs come from people – typically end users – so writing the design brief will benefit from analysis of real users and what they need. A user centred approach will consult users and analyse the way they currently try to address their needs, using and applying this knowledge to the design of the product throughout.

To improve product ease of use

A product that is easy and comfortable to use is likely to enable users to complete their tasks more effectively. They are likely to be able to operate more quickly and reliably, need less training and become tired less quickly. These advantages are also likely to contribute to safe operation as well. It will now not come as a surprise to learn that the secret of design for usability is an understanding of user characteristics! UCD focuses on these characteristics, as we will see in Section 2.

To increase fun & enjoyment of using a product

The notion of a positive *user experience* is increasingly prominent in the marketing of products. In the fickle and competitive world of mobile apps and games, products will stand or fall on whether new users can intuitively grasp how to use them and whether they get a buzz of satisfaction in the process. As consumers themselves students will recognise this! The same applies to other consumer products, as users become more sophisticated and each manufacturer is seeking a competitive edge over their rivals in order to survive. A user centred approach is fundamental to achieving the holy grail of a positive user experience and a winning market position.

Why teach UCD?

Individual differences exist between individuals in any sample of people. These can relate to body size, strength, intelligence, reaction time etc. If you design for just one person, it is very likely that the product will be less easy to use by others who differ in certain respects that may be important for its operation. For example, designing a table for a person of average height to prepare food may be less suitable for a very tall or a very short person. Designing to accommodate individual differences requires taking a broader perspective of the whole likely user population

User experience (UX) is a description of the emotions, understanding and attitudes that emerge in users as they interact with a product or service. See https://www.usability.gov/what-and-why/user-experience.html website for more detail.

Section 2.
UCD Basics

User focus

In this guide the word ***'product'*** is used interchangeably with more specific terms such as 'device', 'machine', 'computer' or 'garment' to describe the thing being designed. The same UCD principles apply, although the details and emphases will differ slightly with different product types: this becomes more relevant in relation to the alternative A level pathways now included in the D&T syllabus – see Section 3.

Ergonomics is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimise human well-being and overall system performance." *International Ergonomics Association. For more information see the* CIEHF website.

Context may include the physical, social or organisational environment.

Of course, users are already, and have long been, a consideration in D&T teaching; 'design problems' have always been owned by users, and *products* have been designed with users in mind. But users have been less central in the way that is implied by the term 'user-centred design'. An important consideration for the designer must be the characteristics of the intended users of a product, including their strengths and limitations. The characteristics will include their **physical dimensions** and abilities to **move and apply force**, but also the knowledge they have, including the **skills they possess** that will determine the way in which they will interact with the product.

The field of *ergonomics* has emphasised the value of utilising users' existing knowledge and behaviour so that when they are faced with a new product (be it a mobile phone, a car or a piece of work wear), they will be able to accommodate its use with their previous experience. This will minimise the need to learn something new or adjust their approach. Some devices – particularly those with a lot of complex functions – will require users to be supported by training and other forms of instruction (such as manuals or help facilities), but these learning overheads can be reduced by good design, and it is this principle that is the focus of UCD.

Products and users don't interact in a vacuum: there will be a *context* for their interaction which will influence the user's ability to achieve a successful interaction with the product. The context might include the physical surroundings such as space, constraints on posture, light, noise, movement of the environment such as vibration, etc. It also includes other people sharing that space, as well as the constraints on the way the product is used as set by relevant legal or organisational frameworks.

Users usually interact with a product for a reason: there will be a purpose in the mind of the user. This might be a clearly defined objective that the user wishes to achieve at work but, in the case of a computer game, a fashion garment, an ornament or work of art, the user's objective might be less obvious. However, even here it is possible to identify particular outcomes that the user might be seeking, like having fun, looking good, developing a skill, winning at something or gaining pleasure from engaging with a beautiful object.

The ***task*** describes the purpose for the interaction – as determined by the user's own objectives. The same device may be intended to fulfill a range of different tasks, for a range of different users, so the designer needs to be aware of all of these in order to create a design truly fit for purpose.

The questions UCD asks

Ergonomics has used the term *task* to describe this purpose for the interaction between the user and the product. It is a useful term because it enables the designer to think about the performance of a product in a more powerful way. Rather than evaluating a product with reference to the number of functions it can perform or its weight or speed, think about how well it assists the user in the performance of a task. How you actually measure performance will depend on the task and context but, generally speaking, the UCD-focused designer's interest will be in aspects such as:

Inclusivity: how accessible is the product to all the types of people who might use it?

Usability: how easy or comfortable is the product to learn and use in achieving task objectives?

Speed: how quickly can users complete a task?

Accuracy: how many mistakes (errors) are made in completing the task?

Safety: how many potentially dangerous or harmful incidents can occur in the course of the task?

Enjoyment: what degree of pleasure is gained from using the product?

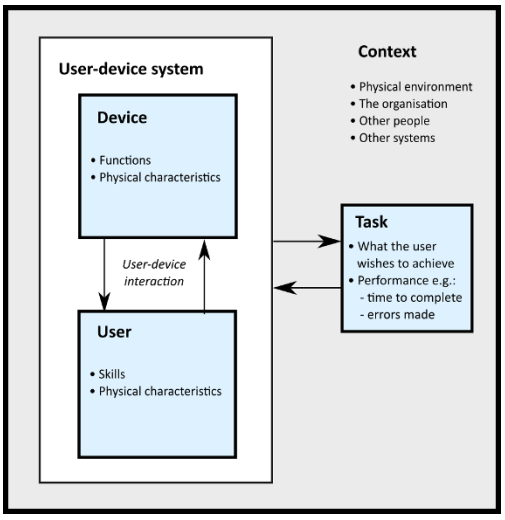


Figure 1 : User-device interaction

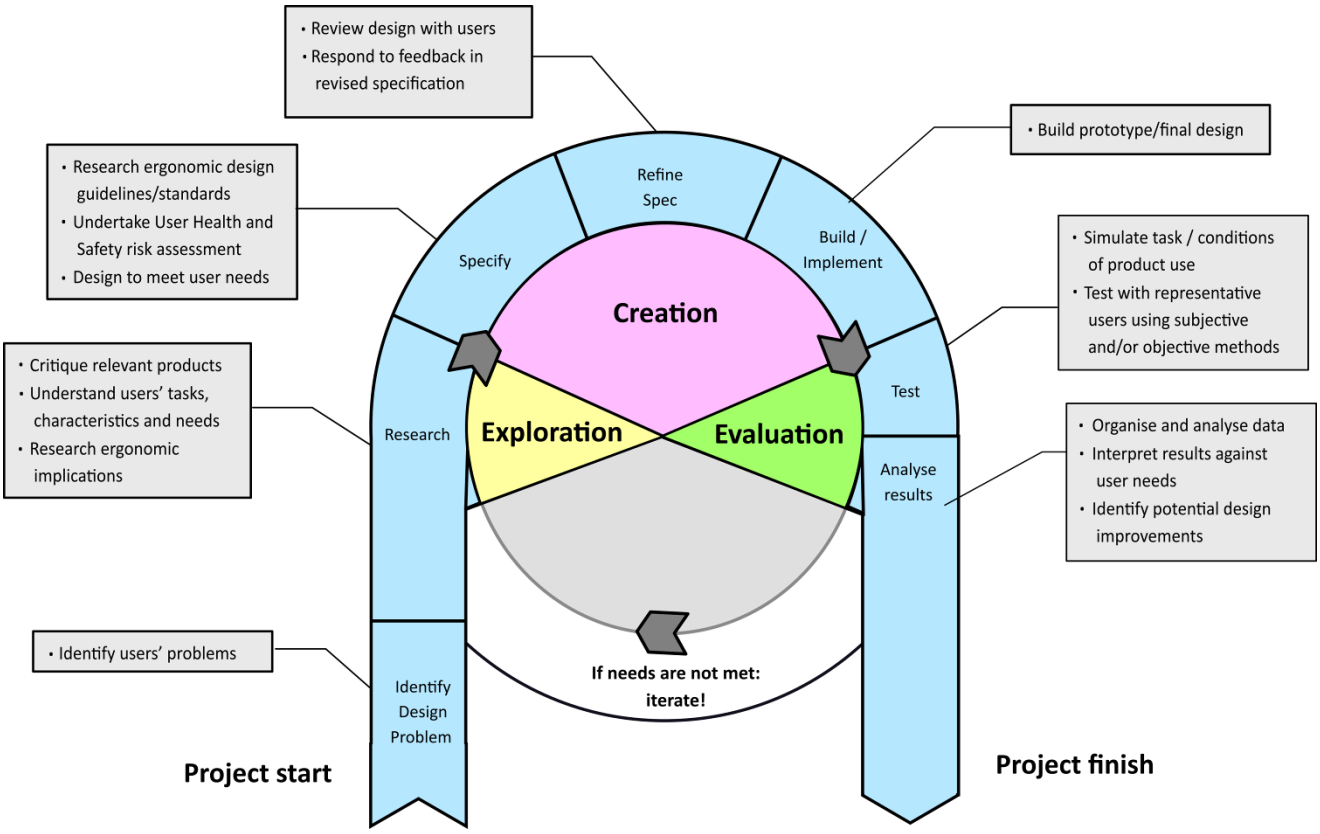
User-device interaction

UCD encourages designers to see the close and subtle interactions between the **user** and the **device** when performing a **task**. These exist within a **context,** which may influence these interactions. A change in any one of these elements may, and probably will, affect interactions between the others.

The UCD Process

UCD has common objectives with any other approach to design, in that it seeks to create a product that meets a set of requirements in a cost effective way. It is basically an iterative design process with a particular focus on users. Figure 2 shows an iterative design model with three familiar stages of **exploration**, **creation** and **evaluation**, each of which can be further broken down into the activities of researching, specifying, refining and so on, ending up in testing of the product. If the original requirements (and particularly user needs) are not met when tested, the cycle is repeated to refine the design. The UCD element becomes evident in the way that these activities are carried out to achieve the user focus we are aiming for.

Figure 2: The process of user-centred design



Section 2.
UCD Basics
continued

UCD in the Exploration Stage of projects

Researching the users
A central tenet of UCD is to understand the users' characteristics and behaviour in detail at the outset, and to bring this knowledge into the design brief. The reason for this is that it becomes more difficult (and expensive) to fundamentally change a design as the design cycle progresses. Unfortunately, leaving it too late can result in last minute cosmetic modifications to 'patch up' a product that is fundamentally difficult to use and which really requires radical rethinking to address its underlying problems. Patching up usually shows!

