UNIVERSITY of BRADFORD

Faculty of Engineering & Informatics

Laboratory handbook

TITLE: **System Design Group Project**

MODULE: CM-0232D

REFERENCE:

LEVEL: 5

SEMESTER: 2

Objectives

To design, build and test a complete system appropriate to the course being studied.

Aims

i) To enable students to appreciate the way that real-life problems are solved in technology/ engineering.

ii) To develop interpersonal skills by working closely with other members of a design group

iii) To understand the need for time management.

iv) To understand how knowledge from various subject areas is utilised to solve a technological problem.

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2nd Year System Design Group Project –Timetable, Semester 2, 2016

Week	Monday	Monday Lab WG2 **WG9/10** 10.00-13:00	Wednesday Lab WG2 **WG9/10** 10.00-13.00	Wednesday Lecture C2.06 10:00am	Milestones
2.01	18h Jan	No laboratory session	No laboratory session-	*GDP introduction* – RWC *Group allocation*	
2.02	25th Jan	No laboratory session- -Understand the problem-	No laboratory session- -Research technologies-	*Signal Processing* - RAH *Arduino programming*	
2.03	1st Feb	Group forming - RWC	System architecture plan – RWC + other	No lecture	***Start of labs***
2.04	8th Feb	Generate functional spec Issue hardware --RWC	Subsystem development – RA + other	No lecture	***Funct req spec + project plan***
2.05	15th Feb	Subsystem development – RWC+ other	Subsystem development – RA + other	No lecture	
2.06	22nd Feb	Subsystem development – RWC + other	Subsystem development – RA + other	No lecture	
2.07	29th Mar	Reviews – RWC + other	Reviews – RWC, RAH	No lecture	***Mid-project review***
2.08	7th Mar	Subsystem development – RWC + other	Subsystem testing – RA + other	No lecture	
2.09	14th Mar	Complete subsystem - RWC + other	System integration - RA + other	No lecture	***Complete subsystems***
2.10	4th Apr	System testing - RWC + other	System testing - RA + other	No lecture	***Complete system***
2.11	11th Apr	System testing - RWC + other	Project demonstration (E&T) – RWC, RA	No lecture	***Project demos***
2.12	18th Apr	Prepare presentation and finish documentation	Project presentations **D0.02** 10.00 – 13.00 ***Submit final report & logbook, all done!!***	No lecture	***Presentations and coursework***

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1. INTRODUCTION

This document briefly describes the Design Project to be carried out by all Second Year MEng/BEng EEE/ETIE and BSc INSYRO students. The primary purpose of the Design Project is to enable students to undertake a group exercise which as far as possible mirrors the real world environment of product development.

Students on specific courses will be sub-divided ahead of the actual starting date by the Design Project coordinator into a set of groups consisting of four (or so) members. Once each group has been established, it will be expected to work independently of all other groups and its members will be expected to manage the project by themselves. Although members of the academic staff will act as technical consultants to provide some guidance where necessary, the responsibility for achieving the project goals and completing the specified task will ultimately rest with the group. The success or otherwise of this exercise will depend entirely on how well the group functions as a coherent unit.

Most of the technical material underpinning the project will have been covered by the modules you have so far completed as part of your studies but a small fraction of it will be receiving coverage in parallel with the Design Project taking the form of seminars. In the event of difficulties being experienced due to deficiencies in background material, you should make use of the Technical Consultants to fill in any gaps.

In the real world of project development a group leader would be assigned the overall responsibility for managing all aspects of the work, including the division of effort among the other members of the group in accordance with their separate skills, expertise and interests. The same approach will be adopted in this design project and every group member must make a full individual contribution to at least one of the design tasks, whilst exercising continuous liaison with other group members and the group leader in order to ensure efficient working of the group as a whole.

2. PROJECT OUTLINE

The design project will enable you to take a product design through its life cycle from the initial technical brief, through specification, design, build and finally test. You will find that some time will need to be spent on other related activities such as project planning, organisation, costing and time management. Each group will act as a design consultancy for a fictitious company. A brief technical brief from the client company will be provided. Each group is to meet the technical brief as best it can in the timescales available and with the equipment provided.

The work will broadly fall into three phases which to some extent mirror the sequential stages of product development:

i) Developing a detailed design specification.
ii) Designing the product.
iii) Building and testing the design.

At the end of the project each group will be required to prepare a presentation to a board comprising members of staff. Each group member will be expected to describe his or her contribution to the project and to answer technical questions on all aspects of the work.

