Unit 22: Introduction to Robotics and Automation

Delivery guidance

Approaching the unit

Robotics and automation allow humans to assign mundane, lengthy or dangerous tasks to a machine. From physical processes such as manufacturing assembly lines, to automated digital processes such as processing forms and applications, robotics and automation can have a significant impact on the productivity of organisations and individuals. This unit provides an opportunity to explore different uses of robotics and automation and their impact on society, and develop an automated solution to meet an identified need.

Developments in personal computing in recent years, and the emergence of the Internet of Things (IoT), has made it easier for individuals to develop robotic and automated solutions. Following the theoretical input for Learning Aim A, the focus of the learning n this units should be on the use of physical computing. Inexpensive, single board computers such as the Raspberry Pi and BBC MicroBit, are highly recommended as the building block for automated solutions. You will need access to a range of input and output devices (including sensors, motors, actuators etc) to allow leaners to explore some of the endless possibilities of physical computing. Learners should be encouraged to experiment and prototype, and lessons should try to provide some time to allow for this in addition to specific directed tasks.

This delivery guide does not cover everything that needs to be delivered for completion of this unit but gives examples of delivery methods. You should refer to the specification for full details of all the content that needs to be covered.

Delivering the Learning aims

Learning aim A you could start with a class discussion to explore learners' current understating of robotics and automation and explore some of the experiences that they have had. Learners are likely to focus on larger more obvious uses of robotics and automation such as assembly lines; try to get learners to also consider other uses that are widespread but may not instantly trigger the thoughts of automation such as traffic lights/crossing controls, or weather monitoring stations.

After exploring the basic concepts and building blocks of robotics and automation such as data, physical components and software, learners should explore the uses of robotics and automation and the impact they have on different aspects of

society. Delivery of this learning aim would benefit from the use pf high quality, detailed case studies as well as talks and presentations from professionals in industry. You should provide learners with opportunities to explore the use of robotics and automation in a range of contexts. Encourage learners to explore and discuss the ethical considerations of robotics and automation, the use of detailed case studies and structured discussions will be of great benefit when exploring these concepts.

Learning aim B focuses on the design of an automated solution to meet identified needs. One of the key skills here is the learners' ability to break a problem down in to its component parts (decomposition) and identify ways in which these problems can be solved. Depending on which units have been studied by the learner previously, some time will need to be spent considering how solutions can be communicated including defining functional and non-functional requirements and algorithmic design and representation (e.g. flowcharts and pseudocode).

Understating the how a wide range of component parts work together to form effective solutions is vital to this unit. Learner's will require an understanding of the factors that impact on the quality and reliability of a solution and how there may be many individual stages to a problem, both in terms of physical computing and software.

Learning aim C focuses on the development of automated solutions. This learning aim should be very practical in its nature. You could start with a look at some small, isolated problems/tasks (e.g. getting a light to switch on at a certain time of day / when it gets dark) and slowly move more complex, multi-faceted problems. You will need to spend some time providing input in to how to build physical solutions, including input of use of appropriate programming languages to control the solution, but once they have the basics learners will get the most out of this unit if they are encouraged to experiment. Providing prompts in terms of types of problems or user needs would be helpful starting points but learners should be given some time and space to explore creative ways to meet these needs. Learners should be encouraged to experiment and be encouraged to try out different solutions, highlight that it is OK if an idea, or part of a solution, fails and in fact constant development and refinement is a highly effective way to develop a digital system.

Learning aims B and C are closely linked. While some parts will be taught separately initially, learners should be provided with practical activities that utilise learning from both learning aims. It is key that learners understand that computational think required to consider the problem and design a solution, are closely linked to the practical aspects of developing the solution itself.

Assessment model

Learning aim	Key content areas	Recommended assessment approach
A Investigate the use of automation and robotics	**A1** Robotics and automation fundamentals **A2** Uses and applications of robotics and automation	A written report exploring how and why robotics and automation have integrated into different industries and society, the benefits they can bring, and any associated drawbacks and wider concerns.
B Design an automated solution for an identified need	**B1** Design documentation	A portfolio of evidence detailing the creation of an automated solution to include: • design documentation for the software solution • record of feedback received and actions taken • evidence of a completed/implemented solution (including initial and refined version) • copy of the solution's source code • test documentation and user feedback • analysis of feedback and evidence of refinement of solution • evaluation of the development, testing and refinement process.
C Produce an automated solution for an identified need	**C1** Coding and connecting an automated solution **C2** Testing an automated solution	

Assessment guidance

This unit is internally assessed. There is a maximum number of two summative assignments for this unit. Tutors should refer to the assessment guidance in the specification for specific detail, particularly in relation to the requirements for Pass, Merit and Distinction grades.

The first assignment requires to evaluate how and why robotics and automation are utilised to meet different needs, the benefits they can bring, and any associated risks and drawbacks. Learners could produce the evidence for this in different ways in including a written formal report or a presentation to the group. If a presentation is used then assessors could use video recording combined with an observation sheet to cite which assessment criteria the learner has met, with appropriate commentary supporting the reason for awarding a particular grade. A blog or some form of audio or visual evidence would also be acceptable and would allow learners to develop their creativity, provided the information is communicated in a clear and detailed manner using appropriate language.

The second assignment requires the learner to create an automated solution to meet a set of identified requirements. Learners will be expected to define a set of objectives for the solution including functional requirements and success criteria. Learners will need to produce a set of design documentation which will cover the algorithm design, plans for the physical aspects of the system and logical plans (e.g. data, deployment stack, APIs). Learners should then develop and test their proposed solution ensuring that they continually test and refine their solution. Finally, learners will be required to evaluate the extent to which their solution meets the identified objectives.