Researching the task
A second objective during this phase is deciding the task(s) and level of task performance that the new product should achieve. The exam boards seem to be placing emphasis on this aspect in their changes to the assessment of students' practical work. Essentially, user needs should be explicit in the design brief, and preferably expressed in quantitative terms, to provide a baseline against which the final product of the project can be assessed during the evaluation phase. How students can go about this will be explained in Section 4.

UCD in the Creation Stage of projects

Using design guidance
Knowledge of tasks and users goes a long way in keeping design on track, but a more detailed understanding of how physical and mental characteristics will influence the way the user operates can save later iterations to refine the design. Such knowledge only tends to come with experience (or specialist education in the applied human sciences or ergonomics), which D&T students will not have. However, what *is* available is a set of tools that bring some of this knowledge in an accessible form to the designer, in the shape of design standards, design guidelines and databases of anthropometric and biomechanical data. We will discuss these tools and provide pointers towards them in Section 4

User trials and prototypes
As just about every project, user population and context is unique, it is inevitable that guidelines cannot provide all the answers, and it is here that an iterative approach comes to the rescue. By designing simple mock-ups on the basis of the ergonomics tools that *are* available, students can test assumptions they are making in quick user trials at an early stage. As the design is refined, options for more sophisticated prototyping are increasingly available, allowing rapid user testing before committing to a final design. Again, Section 4 will provide guidance on the use of prototypes in UCD.

UCD in the Evaluation Stage of projects

Evaluation is the stage during which the design is tested against the user needs set out in the design brief. Exam boards appear keen that students should do this rigorously using an evidence-based approach that UCD can provide. Within the iterative design model, evaluation with user involvement may occur more than once, both during the creation stage as the design is refined, as well as the testing of the final product. In practice, it will therefore be necessary to use evaluation techniques – quantitative and/or qualitative - appropriate to the product. Signposts to guidance on this will be given in Section 4.

How you are already teaching UCD

So far we have concentrated mainly on the technical aspects of the philosophy and process of UCD, but you may well be thinking "How on earth am I going to fit all this in without compromising on something else?" D&T teaching aims to provide students with a broad set of skills: to design and make for themselves, to equip them for the world of work or further studies in the creative industries, craft including fashion and textiles, and the various disciplines of engineering. Given this remit, it is not surprising that the emphasis in the syllabus has generally been towards the understanding of **technology** and how it can be used to realise a **novel design**, and it is important that these aspects are sustained.

Actually, the D&T syllabus has for some time included topics that are very much 'UCD' – for example ergonomics as a consideration in design (particularly *anthropometry*), and the use of *focus groups* in understanding user needs. But these topics have not been seen as part of a bigger picture of explicitly researching users, clearly identifying user needs in the design brief, explicitly designing with user constraints and limitations in mind and then systematically evaluating how well the design (or prototype) has met the originally stated needs. It is this involvement of the user throughout the design process that is new.

Anthropometry is concerned with the measurement of the dimensions of the body and is particularly relevant to the physical design of products.

Focus groups offer insights into user thinking and behaviour by interviewing a small number of users as a group, offering an opportunity for them to discuss aspects of the product and revealing problems and opportunities for redesign.

UCD and iterative design

Iterative design is based upon sequential cycles of design, testing and refinement, but not necessarily user involvement. However, both iterative design and UCD gain power in combination. Iterative design recognises that, particularly when a complex product is being developed, it can be difficult to foresee all of the implications of early design decisions at the outset. Accommodating multiple cycles of design and evaluation can ultimately prove to be a more efficient and effective strategy. Given that users are complex entities and that their behaviour in relation to a design can be difficult to predict, an iterative approach can be particularly fruitful - as was reflected in the iterative model of UCD in Figure 2 and the discussion in Section 2.

The idea of prototyping, where aspects of the function and behaviour of the final product may be simulated following the initial design stage, has long been a key strategy in ergonomics and is now central to the new D&T syllabus. Given the pressure on time and resources faced by D&T students in their project work, the idea of several iterative design cycles may seem ambitious.

Prototyping enables the simulation of the way that a product will ultimately appear and be used before the designer is forced to commit to the design. The fidelity of a simulation relates to the number of features of the final product that are reproduced in the prototype. Very useful insights into the use of the product can be gained with basic models that just include some key features (i.e. ***low fidelity*** simulations).

However, ergonomics has demonstrated that even crude cardboard or foam mock-ups – effectively *low fidelity* simulations – can be very effective at the early stages of design, enabling the dimensions and layout of the features of a product to be tested with users. Such mock-ups can be produced quickly with simple hand tools, and so enable an iterative approach even within the tight schedule of a class design and make project.

Section 3
Teaching UCD
continued

UCD and the systems approach

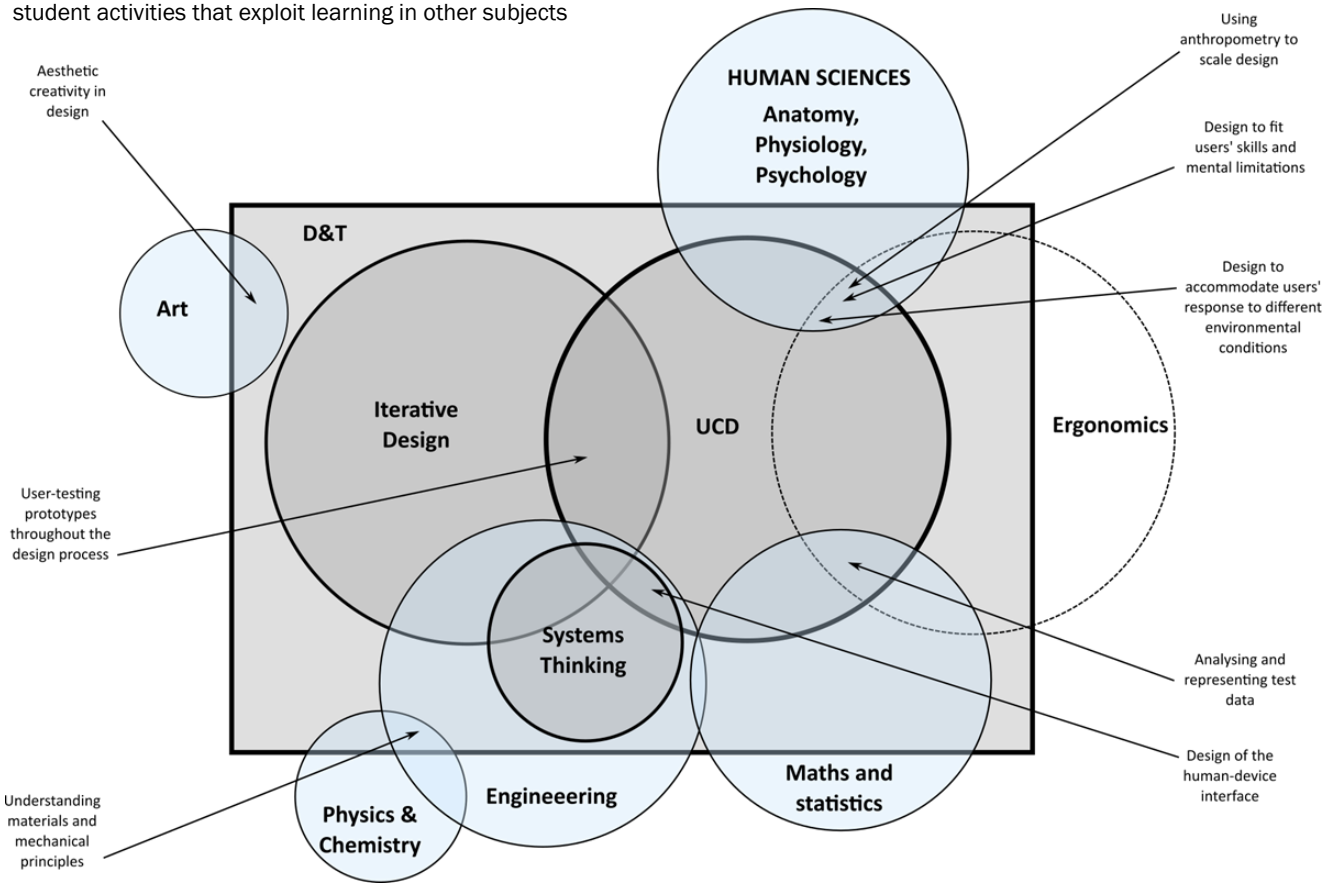
The examination boards are now introducing the topic of systems thinking across the D&T syllabus from GCSE level onwards, but it is of particular relevance to those pursuing the Design Engineering pathway at A-level. Thinking of products in terms of interacting systems has been an established strategy for a long time in engineering, and is now widely used across the sciences. Breaking down a design into a set of functional elements, each defined in terms of a process that has inputs to deliver specific outputs, offers a powerful way of thinking about design. For designing complex products, it is indispensable.

Figure 1 represented the user's relationship to the product and their task in terms of two interacting sub-systems - the user and the device - which together make up a human-device system. As students progress towards KS5, they will find this analysis of design increasingly powerful, for example, it highlights the concept of the user interface which is recognised as a critical aspect of the design of computer-based systems.

The exam boards also emphasise the value of UCD as a means of linking STEM topics and showing their practical application and importance. Figure 3 shows how UCD relates to other new topics in the D&T syllabus and to other subject areas with potential for cross-curricular links. It also suggests the students' design activities that arise in the overlaps between the various domains.

Figure 3: Inter-relationships between new curriculum topics

D&T topics are shown in grey shaded boxes; cross-curriculum topics are shaded light blue. Arrowed points indicate examples of student activities that exploit learning in other subjects



Planning your Teaching

Teaching strategy

We suggest three principles for integrating UCD into your teaching as painlessly as possible:

1. Building students' knowledge of UCD progressively over time:
    - Starting with the student's own experience as a 'user', but broadening it out firstly to others they know and ultimately to unfamiliar user populations.
    - Progressing from students' informal and implicit understanding of 'ease of use' to the objective methods of analysis and evaluation offered by ergonomics.
2. Identifying opportunities for students' self-directed learning and user research.
3. Where possible, tweaking existing lesson plans to cover user aspects as well.