Although the project is intended to simulate as closely as possible the real activities of product development, some artificial constraints, such as the use of a specific microprocessor or particular hardware components, will be placed on the group for entirely practical reasons. There may be times during the project when you may have to consider aspects of product development about which you have little knowledge or experience, but in these cases a detailed submission will not be required. However, evidence that these areas have been considered sensibly by the group will be looked for. It is likely that you as an individual may sometimes find parts of the design process frustratingly difficult. If this happens first seek advice from other group members and if all else fails discuss the problem with one of the technical consultants. Remember, however, that the primary role of the staff is to offer guidance not do the job for you. It is important that you try your very best to think things out for yourself prior to making decisions which will affect the outcome of the project.

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3. ORGANISATION

3.1 Project titles

For the 2013/2014 academic session the project title is for:

i) EEE, ETIE and INSYRO programmes:-

"Design and Implementation of Fitness Monitoring and Recording system"

3.2 Staffing

The following staff will be involved in the Design Project.

Dr R W Clarke WG2/3 Email r.w.clarke@bradford.ac.uk
SDGP coordinator
Technical consultant (Electronics)

Dr R Halliwell WG2/3 Email r.a.halliwell@bradford.ac.uk
Technical consultant (Programming and microcontrollers)

Mr A Mistry WG1
Laboratory Manager

Mr J Browning, Mr P Widdop, Mr P Grainger WG2/3
Laboratory support

Mr J Hall WG11
Laboratory support, stores/ ordering

Mr A Leach WG9/10 or WG19 Email **a.j.leach@bradford.ac.uk**
Microprocessor laboratory support and PCB facility

The above consultants will provide your link with the company. Technician support will also be made available in the laboratory during Tuesday afternoons and Wednesday mornings. Do not expect that all technical consultants will be available during these times. You may have to make appointments to see appropriate staff at non-allocated times.

3.3 Laboratory availability The following laboratories have been booked and are available for GDP students at the following times. You will have to check with the laboratory manager if you require access at other times.
WG2/3 Mon AM & Wed AM Wk3-11, EEE & ETIE & INSYRO
WG9/10 Mon AM & Wed AM Wk3-11, EEE & ETIE & INSYRO

3.4 Budget Arrangements

Each group must appoint one group member as the person responsible for administering the £40 budget allocation and the requisitioning/ordering of items from it. All material and component orders must be placed through WG11 stores.

NOTE: The department will not reimburse any students for purchases and expenses incurred for the Design Project **unless** they are made using the system defined above or **specific permission has been given.**

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4. ASSESSMENT

The assessment of the design project will be carried out at two main levels namely group and individual. The final mark a student obtains for the design project will be calculated from the group mark and the individual mark after appropriate weightings have been applied.

4.1 Group assessment

The group mark will consist of the following four elements:-

i) Mid-project review held in **week 7**. This assessment will be worth **15%** and will be based partly on how well the group can demonstrate that they have worked as a cohesive unit and partly on a hardware/software demonstration.

ii) Project demonstration held in **week 11**. This assessment will be worth **25%** and will be chiefly based on how closely the finished product matches the original target specification.

iii) Presentation to be held during **week 12**. This assessment will be worth **15%** and will be based on how well the presentation is structured, how well the questioning is handled and how well the groups are judged to have worked together.

iv) Group final report with contributions from all group members should be handed in by 3:30pm Thursday, **week 12**.This assessment will be worth **10%.**

4.2 Individual assessment

The individual mark will consist of the following three elements:-

i) Mid-project report worth **15%** which should be handed in by 3:30pm Thursday, **week 7**. The structure of this report should follow the guidelines appearing later in this document.

ii) Logbook record to be handed in by 3:30pm Thursday, **week 12**. This assessment will be worth **20%** and will be based on how well the logbook complies with some guidelines, which will be given later in this document.

iii) It is possible to lose marks by failing to attend lab sessions. After the first 4 absences, the penalty of 2% per session missed will be applied. So make sure you attend all the sessions and sign in.

iv) Peer marks are marks awarded to each group member as a proportion of the 100% total and are decided upon by consensus with the group. They are used as a weighting factor for some aspects of the group work. The 1st set is awarded at the mid-project review stage and are used as a multiplier for this assessment. The 2nd set are used in the same way, but applied to the Demonstration. If a group awards all members equal marks, then the multiplication factor is x1. You will be expected to obtain the peer marks in a reasonable way. However, in the event of an irreconcilable dispute, the technical consultants will arbitrate.