Getting started

This gives you a starting place for one way of delivering the unit, based around the recommended assessment approach in the specification.

Introduction

Introduce this unit by discussing with learners their experiences with a and current t understating of robotics and automation and explore some of the experiences that they have had. Learners are likely to focus on larger more obvious uses of robotics and automation such as assembly lines; try to get learners to also consider other uses that are widespread but may not instantly trigger the thoughts of automation such as traffic lights/crossing controls, or weather monitoring stations.

It is a good starting point for learners to understand that robotics and automation are used a wide range of situations and the problems they solve can vary significantly.

Learning aim A: Investigate the use of automation and robotics

- Learning aim A should give learners an understating of the scope of robotics and automation, how they are used, why and the associated issues. The learners should explore the "bigger picture" considering the impact robotics and automation have on different individuals and organisations.
- For A1 it may help to first establish the differences between physical robotics and 'robotic process automation' including examples of when these are separate and when they might work together.
- You could provide learners with a access to physical systems that they can make use of to see robotics and automation in action. At this stage it would be helpful for learners to be provide with working systems that they can explore and use, in order to gain an understating of what the different components do.
- You may wish to initially provide some tutor-led input regarding different components (e.g. sensors, data sources etc) before the learners start using physical examples, but this can be kept to a minimum. The hands-on nature of using systems is recommended and can provide a meaningful and engaging experience for the learner.
- For A2 need to look at uses of robotics and automation. As with topic A1 providing practical examples that the learners can interact with is the most engaging. However, for larger systems (such as industrial applications) this may not be possible. In these cases good quality and engaging case studies

can be helpful. Where this may not be possible a guest speaker either in person or via video link can also provide a valuable experience for learners.

- The ethical considerations of robotics and automation can provide material for lively and engaging class discussions. Use of news articles or prompts in the form of 'what if…?' scenarios are useful prompts for whole class or small group discussions. Splitting group and getting half to present the 'for' case and the other half the 'against' can add interest and variety to the activity, and ensures that a subject is considered form both sides.

Learning aim B: Design an automated solution for an identified need

- Learning aim B should provide learners with opportunities to explore computational thinking techniques to design a solution to an identified problem.
- Depending on which units learners have done before this, it may be helpful to consider computational thinking techniques. Spend some time with learners exploring how a problem can be broken down into smaller tasks to make the easier to solve, and how in turn the identification of the smaller tasks can lead to clear definition of the functional and non-functional requirements of the system.
- After some tutor-led input into conventions for pseudocode and flowcharts, you could provide learners with opportunities to apply these skills to explain solutions. Initially it can be helpful to separate the identification of the requirements from the algorithmic design. You could provide the learners with already decomposed problems, and a defined set of requirements, from which they can design the algorithms. Once they are comfortable with the algorithm stage then provide them with opportunities to practice the whole process.
- The quality and clarity of design documents is very important to ensuring a final solution is appropriate. Provide learners with examples of good and not so good design documents that they can analyse. You could also provide learners with a completed system that they have to 'reverse engineer'. In these types of activities, the learner must use a completed system to produce what they think the design documents might have looked like. Reverse engineering tasks can help learners more clearly see the link between design and final product.
- It can also be helpful to link this learning aim with Learning Aim C. Once learners have sufficient practical skills, you could provide opportunities for them to create systems from prewritten design documentation. Varying the

quality of the documents you present them allows learners to see issues that can arise if design documentation is not of sufficient quality.

Learning aim C: Produce an automated solution for an identified need

- Much of the learning for this learning aim should be in the form of practical tasks. Provide opportunities for learners to spend time building physical solutions to a range of different problems.
- You could start by building on the learners' experience of the physical devices by exploring smaller, clearly defined tasks/problems. Getting the learner to build the physical aspects and then providing some prewritten code to control it can help leaners start to see the links between the physical and software aspects of the solution.
- As learners grow in confidence you can provide less scaffolding ad get learner to produce the program code themselves. Sometime will need to be spent introducing use of computer programming languages, and associated libraries and frame works. This can be achieved through a combination of tutor-led practical demonstrations, self-directed online learning and practical challenges.
- You could introduce the concept of testing by providing learners with example projects/solutions in various stages of completion and with various levels of functionality. Learners could test the solutions against a defined set of requirements and document the results. For solutions that lack functionality, the learners could use their testing to identify issues and then perform the corrective actions which can then be recorded.
- As learners' familiarity with the problems and solutions increases, provide less scaffolded tasks. For example, you could start with providing a clearly set of defined criteria form which the learners can build a system and progress toa a general statement of problem that the learner must fully decompose before developing a solution.

Details of links to other BTEC units and qualifications, and to other relevant units/qualifications

This unit links to:

- Unit 4: Programming
- Unit 18: The Internet of Things
- Unit 21: Introduction to Artificial Intelligence (AI)

Resources

Textbooks

Halfacree, G – *The Official Raspberry Pi Beginner's Guide (The Official Raspberry Pi Beginner's Guide: How to use your new computer)* (Raspberry Pi Press, 2020)) ISBN 191204773X

Craig, J – *Introduction to Robotics, Global Edition, 4th edition* (Pearson, 2021) ISBN 9781292164953

Websites

https://www.raspberrypi.org/teach/

Raspberry Pi foundation – teaching and learning resources

https://microbit.org/teach/for-teachers/

Micro:bit official site. Teaching and learning resources for use with Micro:bit

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