Building technical knowledge over time

We suggest that the general principles of UCD should be introduced to students at KS3 where the initial emphasis will be on understanding how other people's characteristics and needs might be different from their own, and what it might mean to accommodate other people when they design something. When students get to GCSE level, they will already have grasped the concepts of tasks and task performance (including usability, comfort, safety, time and errors) and simple human-device systems. They will then learn basic techniques for finding out user needs, making mock-ups, and assessing how well their design will meet these needs. They will be moving away from an egocentric approach to design, and will be able to describe how their work might subsequently be developed for users with different characteristics.

Finally, at AS/A-level, students will be developing a more sophisticated understanding of tasks, users' physical and mental limitations and safety risk, and will be focusing on a specific pathway: *Product Design*, *Fashion and Textiles* or *Engineering Design*. Although the emphasis may differ in small respects between pathways, the general principles will remain the same. Students will be encouraged to bring to bear knowledge they might have acquired in other relevant subjects – for example, human anatomy and physiology for those studying biology, and experimental design and statistics for those studying psychology - and they will be comfortable with more abstract concepts. The systems approach might therefore receive more emphasis, for example showing how a human-device system might relate to other systems in the context of use, and how design of a machine will determine the nature of human interaction. We expect this focus to be particularly valuable for students pursuing Design Engineering. All A-level students will learn more sophisticated prototyping methods and techniques for analysing tasks and evaluating their work from a user perspective, both qualitatively and quantitatively.

Section 4

Planning your Teaching

continued

Opportunities for self-directed learning

Many students enjoy researching things themselves and following a learning trail. We think that the UCD aspect of the D&T syllabus offers students opportunities for this, building on their own experience to develop an awareness of the user needs around them that are not being adequately addressed by current designs. They can then move from an intuitive approach to designing for a loosely defined target group to designing for a specific target group based upon user research. We recognise that this will only work if they are provided with resources appropriate to their own stage of development, so we are working towards creating materials with the needs of students at KS3, KS4 and KS5 in mind and these are discussed in more detail in Section 5. Currently in development, it is our intention that the resources will ultimately include:

- Introductory articles on the key topics forming the basis of the UCD philosophy and process that can form the basis of subsequent group or class discussions
- Examples and real-world case studies illustrating topics and showing how UCD techniques are applied
- Tools to support students in applying methods and techniques
- Hints and tips for teachers and students

Supplementing existing lesson plans

A UCD angle can probably be slipped into some of your existing lesson plans pretty easily. For example a lesson on mechanics might introduce the idea of the human body as a machine and its own effective application of forces to objects. In lessons on materials, it would be possible to introduce additional properties such as the feel of a material, grip enhancement or even what it smells like.

While the UCD philosophy could be considered a set of core topics, the approach is best understood as a practical design strategy. We therefore expect most students to find it easier to develop their understanding through their own design and make projects, and recommend that teaching is organised around the stages of the design process.

Table 1: How to introduce a UCD element to existing teaching plans and resources

Existing core topic	UCD extension	Examples
Iconic designs / designers	Include design classics renowned for their usability	Windows user interface; Apple IPhone; Anglepoise light; Barbour jacket; OXO kitchen utensils
Materials selection	Include criteria relevant to user experience	Tactile experience, grip, smell, toxicity
Component selection	Include display and control behaviour as part of user interface	Display output brightness, clarity, colour; Sound output characteristics for different functions; input control suitability for different tasks/contexts
Surface treatment selection	Include criteria relevant to user experience	Ease of cleaning/maintaining; smell; toxicity; speed of drying
Workshop/kitchen health and safety	Include risk assessment of the use of the students' designed product	Identifying risks faced by end users and how they will be addressed in the design
Evaluation of the student's designed product	Include user task performance criteria in the brief and evaluation	Compare usability of the existing design offering with that achieved by the student's product.

Planning your teaching activities & course content

Figure 2 has shown, in general terms, the kind of UCD input that can occur at each stage of the iterative design cycle. In this section we suggest what these inputs might look like at KS3, KS4 and KS5 respectively, and point you and your students towards materials that will help them to understand and use UCD in their own projects.

Again, currently in development, it is our intention to provide materials addressing four areas:

- **UCD general principles.** These are the basic ideas underlying UCD. We suggest that these might be introduced to students in teacher-led class discussions.
- **UCD methods and techniques**, which are processes to carry out to ensure a user focus (e.g. interview and evaluation techniques). We aim to provide student-accessible online guidance on these.
- **UCD technical knowledge**, information that students can use to improve their designs from the user's point of view. This could include topics like ways of measuring performance or on-line resources like anthropometric data or checklists. This can be introduced through directed reading and web-based research. Again we aim to provide online guidance.
- **Cross-curricular links,** which suggest ways in which students might use aspects of their knowledge of other subjects taught at school to improve their design work (especially in the A-level curriculum).

In this section, you will find an overview of the learning activities for the year groups that you will be teaching, alongside which we hope to provide materials to support you and the students. This information is summarised with more detail in tables included in the Appendix, which will also provide pointers towards the available resources as they are developed.

We have chosen not to attempt to prescribe what should be taught at each Key Stage, as the exam boards show some variation in the scope of what should be included and in their assessment criteria. Furthermore, you may (at least initially) be working with existing materials, and may prefer to adjust the ordering and emphasis of topics in your lesson plans to suit the needs of your particular students. We have therefore decided to indicate learning objectives in terms of levels: as 'Basic' (which might approximate to KS3); 'Intermediate' (roughly GCSE level); and 'Advanced' (roughly A/AS-level).

There is a separate section for each of these levels, and we have tried to make each of these sections stand alone - at least to a degree - so that you can avoid wading through information that isn't directly relevant to you. As a result there is some repetition between them. In spite of this, teachers of intermediate and advanced students might find it useful to look at the preceding sections to get a feel for how student knowledge builds over the years.

Exam boards do vary in their emphasis on UCD topics. We STRONGLY recommend that you study the detailed specifications of the exam board you use before planning the details of your programme.

Section 4

Planning your Teaching

Basic level

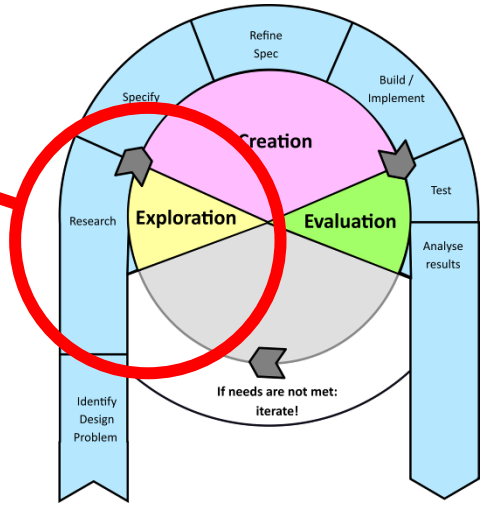
What to teach at the Basic level

The Basic level can be introduced as early as KS3 and provides a foundation in UCD that students can build on if they decide to take D&T further. We recommend teaching it with a hands-on, common-sense approach to avoid overloading students too many abstract concepts.

What to teach in the Exploration phase

Teach students how to:

- Identify users' problems (normally only at beginning of project)
- Critique relevant products
- Understand users' tasks, characteristics and needs
- Research ergonomic implications



UCD general principles

The main objective at this stage is to introduce the philosophy of UCD and how it relates to other approaches to design. The key concepts discussed in Section 2 are introduced to students, but in a way appropriate for their age and experience.

At KS3, students are at an age where they tend to be focused on themselves and their own experience, so the main message to get over is that people actually differ from one another, and a product designed for one person may not be suitable for others. Students also need to grasp the idea of a task and how different products can make performing it easier — or can actually make it more difficult. Here it is best to provide students with direct experience of the concepts, and having a *Handling Collection* of products for students to try and evaluate informally can be particularly engaging. See Appendix: Table A1.1.

Handling collection: A box of products purchased or collected for students to pick up, handle and try using to illustrate how some are easier to use or more attractive than others. It might include for example, old mobile phones or kitchen utensils.

UCD methods and techniques

At Basic level, the techniques students will learn are about observation, measurement and basic analysis of users doing simple tasks, and they will need encouragement to begin looking at familiar products from a user perspective. Items in a handling collection are a good place to start. They will also need encouragement to communicate with users about the problems they face using a product and apply this information to their own design activities. At this point it is assumed that students will be able to use simple statistical techniques (e.g. averages, graphs and bar charts) for representing their data, and so have an opportunity for using maths to solve their own practical problems. They should be introduced to the on-line resources available to them and shown how to use them. See Appendix: Table A1.1.

UCD technical knowledge

At Basic level, students will primarily be concentrating on developing an understanding of the UCD philosophy and techniques that they can apply during the later phase of their project. However there are two specific areas of knowledge that they will need if they carry on to GCSE and which should

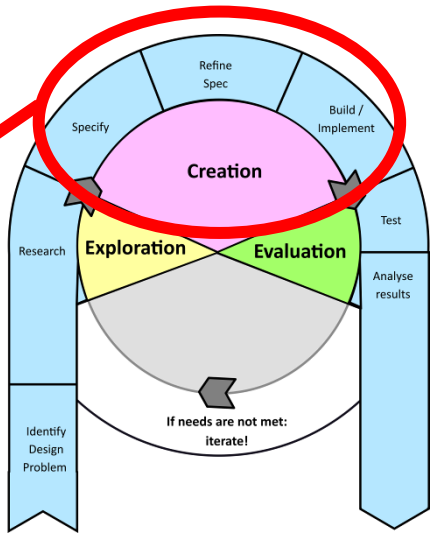
be introduced initially at KS3: the principles of Health and Safety (H&S) in design, and the topic of anthropometry. Students should already know the need to be aware of their *own* safety in the workshop or food preparation area, so most will be to see how they can use the same principles to avoid hazards created by products they are designing and the risks of harm to *users*. This awareness can be developed by looking at and discussing existing products and, later, talking to users of products that they design. Students can use simple checklists to help them carry out basic assessments on familiar products and later on their own designs.