4.3 Overall mark

The formula below shows the exact way that your final mark is calculated.
FinalMark=(((Demo*0.25)*(Peer2*0.05))+((Midprojrev*0.15)*(Peer1*0.05))+(Pres*0.15+Finrep*0.1+Midrep*0.15+Logbook*0.2-Absence))

The assessment scheme may appear complicated and it is possible that the last assessment items may lead to some degree of contention. It is extremely important that during this Design Project you never lose sight of the fact that every member of a group will lose out if the group mark is poor. It is in everyone's interest to put the good of the group ahead of everything else. Whenever people are constrained to work closely together, as you will have to do for these ten weeks, personality clashes can develop and if this does occur in your group be prepared to push it to the background if you are directly involved or act as a mediator if other people are having difficulty in getting on well together. In the long term this is all part of growing up and maturing into someone who can play a full role as an engineer in your future career. In the short term, how well you interact with the other people in your group will markedly affect your Design Project mark and may ultimately determine the type of degree you obtain.

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5. TECHNICAL BRIEF FOR THE FITNESS MONITORING AND RECORDING SYSTEM

5.1 INTRODUCTION

SESAME Enterprises Inc., a consortium of non-technical venture capitalists, have identified a potentially lucrative niche market and wish to develop a range of fitmess monitoring systems for individual training use. They do not, however, have access to technical R&D expertise and wish to sub-contract this activity to an outside organisation. Your objective therefore, is to provide this expertise and to develop a complete working system enabling the wearer to monitor and record their training activity to provide a fairly complete indication of their progress for each session.
Some hardware will be made available at the start of the project due to cost and availability factors.

5.2 TECHNICAL REQUIREMENT

Phase I (achieved by end of Wk 4)

- Functional requirements specification including a block diagram of proposed system

Phase II (achieved by mid project review, week 7)

- System capable of showing heart rate and cadence of an individual.
  The hardware can be in prototype form i.e.: a lash up on the bench or a breadboard.

Phase III (achieved by end of project, week 11)

- Complete wearable system capable of displaying and recording in real time: current time and date, time elapsed (session duration), heart rate, speed, distance travelled and calories used. This data should be recorded in a form such that it can be downloaded after the training session and presented in a permanent form on a PC or equivalent smart device and a hard copy obtained when required.
- Accurate heart rate +/- 1 bpm and speed/ distance +/- 2%. This will necessitate direct reading of heart rate (chest band) and cadence (foot mounted accelerometer).
- Real-time display showing the main parameters without button pressing.
- Easy to operate start/ stop function.
- Wearable devices should not impede training activity.
- System should be capable of presenting all the data such a way that it can be downloaded wirelessly or by USB to a PC.
- The downloaded data should be able to be displayed in graph format, either using Excel spreadsheet with macros or custom software. Each record should be date stamped.
- The wearable system should use either coin cells or a rechargeable battery and have some non-volatile memory for semi-permanent data.
- User data such as height and weight should be able to be updated as required and walking/running rate should capable of being adjusted by calibration. In addition there should be user selectable speed units, m/s, mph, kph etc.
- The system can use GPS, but should not rely on it for speed and distance data, since the system should be able to be used on a treadmill.
- Other features such as lap time and altitude information can be included if desired and after the main functionality has been achieved.
- The system should be designed to be with sustainability in mind. That is, consideration should be given to the quantity and type of raw materials used for construction, the power consumption and power supply type and the end-of-life disposal implications of the product. This should aspect should be specifically addressed in the Final Report and Presentation.

5.3 CONSTRAINTS

Reliable manufacturing techniques for heart rate and cadence sensors are notoriously difficult to implement and it is not expected that a fully-engineered front-end devices will be produced by this project. Off-the-shelf devices are available in order to produce the detailed requirements for the final product design.
Similarly the signal processing scheme adopted – should be based on the Arduino micro-controllers, programmed in an appropriate way. This hardware is supported in the School along with programming expertise and other infrastructure.

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5.4 COMMERCIAL

SESAME will decide on the basis of a working demonstration, delivery of detailed production plans and a unit costing outline, whether to go ahead with product development. Therefore, there will be a winning product.

6. DELIVERABLES

6.1 Functional Requirements Specification

This is an essential part of the top-level document for the project. It should define what the system has to do and not how the functionality is going to be achieved. This is regarded as the requirements capture phase of the project. It could well take the form of a **Block Diagram** and should describe exactly what the system has to do, quantitatively. This is particularly important in situations where the customer doesn't have a well defined specification and should always be completed before work commences on the project.