Anthropometry and postural and strength issues are already included to some extent in the D&T syllabus. The concept and its relevance is easy to grasp, and is an excellent introduction to the general idea of individual differences between people, e.g. by looking at different heights of students in the class . The concepts will be picked up and applied when students get to the design stage of their projects. See Appendix: Table 1.1.

What to teach at the Basic level in the Creation phase

Teach students how to:

- Use ergonomic guidelines and standards that are relevant to the project
- Design with user needs at the forefront of the student's mind
- Monitor the H&S implications of design decisions
- Maintain dialogue with users during the design process
- Use feedback to refine the design
- Ensure any construction decisions maintain a user focus.



The *Creation* phase of a project is the point at which a student's personal creativity can be developed and demonstrated, and the objective must be to nurture this while continuing to support a user-centred approach. In this phase there are three primary activities: (1) developing a design specification; (2) refining that specification; and (3) building. In early iteration(s), students will be building a prototype, and later on either a final product or (more likely) a refined prototype that can clearly demonstrate the viability of the student's concept.

UCD general principles

At the Basic level the overarching objective will be to encourage creativity, and we recommend that the UCD message should be simple: the student should recognise **"designing for ME is not the same as designing for THEM"**; they need to design with an inclusive rather than egocentric focus. With this principle in mind, it becomes common sense to involve other people in the design process, and this orientation will follow through to the *Evaluation* phase of the project. See Appendix: Table A1.2

UCD methods and techniques

At KS3 we recommend encouraging a *user-centred orientation* rather than getting students to assimilate new methods. They can use these in developing simple (e.g. cardboard) mock-ups to try out the dimensions of

Section 4

Planning your Teaching

Basic level continued

their designs on other people. This will help establish in their mind that designing for others is challenging, but that they can use on-line resources to help them solve problems. It will also help establish a sense of the value of iterative design involving prototypes for communicating with, and testing by, users.

UCD technical knowledge

Some exam boards issue their own sets of anthropometric tables for use in student projects. Tables will also be available at www.designingforpeople.com/

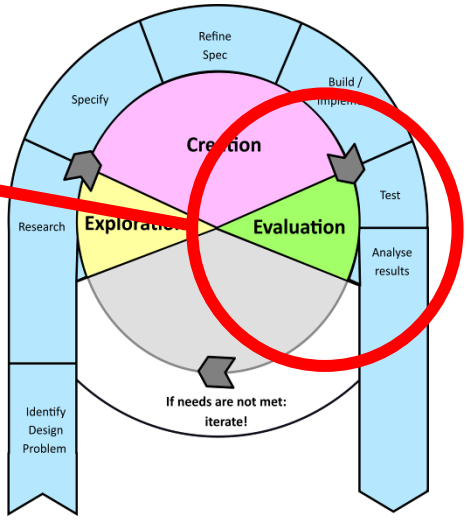
What to teach at Basic level in the Evaluation phase

The *Evaluation* phase in the UCD design cycle is where the realised product created by the student is tested against the user needs identified in the Design Brief. Clearly there will be other aspects of the student's work that will be assessed at this point, including the novelty of the design, the suitability of materials, quality of construction and achievement of functional requirements set out in the Design Brief, but here we will focus on the user aspect.

During early iteration(s) of the project, students will incorporate the necessary design improvements as part of a new cycle of exploration, creation and evaluation. For GCSE and A/AS students the final iteration will culminate in the documentation of the project for their portfolio. The number of iterations is likely to be limited by the time and resources available to the student, but a minimum of **two iterations** (model & working prototype) in the cyclical model below will show KS3 students the value of prototyping.

Teach students how to:

- Simulate the task / conditions of product use
- Test with representative users using subjective and/ or objective methods
- Organise and analyse data
- Interpret results against user needs
- Identify potential design improvements



UCD general principles

For Basic level students, the overarching objective is to understand the importance of systematic testing of their product or prototype against their design brief, doing this with real users, and being able to document the results in a report of their project. Again this will reinforce the idea of inclusive design that has been the objective up to now, and which will place students in a good position to apply more demanding evaluation techniques if they pursue D&T at GCSE level. See Appendix: Table A1.3

UCD methods and techniques

Actually running user trials demands a set of skills that students will need to build. They need to communicate with their user sample, undertake the tests in a controlled and consistent way and measure and record results systematically. At KS3 the emphasis will be on the collection of quantitative data based on simple user tasks observed at the *Explore* phase. This is an

opportunity to use data collection skills - perhaps acquired in STEM subjects - in a creative project of their own. *Objective* measures such as time to complete a task, numbers and types of errors made, and *subjective* comments from users might be used, but the primary aim should be for students to learn to use and work with the evidence-based techniques, rather than striving to beat the performance of their friends' creations. We would therefore recommend placing more emphasis on the process of carrying out the tests than on judging how well students' products have performed in the tests!

Students should use the subjective comments of users to form the basis for specifying improvements to the design, either to be implemented in a further iteration of the design cycle or explained in their report of their project. See Appendix: Table A1.3

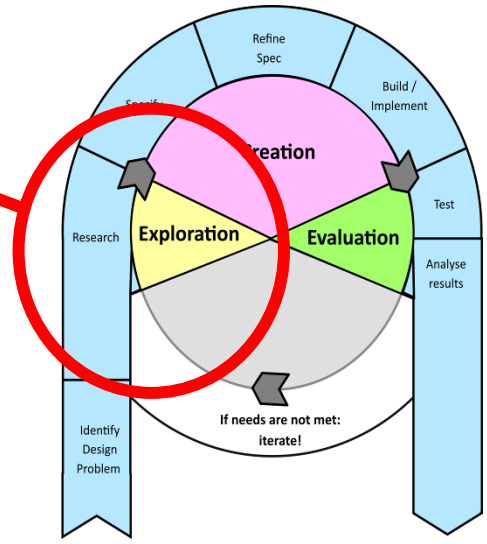
What to teach at Intermediate level

The Intermediate level roughly corresponds to that required for GCSE. Teaching needs to build on the basic material that students will have picked up in KS3, bringing in more quantitative methods and techniques and a wider range of UCD technical knowledge to meet the needs of the exam specifications from 2017 onwards.

What to teach at Intermediate level in the Exploration phase

Teach students how to:

- Identify users' problems (normally only at beginning of project)
- Critique relevant products
- Understand users' tasks, characteristics and needs
- Research ergonomic implications



The main objective at this stage is to introduce the philosophy of UCD and how it relates to other approaches to design. The key concepts discussed in Section 2 are introduced to students, but in a way appropriate for their age and experience.

UCD general principles

Students at GCSE/Intermediate level need a structured view of the UCD concepts (users, tasks, contexts etc) that will form the basis for learning some basic UCD techniques for identifying user needs. They will also need to understand how UCD relates to other approaches, such as iterative design and systems thinking , and the advantages of a user-centred approach in specifying user needs in their design brief. See Appendix: Table A2.1

Section 4

Planning your Teaching

Intermediate level continued

UCD methods and techniques

Intermediate level students need to understand and apply some UCD techniques to help them characterise users and collect information about their needs. The idea of *personas* can be very helpful to students at this stage, giving them an engaging framework to classify different types of users, and *scenarios* are a means to capture characteristic tasks and contexts for product use. Students will learn how to conduct interviews and focus groups, as well as use observational methods, surveys and questionnaires to collect information about how real users interact with products to perform tasks.

Personas are imaginary (and usually named) individual characters invented to represent classes of user that are assumed to use the designed product in the same way. They can be incorporated into 'stories' about the way the product fits into users' activities.

GCSE requires students to demonstrate the gathering of quantitative data when specifying user needs in their design briefs. The techniques of both objective (e.g. time to perform a task) and subjective measurement (e.g. ratings of how easy or comfortable a product is to use) can enable them to do this. They should learn to use standard statistical concepts such as means, medians, frequency distributions and graphing techniques, and tools such as spreadsheets to present their data. Again the UCD project is a great opportunity for cross-curricular links. See Appendix: Table A2.1

A ***user scenario*** is a story of an action or goal that a user wants to accomplish, and hence a task and context for the use of a product. This can form the basis for simulating a task at the evaluation stage of a project (see, for example, Interactive Design Foundation website).

UCD technical knowledge

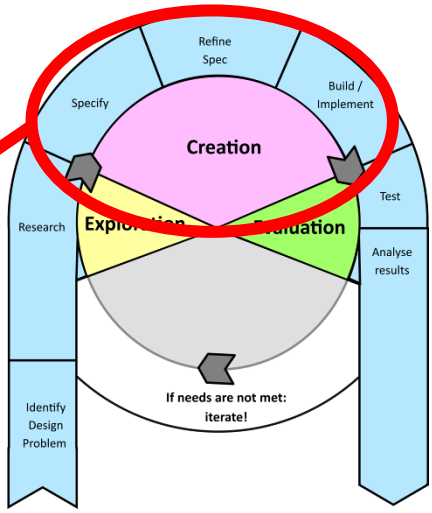
Intermediate students must understand the importance of accommodating diversity in the user population. This can start with individual differences over an age or ability range and be extended to cultural preferences and the particular requirements of people with disabilities or other special needs (including those of very young and older people). The different ways of thinking about performance will also need to be developed, including concepts like functionality, usability and comfort.

To complete their Design Brief, GCSE students will need to develop a more complete understanding of anthropometry, posture and strength. Anthropometric tables are based upon the ideas of a normal frequency distribution and the use of percentiles, so that students can use tables to determine what proportion of a user population their design will accommodate. They also need to include ergonomic design guidelines and standards that are relevant to their design. See Appendix: Table A2.1

What to teach at Intermediate level in the Creation phase

Teach students how to:

- Use ergonomic guidelines and standards that are relevant to the project
- Design with user needs at the forefront of the student's mind
- Monitor the H&S implications of design decisions
- Maintain dialogue with users during the design process
- Use feedback to refine the design
- Ensure any construction decisions maintain a user focus.



The *Creation* phase of a project is the point at which a student's personal creativity can be developed and demonstrated, and the objective must be to nurture this while continuing to support a user-centred approach. In this phase there are three primary activities: (1) developing a design

specification; (2) refining that specification; and (3) building. In early iteration(s), students will be building a prototype, and later on either a final product or (more likely) a refined prototype that can clearly demonstrate the viability of the student's concept.

UCD general principles

Intermediate students need to show an understanding of the value, principles and process of UCD in their project, and to integrate this with other perspectives (e.g. iteration, biomimicry, prototyping) as they design. A recognition of the need to accommodate diversity must also be evident. Furthermore, they need to show that they understand their obligation to the health and safety of users and are able to undertake a basic risk assessment at the design stage. A sensitivity to H&S should already be established at KS4 through the rules that students will have been following to ensure their own safety in the workshop. See Appendix: Table A2.2

UCD methods and techniques

Intermediate students will design progressively more complex products over time and will therefore be needing to exploit more resources to help them. If they have already started to use personas during the Explore phase, they will find them useful as they think about design. We are developing web-based resources to provide students with anthropometric and design information about strength, posture and other physical aspects of users, as well as guidelines and standards taking account of mental abilities and social and affective behaviour. They will need to understand how to carry out a risk assessment, taking into account of the hazards that users may encounter, the likelihood of user injury and the severity of injury to which they might be at risk.

Affective aspects of behaviour relate to feelings and emotion

It is important for you to stress to students the value of continuing the dialogue with users started during the *Exploration* phase. Being able to communicate through a range of different media – talking, sketching and through modelling with mock-ups – are invaluable skills for designers. Students can start to develop these at KS3, but they must now be encouraged to create a record of their interactions with users to include in their project portfolio. Learning to evaluate the feedback that users provide is another skill that can be established at this stage. For example, students must learn to decide whether a comment is likely to be relevant to a small or large proportion of users, and hence whether a change in the design is important and necessary. See Appendix: Table A2.2

UCD technical knowledge

At Intermediate level students will be exposed to a fuller set of anthropometric tables, and more general design guidelines to help them in the layout and design of handles, controls and displays to which users of their product will be exposed. These could range from simple buttons or switches and LED indicators to keypads and numeric or simple text displays. The information may also include design standards, particularly where user health and safety is a consideration. See Appendix: Table A2.2.

What to teach at Intermediate level in the Evaluation phase

The *Evaluation* phase in the UCD design cycle is where the realised product created by the student is tested against the user needs identified in the Design Brief. Clearly there will be other aspects of the student's work that will be assessed at this point, including the novelty of the design, the suitability of materials, quality of construction and achievement of functional requirements set out in the Design Brief, but here we will focus on the user aspect.

During early iteration(s) of the project, the identified design improvements will be implemented in a new cycle of exploration, creation and evaluation,

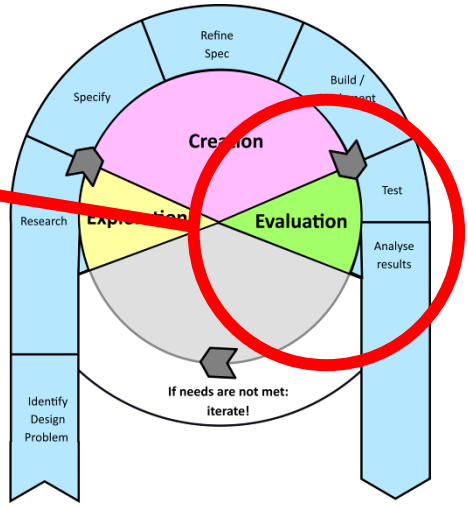
Section 4

Planning your Teaching

Intermediate level continued

Teach students how to:

- Simulate the task / conditions of product use
- Test with representative users using subjective and/ or objective methods
- Organise and analyse data
- Interpret results against user needs
- Identify potential design improvements



but the final iteration will culminate in the full documentation of the project for the student's portfolio. The number of iterations is likely to be limited by the time and resources available to the student, but ideally **at least two iterations** (model & working prototype) should be achieved (see the figure above).

UCD general principles

At Intermediate level the message of the importance of testing against the design brief is the same as at Basic level, but for the GCSE assessment, they will need to demonstrate that they can run user trials appropriate to (a) the kind of product they have produced; (b) the stage that they are in the iterative design process; and (c) the way that user needs were expressed in the Design Brief. This will pick up on the objective and subjective measures introduced at the *Exploration* phase, and also introduce the idea of *simulating* tasks and, where necessary, users for the purpose of evaluation of the performance of their product. See Appendix: Table A2.3.

UCD methods and techniques

Actually running user trials demands a new set of skills that students will need to learn. They will have to communicate with their user sample, undertake the tests in a controlled and consistent way, and measure and record their results systematically.

Intermediate students will need to show that they have a coherent *plan* for their evaluation, taking account of its *purpose* within the project as a whole. So a cardboard mock-up to determine whether the designed dimensions will suit the intended range of target users will need a much simpler task simulation and evaluation than a fully functioning prototype or finished product later in the project. Similarly, students will need to have a plan for selecting a suitable *sample* of representative users that will behave in a consistent way. In practice, most students are likely to have to compromise and use anyone they can find who would be willing to be involved! They shouldn't be penalised for this as long as they flag up that they recognise there is an issue with their sampling and try to explain the possible impact on their results.

An important step prior to running the trials will be a brief health and safety review of their product, maybe checking it against relevant design standards, and accordingly modifying the design or the way it is used. Compliance with many basic health and safety standards can be picked up from 'DIY' tests for school students offered by the British Standards Institute (see *Section 5, Resource Data Cards* for current status and location of the BSI Education web site. At the time of writing it appears to be under development.).

Planning your Teaching
Intermediate level

Again students will be able to use, and develop further, data collection skills and data analysis and presentation techniques acquired in the study of other school subjects, including both objective and subjective aspects. It is particularly important that they learn the strengths and limitations of their evaluation in drawing conclusions about their design. Deciding whether and how to use feedback from users is a skill in itself: user comments need to be assessed as to whether they are (a) likely to be representative of users more generally, or specific to an individual person; and (b) whether the changes are feasible to make within the constraints of the project. These practicalities will help students to recognise issues of variability in data that is common to the testing of people performing 'real world' tasks, and it will help them to understand the importance of simplifying and standardising tasks for testing and selecting a representative sample of users.

The time and resource pressures of a school project will mean that many students will not be able to achieve the user task performance improvements that they might have hoped for. Therefore, at Intermediate level we recommend that undertaking and reporting the evaluation process should be considered more important than the success of the project in meeting all the user needs. Students should be given credit for understanding realistically the improvements they might have achieved given more time. Students should nevertheless show that they have evaluated subjective comments from users and responded appropriately in recommendations for redesign. See Appendix: Table A2.3

UCD technical knowledge

In general, most of the UCD concepts relevant to evaluation will have been acquired by students during the *Exploration* and *Creation* phases of the project. This will particularly include the concepts of task performance, such as usability, comfort, speed and errors, and the principles of health and safety risk assessment.

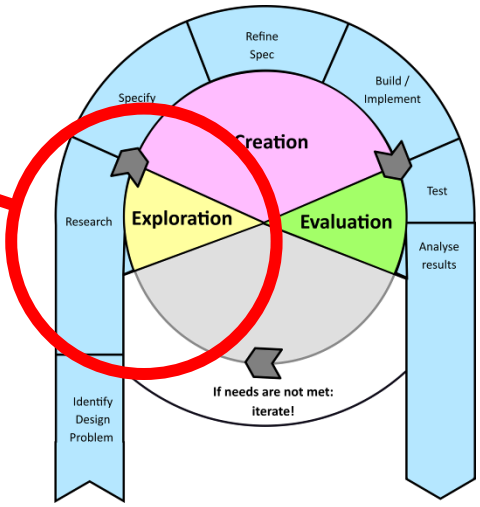
What to teach at Advanced

In terms of examination specifications, Advanced students roughly corresponds to A/AS level. The UCD principles remain the same, but students are provided with a deeper understanding of the concepts and more rigorous techniques to help them with more sophisticated design projects.

What to teach at Advanced level in the Exploration

Teach students how to:

- Identify users' problems (normally only at beginning of project)
- Critique relevant products
- Understand users' tasks, characteristics and needs
- Research ergonomic implications



The main objective at this stage is to introduce the philosophy of UCD and how it relates to other approaches to design. The key concepts discussed in Section 2 are introduced to students, but in a way appropriate for their broader knowledge and experience.

Section 4
Planning your Teaching
Advanced level continued

UCD general principles

As more sophisticated consumers themselves, and with increasing knowledge of human behaviour acquired through their own experience, Advanced students will be able to appreciate more aspects of product design quality. Critiques of existing products will recognise tensions that can exist between different design criteria, e.g. between aesthetics and usability. Students will acquire a deeper theoretical understanding of UCD concepts and processes and will recognise the value of thinking about products and users in terms of interactive sub-systems of a human-device system. They will have developed an understanding of the desirability of *universal design* and the implications of diversity in the population for achieving it. See Appendix: Table A3.1

Universal design describes the concept of designing products and the built environment to be aesthetic and usable to the greatest extent possible by everyone, regardless of their age, ability, or status in life. The concept is related to inclusive design.

UCD methods and techniques

At Advanced level, the techniques for user data collection learned at the Intermediate stage will be applicable, but implemented to a more rigorous standard. The relevance of design to other stakeholders, including maintainers and installers, will be introduced, and *task analysis* techniques made available, as more exacting means of understanding the effects of changed technology on the way a task is performed.

Task analysis is the process of learning about users by observing them in action to understand in detail how they perform their tasks and achieve their intended goals. Task analysis helps identify the tasks that a product must support and how user behaviour might be changed through the introduction of the product (e.g. see Usability.gov website).

Particularly for students following the Design Engineering pathway, the use of a *systems approach* should be encouraged where appropriate, to consider the options for allocating functions between users and devices, and interactions with other systems within the context of use. Advanced students will be able to use specialist websites for ergonomic design information and guidance, and develop skills in evaluating the quality and fitness for purpose of information gathered on-line. See Appendix: Table A3.1.

UCD technical knowledge

Advanced students should be building a practical understanding of the way that science and engineering concepts can inform the assessment of user needs, and the potential value of this deeper insight is reflected in the new introduction of the three alternatives subject pathways. For example, students pursuing the *Fashion and Textiles* pathway would benefit from knowing the way that the human body responds to changes in its environment – for example temperature and humidity - as this will influence the choice of textiles for different clothing applications. Those studying *Design Engineering* and *Product Design* will encounter the issue of allocation of function between human and device elements of a system when making decisions about the task performance benefits (or otherwise) of automating activities currently undertaken by people. See Appendix: Table A3.1.

Students across all pathways will need to understand the concepts of performance introduced at the Intermediate level, but at Advanced level they will be developing a sensitivity to the balance that they may need to make between the desire to achieve optimal usability but also to respond to aesthetic values that may be very important in the marketplace. The requirements for the design brief will also be more demanding, and the use of both *objective* (e.g. observational data) and *subjective measures* (e.g. based upon user ratings of comfort) will have a place in the setting of performance targets for their designs. Students should also be capable of consulting a broader range of ergonomics information sources that will guide their design brief and help during the design specification process. See Appendix: Table A3.1

Planning your Teaching

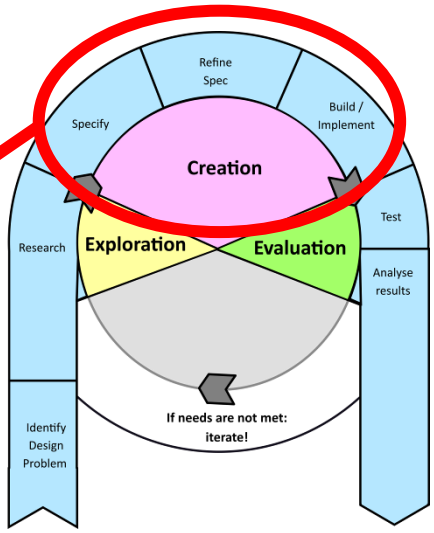
Advanced level continued

What to teach at Advanced level in the Creation phase

The *Creation* phase of a project is the point at which a student's personal creativity can be developed and demonstrated, and the objective must be to nurture this while continuing to support a user-centred approach. In this phase there are three primary activities: (1) developing a design specification; (2) refining that specification; and (3) building. In early iterations, students will be building a prototype, and later on either a final product or (more likely) a refined prototype that can clearly demonstrate the viability of the student's concept.

Teach students how to:

- Use ergonomic guidelines and standards that are relevant to the project
- Design with user needs at the forefront of the student's mind
- Monitor the H&S implications of design decisions
- Maintain dialogue with users during the design process
- Use feedback to refine the design
- Ensure any construction decisions maintain a user



UCD general principles

For Advanced students, the essential background will be as for Intermediate level, but at this stage they will need to understand that design will need to focus, not only on the final product of their work, but also on where they are in the iterative process. This is a subtle but important point. A prototype will serve a number of purposes, but among these will be to communicate to, and to undergo tests with, end users. The power of prototyping lies in not putting a lot of effort into implementation that might be wasted if it turns out that there is a flaw in the design. So the designer might to start with relatively crude mock-ups to test out the broad parameters of the design with users, and then build more detail into prototypes on subsequent design iterations. Judging what 'how good' the prototype needs to be to answer questions about the design as it progresses is a powerful skill for a student to learn. See Appendix: Table A3.2.

UCD methods and techniques

Advanced students will be familiar with designing for usability through critiques of products during the *Exploration* phase. When approaching the design of their own products, using principles for the user interface seen in related products may not only save them effort, but also exploit the knowledge that users bring from their experience with those products. Being able to do this while applying their own originality to improve what has been done before is extremely valuable and should be cultivated. Again, advanced students will need the techniques introduced at Intermediate level for bringing ergonomics knowledge to their work through on-line resources.

The needs of the alternative A-level pathways means that students may diverge in the approaches required to meet user needs in their designs. For example those studying *Design Engineering* and *Product Design* will find it valuable to take a systems approach and may find techniques developed for the design of the human-computer interface useful; these might not be so relevant to most on the *Fashion and Textiles* route. See Appendix: Table A3.2

Section 4

Planning your Teaching

Advanced level continued

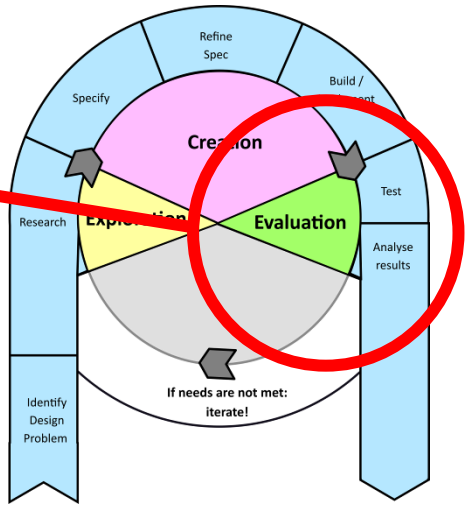
UCD technical knowledge

Advanced students will use the same set of basic tables, guidelines and standards described at the Basic and Intermediate levels, but also human-computer interaction (HCI) design guidelines, accommodating a wider variety of information input and output devices. A more detailed understanding of Health and Safety Regulations relevant to the context of their design will also be required, and there will be opportunities for those studying biological sciences (especially topics such as anatomy and physiology) to bring their cross disciplinary knowledge to bear on their design solutions. See Appendix: Table A3.2.

What to teach at Advanced level in the Evaluation phase

Teach students how to:

- Simulate the task / conditions of product use
- Test with representative users using subjective and/ or objective methods
- Organise and analyse data
- Interpret results against user needs
- Identify potential design improvements



The *Evaluation* phase in the UCD design cycle is the point at which the realised product created by the student is tested against the user needs identified in the Design Brief. Clearly there will be other aspects of the student's work that will be assessed at this point, including the novelty of the design, the suitability of choice of materials, quality of construction and achievement of functional requirements set out in the Design Brief, but here we will focus on the user aspect.

During early iteration(s) of the project, the identified design improvements will be implemented in a new cycle of exploration, creation and evaluation, but the final iteration will culminate in the full documentation of the project for the student's portfolio. The number of iterations is likely to be limited by the time and resources available to the student, but ideally **at least two iterations** (to fully access the mark scheme, one would anticipate one low - fidelity model, one high-fidelity model and one working prototype) should be achieved (see the figure above).

UCD general principles

Advanced level evaluation recalls the performance concepts introduced at the start of the project, and explores the issue of simulation in greater depth, reflecting the greater rigour in evaluation required at A-level. See Appendix: Table A3.3

UCD methods and techniques

Actually running user trials demands a set of skills that students will need to acquire. They will need to communicate with their user sample, undertake the tests in a controlled and consistent way and measure and record their results systematically.

At Advanced level the principles of evaluation will be the same as at

Intermediate level, but the expectation is for greater rigour in their application. Although there is no prior assumption of statistical knowledge beyond that at GCSE level, some students studying A-level maths, statistics or human sciences (such as psychology) may be able to apply their knowledge in the use of inferential statistical tests to determine whether observed performance differences are due to the design of their product or could be explained by chance variability in the user sample. Advanced students who have developed more complex products might also consider the way that users may require training or other support in the way they use them. See Appendix: Table A3.3.

UCD technical knowledge

In general, most of the UCD concepts relevant to evaluation will have been acquired by students during the *Exploration* and *Creation* phases of the project. This will particularly include the concepts of task performance, such as usability, comfort, speed and errors, and the principles of health and safety risk assessment. Advanced students will additionally need to develop an understanding of the costs and benefits of different types of evaluation and performance measurement technique, and their suitability for their project. See Appendix: Table A3.3.

Section 5

Further Resources

Overview

The development of resources to support teaching is currently being undertaken by the *Design for Real People Action Group.* At this point we have produced a set of Resource Data Cards that can be used by you or your students to guide self-directed learning (see overleaf). The central resource is the online knowledge base hosted by the Chartered Institute of Ergonomics & Human Factors(CIEHF) - the UK membership body that sets professional standards for the discipline. We hope that in its final form the site will provide a first point of contact for both teachers and their students at all levels in the educational process, which will either present material directly or provide pointers to other sources. We expect it to go live in September 2017, but in practice it is unlikely be fully-formed at the outset, and we expect that we will have to prioritise some topics over others while it develops over subsequent months. We would welcome comments on the material at all times, and particularly during this development phase, to ensure we are meeting teachers' and students' needs.

Specialist support

CIEHF endeavours to provide a specialist online answering service for students and teachers who need additional help that isn't already available on the website. This is accessible through a form at: http://www.designingforpeople.org.uk/

Website

We intend that the website to support your teaching http://www.designingforpeople.org.uk/ will include in due course:

- Introductory articles on the key topics forming the basis of the UCD philosophy and process, which can form the basis of subsequent group or class discussions
- Examples and (where possible) real-world case studies illustrating topics and showing how techniques are applied
- Tools to support students in applying methods and techniques
- Hints and tips for teachers and student

Assessment matters

It is evident that there are differences between the Boards in the depth of coverage expected and in the form of assessment for different topics.

You must consult the full up-to-date specifications and guidance on examinations available on the website of the awarding body relevant to your school!

Acknowledgments

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If you have comments on this document and the other resources, or if you would like to be more involved in developing them, please contact: info@designingforpeople.org.uk

Title	CIEHF Case booklet Cases such as: Improving the usability of pin pads
Source	Chartered Institute of Ergonomics & Human Factors case study
Where to find this	http://www.ergonomics.org.uk/wp-content/uploads/2015/05/2-Improving-the-usability-of-PIN-pads.pdf
Summary of content	Provides a usability/accessibility case study. Shows how user testing has created a better product. Familiar object of pin pad.
How to use in teaching	Can be used as an example. Perhaps ask students to critique the original and see how their thoughts match up to the findings of this work - likely they will miss some accessibility issues so these can be introduced.

Title	Schoolbag weight and the effects of schoolbag carriage on secondary school students
Source	Dockrell, S., C. Kane, and E. O'keefe. "Schoolbag weight and the effects of schoolbag carriage on secondary school students." Ergonomics 9 (2006): 216-222.
Where to find this	http://www.ergonomics4schools.com/research/schoolbags.htm
Summary of content	Measurements of body weight and schoolbag weight were taken and completion of a daily Body Discomfort Chart (BDC) survey was conducted over the five-day period of one school week. Fifty-seven students, mean age 13.1 years, successfully completed the five days of objective testing. The mean schoolbag weight was 6.2kg, and over the course of the week, 68% of the schoolbags weighed >10% body weight. The mean percentage body weight carried in schoolbags was 12%. The majority of students used backpack-style schoolbags (95%), but only 65% carried them on their back over two shoulders. The reported discomfort was higher for girls (80%) than boys (63%) on the initial questionnaire, but over the study period, equal numbers of boys and girls reported discomfort due to carrying their schoolbags (59%). Girls reported fewer areas of discomfort but higher VAS intensities than boys.
How to use in teaching	Measure own bags/friends bags, calculate body weight percentage and conformity with best practice - evaluate what could be done better. Perhaps use statistics to chart class averages.

Title	The Design of Everyday Things
Source / author	Don Norman
Where to find this	ISBN 978-0-465-06710-7 https://books.google.co.uk/books/about/The_Design_of_Everyday_Things.html?id=w8pM72p_dpoC
Summary of content	Classic introductory book on how design bridges the gap between product and consumer, fairly engaging and accessible, with great examples that are relatable.
How to use in teaching	Full of examples/stories of design in the world, can give teachers back-ground or parts can be shared with the class as examples. Potentially add to reading list.

Title	Design process checklist
Source / author	Inclusive design toolkit
Where to find this	http://www.inclusivedesigntoolkit.com/betterdesign2/integratedtool/integratedtool.html http://www.inclusivedesigntoolkit.com/betterdesign2/processreview/processreview.html
Summary of content	Management of coursework, planning of projects: Cambridge integrated design/design process checklist, allowing stage-by-stage recording of project process
How to use in teaching	Could be used by teachers to see how elements of UCD can be recorded and use these templates to add this to coursework. Checklists could be used throughout the design process to facilitate.

Title	Bodyspace: Ergonomics, Anthropometry and the Design of Work
Source / author	Pheasant & Haselgrave
Where to find this	ISBN 978-0415285209 https://books.google.co.uk/books?id=0vAbDAAAQBAJ&dq=bodyspace&source=gbs_navlinks_s
Summary of content	Anthropometry/physical ergonomics text book, contains data tables for British measurements from children to seniors.
How to use in teaching	Tables at the back can be used to get measurements and percentiles - students can measure each other and work out what percentile they fit into compared to each other. Teach the 'no such thing as an average human being' concept.

Title	Human Factors Methods
Source / author	Stanton et al
Where to find this	ISBN 978-1409457541 https://books.google.co.uk/books/about/Human_Factors_Methods.html?id=BSVgF7DYJqIC&redir_esc=y
Summary of content	Basic introduction to research techniques, describing how to design/ conduct questionnaires, interviews and focus groups for data collection purposes, inc. a list of advantages/disadvantages for each. Also includes a basic introduction to task analysis techniques, including examples. Particularly useful for task analysis methods.
How to use in teaching	May give teachers the materials they need to introduce these methods and topics. Activities could include design their own questionnaires, or answering fact sheets about the advantages/disadvantages of each method. Practise applying task analyses to routine activities, developing understanding of the strengths and weaknesses of the method.

Title	Design Failures
Source / author	Webpages
Where to find this	https://www.interaction-design.org/literature/article/design-failures?ep=mb
Summary of content	Examples that are accessible of where design has not included users (such as being unreachable, or in the wrong place, or inaccessible, or potentially visually confusing/interesting layout). These would be basic ways for teachers to see practical/funny examples that may be used to engage students.
How to use in teaching	Interesting examples that may be easily relatable. Teacher discretion in picking the most appropriate.

Title	Evaluation design checklist
Source / author	Various
Where to find this	https://wmich.edu/sites/default/files/attachments/u350/2014/evaldesign.pdf https://wmich.edu/sites/default/files/attachments/u350/2014/UFE_checklist_2013.pdf
Summary of content	A set of checklist objectives/guidelines in order to create your own checklist for evaluating a design - can be used at a range of levels, would be useful for teachers to develop evaluation methodologies for students. Based on a combination of objective, consumer, utlization and responsive approaches to create a hollistic method.
How to use in teaching	Potential material to be used to evaluate. Students/teachers could construct their own questionnaires using this as a basis.

Title	Persona development materials
Source / author	Various
Where to find this	https://www.usability.gov/how-to-and-tools/methods/personas.html http://uxstrategized.com/Persona_Paper_HCII_2011.pdf https://dl.dropboxusercontent.com/u/359667/UJM/BlankEmpathyMap.pdf http://www.inclusivedesigntoolkit.com/betterdesign2/examplepersonas/example_set_of_personas.pdf
Summary of content	Persona template
How to use in teaching	Students can develop their own personas using these, can discuss what is important and critique examples.

Title	Scenario development materials
Source / author	Various
Where to find this	https://www.usability.gov/how-to-and-tools/methods/scenarios.html
Summary of content	Scenario template
How to use in teaching	Scenarios can be developed for the personas of the students.

Title	Empathy materials
Source / author	Various
Where to find this	https://dl.dropboxusercontent.com/u/359667/UJM/BlankEmpathyMap.pdf http://www.inclusivedesigntoolkit.com/betterdesign2/inclusivetools/inclusivedesigntools.html
Summary of content	Empathy mapping: using templates and electronic resources (or physical workshop resources such as glasses/gloves/buttons) it is possible to create 'empathy' and understanding of user groups for inclusive design. Included are links to the Cambridge resources that can be used electronically, and a template for considering how someone perceives/feels about a product.
How to use in teaching	Activities could include a full empathy workshop, or using the free materials provided electronically by the inclusive design toolkit. Students can fill out empathy map.

Title	Oxo Products handling collections
Source / author	Oxo Products
Where to find this	https://www.oxouk.com/products/preparing/measuring https://www.oxouk.com/products/cooking-baking/silicone-nylon-cooking-tools https://www.oxouk.com/citrus-squeezer-359
Summary of content	OXO products can be used to create an example handling collection. Their products are ergonomically designed with the user in mind. They have a citrus squeezer, which can be directly compared to the Philippe Starck version.
How to use in teaching	Several excellent videos explaining the design rational of their products. The handling collection can be used for the 'Learning from Existing Products' element of the curriculum — exploring and critiquing.

Title	Examples of poor website design
Source / author	Webpages
Where to find this	https://www.elegantthemes.com/blog/resources/bad-web-design-a-look-at-the-most-hilariously-terrible-websites-from-around-the-web http://www.angelfire.com/super/badwebs/ http://www.theworldsworstwebsiteever.com/
Summary of content	There are many examples of these, and teachers may have their own favourites. These can be used to illustrate the principles of good web design.
How to use in teaching	Would work as a good ice breaker. Can set a 'find the worst website' assignment, with accompanying explanation of what prevents it from being usable. Potential to expand on how UCD can make it better.

Title	IEA Website
Source / author	IEA Website
Where to find this	http://www.iea.cc/project/EQUID.pdf http://www.iea.cc/whats/index.html
Summary of content	The website homepage provides a simple overview of ergonomics in general. The report describes conditions necessary to design ergonomic products. This document describes five groups of requirements: 1. Organization management (not relevant) 2. Initial definition of the user requirements 3. Design reviews 4. Final ergonomic evaluation 5. Evaluating after-sales user satisfaction
How to use in teaching	

Resource Data Cards

Title	BSOL Academic
Source / author	British Standards On-Line
Where to find this	http://www.edcomsteachers.com/resource-library/bsi-education/
Summary of content	Online interactive tools that emphasise the importance of standards, created for the BSI. Description states: "Students will become familiar with the idea of products meeting Standards and how Standards are met in order to keep us safe and sound. Full of lesson plans, interactive activities, games, quizzes, worksheets, design assignments and articles, this suite of free resources provides students with everything they need to understand and learn the many ways in which Standards affect our everyday lives." Resources can be accessed through the BSI website and the 'BSOL Academic'
How to use in teaching	

Title	Anthropometrics - An introduction for school and colleges (NO LONGER IN PRINT)
Source / author	Stephen Pheasant
Where to find this	https://books.google.co.uk/books/about/Anthropometrics.html?id=Xho5PAAACAAJ&redir_esc=y
Summary of content	Anthropometrical data for school children, including work exercises, examples and charts specifically for children. Large poster of anthropometric measurements and accompanying diagram. Data about anthropometrics and in easily accessible format, based on the British population.
How to use in teaching	Can be used as a prompt to calculate percentiles, discuss design for the "average" user (and that there is no such thing) and how to determine if equipment is suitable.

Title	BSI education website (archived)
Source / author	British Standards Institute
Where to find this	https://web.archive.org/web/20150926222726/http://www.bsieducation.org/Education/7-11/default.shtml
Summary of content	Website featuring useful basic information. Most useful for links to tests that can be applied to evaluate products
How to use in teaching	Product evaluation—an excellent and well-structured resource, in particular showing how fair testing can be carried out in the school environment.

Your own Resource Data Cards

Title	
Source / author	
Where to find this	
Summary of content	
How to use in teaching	

Title	
Source / author	
Where to find this	
Summary of content	
How to use in teaching	

Title	
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How to use in teaching	

Title	
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Summary of content	
How to use in teaching	

Appendix
Teaching activity tables

Table A1.1 Basic Level Activities & Content (Exploration Stage)

Generic UCD activities	Identifying problems	Exploring & researching		
	Identifying users' problems	Critiquing relevant products	Researching users' tasks, characteristics and needs	Researching ergonomic design requirements
UCD general principles	• Designing for users engaged in tasks • Similarities and differences between people • Task performance • How designing with user characteristics in mind can improve performance			
Methods and techniques		• Observing and analysing products from users' perspective • Using basic measures of performance and measurement • Interviewing users; focus groups		• Researching on-line and library resources
UCD technical knowledge		• Basic principles of Health and Safety		• Concepts of anthropometry, posture and strength
Cross-curricular links		• Applying statistical concepts: averages, percentiles, range		

Table A1.2 Basic Level Activities & Content (Creation Stage)

Generic UCD activities	Create					
	Specify			Refine		Build
	Applying ergonomic design guidelines / standards	Designing to meet user needs	Undertaking User Health and Safety risk assessment	Reviewing design with users	Responding to feedback in revised spec.	Building prototype / final design
UCD general principles	• 'Designing for me might not be the same as designing for them' • Involving users in iterative design					
Methods	• Researching on-line and library resources	• Using ergonomic resources to inform design • Using simple mockups to inform design		• Communicating with users to inform design (e.g. using simple mock-ups)		
UCD technical knowledge	• Concepts of human size, posture and strength					
Cross curricular links	• Statistical concepts: averages, percentiles					

Table A1.3 Basic Level Activities & Content (Evaluation Stage)

Generic UCD steps	Evaluate				
	Test		Analyse		
	Simulating task / conditions of product use	Testing with representative users using subjective and/or objective methods	Organising and analysing data	Interpreting results against user needs	Identifying potential design improvements
UCD general principles	• 'Designing for me might not be the same as designing for them' • Involving users in iterative design				
Methods	• Testing a design with users		• Interpreting tests with users and improving the design		
UCD technical knowledge					
Cross-curricular links					

Appendix
Teaching activity tables

Table A2.1 Intermediate Level Activities & Content (Exploration Stage)

Generic UCD activities	Identifying problems	Exploring & researching		
	Identifying users' problems	Critiquing relevant products	Researching users' tasks, characteristics and needs	Researching ergonomic design requirements
UCD general principles	• Understanding UCD principles and process • Understanding UCD relationships with other design approaches (Iterative Design; Systems Thinking....) • Understanding the advantages / contributions of UCD • Identifying user needs in the Design Brief			
UCD methods and techniques	• Using personas and scenarios to characterise users, other stakeholders, tasks and problems	• Analysing products from the user's perspective	• Observing users and tasks • Interviewing users and stakeholders • Analysing and recording observations • Using objective measures (time and errors) subjective measures (questionnaires and surveys)	• Researching on-line and library resources
UCD technical knowledge		• Universal design and users with different needs • Concepts of functionality, usability, comfort and task performance		• Concepts of anthropometry, posture and strength • Design guidelines and standards
Cross-curricular links			• Statistical concepts (means and frequency distributions; rating scales)	• Individual differences • Statistical concepts (means, percentiles etc)

Table A2.2 Intermediate Level Activities & Content (Creation Stage)

	Create					
	Specify			Refine		Build
Generic UCD activities	Applying eergonomic design guidelines / standards	Design to meet user needs	Undertake User Health and Safety risk assessment	Review design with users	Respond to feedback in revised specification	Build prototype / final design
UCD general principles	• Relationship with other design approaches (especially Iterative Design and Systems Thinking) • Advantages / contributions of UCD • User needs in design specification and building • Principle and obligations to ensure Health and Safety of users					
Methods	• Researching on-line and library resources	• Using ergonomic resources to inform design • Thinking about users during the design process (e.g. through personas) • Communicating with real users as design progresses	• Performing a user risk assessment (e.g. using personas)	• communicat-ing effectively with users and obtaining feedback on design	• Evaluating users' comments • Using comments to improve design	• Thinking about users during the making process (e.g. through personas)
UCD technical knowledge	• Concepts of anthropometry and biomechanics • Design guidelines and standards	• Design guidelines and standards	• Knowledge of hazards in the user context	• Knowledge of appropriate media to represent relevant aspects of the design to users	• Design guidelines and standards	• Design guidelines and standards
Cross curricular links	• Individual differences • Statistical concepts (means, percentiles etc)		• Maths concept of probability	• Sketching, use of computer-based drawing tools		

Appendix
Teaching activity tables

Table A2.3 Intermediate Level Activities & Content (Evaluation Stage)

Generic UCD steps	Evaluate				
	Test		Analyse		
	Simulatingtask / conditions of product use	Testing with representative users using subjective and/ or objective methods	Organising and analysing data	Interpreting results against user needs	Identifying potential design improvements
UCD general principles	• Explanation of UCD principles and process • Advantages / contributions of UCD • Principle of testing design against user needs in design brief				
Methods	• Planning evaluation (s) appropriate to stage in the design cycle • Planning the testing of the product / prototype with representative users • Planning to simulate aspects of a task	• Implementing and controlling tests • Communicating with users to obtain accurate and usable results	• Summarising data and drawing conclusions from it	• Comparing performance of product with user requirements • Discerning the effects of artefacts of the evaluation process	• Evaluating users' comments • Using comments to improve design
UCD technical knowledge		• Concepts of task performance: functionality, usability, comfort • Distinctions between objective and subjective measures	• Concepts of functionality, usability, comfort and task performance • Distinctions between objective and subjective measures		
Cross curricular links		• Collecting and recording data	• Statistical concepts (means and frequency distributions; rating scales) • Analysing data • Presenting data and results		• Interpreting and reporting results

Appendix

Teaching activity tables

Table A3.1 Advanced Level Activities & Content (Exploration Stage)

Red text : particularly relevant to Design Engineering pathway
Blue text : particularly relevant to Fashion & Textiles pathway

Generic UCD activities	Identifying problem	Exploring & Researching		
	Identifying users' problems	Critiquing relevant products	Researching users' tasks, characteristics and needs	Researching ergonomic design requirements
UCD general principles	• Understanding UCD principles and process • Understanding the relevance of statistics and human sciences to UCD • Understanding the systems view of people, machines and user-product interaction • Understanding the critical need to accommodate diversity in the user population			
Methods and techniques	• Use of personas and scenarios to characterise users, other stakeholders, tasks and problems • Analysing product use in terms of interacting systems operating in a particular task context	• Observing and analysing products from users', maintainers', retailers and other stakeholders' perspectives • Analysing product use in terms of interacting systems operating in a particular task context	• Applying techniques for collecting quantitative and qualitative information from users: interviews and focus groups; observations of products in use; questionnaires or surveys • Analysing tasks involving existing products • Using the analysis to determine performance requirements for a new product	• Methods for searching specialist websites for ergonomic design information and guidance • Evaluating the quality and fitness for purpose of information obtained on-line
UCD technical knowledge	• Effects on task performance of environmental conditions • Value and drawbacks of automation of functions	• Concepts of functionality, usability, comfort and task performance • Balancing the priorities of functionality, usability and aesthetic values in product design	• Distinctions between objective and subjective measures	• Anthropometry, posture and strength constraints • Layout and presentational constraints • Ergonomic design guidelines and standards • HCI design guidelines and standards
Cross-curricular links	• Potential for uptake of human science concepts: biology (anatomy, physiology) and psychology	• Potential for uptake of human science concepts: social implications of products and design	• Science knowledge: collecting, recording and analysing data • Statistical concepts (measures of central tendency and variation; rating scales)	• Potential for uptake of human science concepts: biology (anatomy, physiology) and psychology • Understanding statistical concepts (frequency distributions; percentiles etc)

Appendix
Teaching activity tables

Table A3.2 Advanced Level Activities & Content (Creation Stage)

Red text : particularly relevant to Design Engineering pathway

	Specify			Refine		Build
	Applying ergonomic design guidelines / standards	Designing to meet user needs	Undertaking User Health and Safety risk assessment	Reviewing design with users	Responding to feedback in revised specification	Building prototype/final design
UCD general principles	• Understanding UCD principles and process • Integrating UCD with other design approaches (Iterative Design; Systems Thinking; Biomimicry) • Understanding strengths and limitations of UCD in generating design ideas • Understanding the critical need to accommodate diversity in the user population • Responding to user needs in design specification and building • Understanding the principle and practical obligations to ensure Health and Safety of users • Understanding fidelity as a factor in prototypes at different stages in the development process.					
UCD methods and techniques	• Surveying and analysing user interface design features of related products • Applying anthropometric and biomechanical data to constrain product design • Applying relevant design standards to constrain product design	• Using user needs in the design brief to set the parameters for design • **Applying a systems approach to design** • Applying knowledge gained from user contact at requirements stage to inform product design • Using personas to inform product design	• Performing a user risk assessment (e.g. using personas)	• Communicating effectively about the design with users and other stakeholders • Designing effective mock-ups and prototypes to elicit useful information from users	• Interpreting and evaluating user feedback • Responding to user comments in design • Documenting changes in design	• Prioritising features to be included and tested with users in the construction of prototypes • Thinking about users during the making process (e.g. through personas)
UCD technical knowledge	• Anthropometric and biomechanical databases • Ergonomic design guidelines and standards • **Human-computer interaction (HCI) design guidelines and standards**	• Anthropometric and biomechanical databases • Ergonomic design guidelines and standards • **HCI design guidelines and standards**	• Knowledge of hazards in the user context • Know ledge of health and safety legislation	• Knowledge of appropriate media to represent relevant aspects of the design to users	• Knowledge of the strengths and weaknesses of user comments • Design guidelines and standards	
Cross curricular links	• Application of human science concepts: biology (anatomy, physiology) and psychology • Application of statistical concepts (frequency distributions; percentiles etc)	• Application of human science concepts: biology (anatomy, physiology) and psychology • Knowledge of human responses to properties of manufacturing materials	• Mathematical concept of probability	• Sketching, use of computer-based drawing tools		

Table A3.3 Advanced Level Activities & Content (Evaluation Stage)

Generic UCD steps	Evaluate				
	Test		Analyse		
	Simulate task / conditions of product use	Test with representative users using subjective and/or objective methods	Organise and analyse data	Interpret results against user needs	Identify potential design improvements
UCD general principles	• Explanation of UCD principles and process • Advantages / contributions of UCD • Principle of testing design against user needs in design brief				
Methods	• Planning evaluation(s) appropriate to stage in the design cycle • Planning the testing of the product / prototype with representative users • Simulating aspects of tasks	• Planning and implementing a user risk assessment and addressing all significant risks • Planning, implementing and controlling tests • Communicating with users to obtain accurate and usable results	• Using spreadsheets to organise data (?) • Summarising data and drawing conclusions from it	• Comparing performance of product with user requirements • Discerning where differences might have been due to artefacts of the evaluation process	• Evaluating and explaining mismatches between requirements and performance in tests • Using results and user comments to improve the design • Identifying requirements for user instruction documentation, practice and training • Identifying ways in which testing process could be improved
UCD technical knowledge	• Knowledge of costs and benefits of different types of evaluation and implications for task simulation	• Concepts of functionality, usability, comfort and task performance • Metrics for assessing different aspects of performance • Distinctions between objective and subjective quantitative measures	• Concepts of functionality, usability, comfort and task performance • Distinctions between objective and subjective measures		
Cross curricular links		• Collecting and recording data	• Statistical concepts: measures of central tendency and frequency distributions; rating scales) • Analysing data • Presenting data and results [If learned in other subject areas studied: • Experimental design for the human sciences • Inferential statistical tests for the human sciences]		• Interpreting and reporting results as part of project report