6.2 Project Plan

The project plan should allow for good management of the design process. A project plan really consists of two parts namely a time plan showing how long each task is expected to take and a resource allocation plan showing who is going to do what. If it is used as a reference document, tasks which are running late can be easily identified and remedial action taken, either by re-allocation of resources or extra effort being used, to ensure the project gets back on course. It is probable that this document will take the form of a **Gantt Chart**. The Project Plan should be incorporated into the same document as the Functional Requirements Specification. The combined document will form an important element in both the Mid-project Review and the Project Demonstration assessment exercises.

6.3 Individual Mid-project Report

The interim mid-project report should be constructed in accordance with the following guidelines.

i) The report should spell out what design decisions have been taken, what progress has been made towards implementing the design and what strategy is being adopted to solve all remaining technical problems. It should contain the following items within a total word count not exceeding 2000 words.

a.	Summary:	150 word overview of the project as a whole;
b.	Contents:	a half page description of the report's structure;
c.	Introduction:	half a page of background to the overall problem
d.	Top level design:	description of the group design solution;
e.	Individual contribution:	description of the individual task assigned; problems already solved, problems remaining; proposed solutions to the remaining problems; combining the final solution with other elements

ii) Any technical considerations in the individual contribution section should not necessarily include very detailed design information but should concentrate on proposed top-level solutions to specific parts of the individual design problem. If you feel that technical design information must appear in the report then include it in the form of appendices. The sort of things that should be placed in appendices are: Software listings, extra test data, parts lists etc.

iii) You should include the group Project Plan and a complete list of the role of each group member as appendices.

iv) The latest version of the Functional Requirements Specification should also be included in the appendices.

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6.4 Presentation

After the project work has been completed your group will have to present its design to a panel of senior managers from the company for whom you are undertaking the work. This panel is likely to contain both technical and non-technical people who have the power to authorise more money to be spent on the project.

The following provides some simple guidelines for the presentation :-

i) You are presenting to representatives of the company for whom you are undertaking the design work. Not all members will be technical people.

ii) You should not include discussion of the details of your system. Keep it at a high level, i.e. hardware block diagram, top level software design etc.

iii) Each group member must talk about his contribution to the work and there should also be a statement about group work, problems encountered and how they were resolved.

iv) Following the presentation which should last for 12 minutes, the group will be questioned by the panel probably on matters of technical detail for 3 minutes.

v) The customer is primarily interested in what it costs, how well it works and what recommendations you make about future work/modifications of the design.

6.5 Final report

The group final report will be a short technical report describing the finished product. As such it expected that all technical data, diagrams and software listings will be present. You may chose how the report is compiled, however it is expected that all group members make a contribution. The word count is approx 1500.

6.6 Logbooks

A logbook is an important record of what an engineer does during the design process. Listed below are several important reasons why a logbook should be kept.

i) It provides evidence of work carried out and the reasons for certain decisions being made in case a legal/commercial dispute arises later.

ii) It provides evidence to your supervisor/employer of what was done when and why.

iii) It helps you clarify your objectives and make efficient use of your time.

iv) It provides vitally important information when you need to write a report.

v) It may record interesting ideas and activities which may not be directly useful in the project being worked on but might be used in another project at a later date.

6.6.1 General

i) Ensure that your name and the project title are on the front cover of the log-book it should be bound, either soft of hard-backed logbook, spiral bounds are permitted but **not** the type that has perforated pages for easy removal.

ii) Entries in the logbook should be made at the time the work is being done, **not later on**. Notes written on loose sheets of paper must be permanently attached to pages inside the logbook.

iii) Ensure that you enter both the date and time at the start of each entry.

v) Whilst neatness is not paramount, do ensure that the information in the logbook is laid out legibly, logically and methodically.

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vi) If talking to anybody over the phone ensure that you record what is discussed.

vii) Paste any plots, printouts etc. in to the logbook.

6.6.2 Requirements

i) Use your logbook to record any assumptions that you may make.

ii) Record any questions you may need to ask the client, and the answers that you get.

6.6.3 **D**esign

i) Use your logbook to record all your thoughts and ideas on design even if you reject some ideas fairly quickly. Design ideas can be circuit diagrams, words, sketches, data-flow diagrams, flow-charts etc.

ii) Record what assumptions you have made in deciding on a particular design approach, and why you have chosen that approach.

6.6.4 Testing

i) Record any test procedures used, (and test equipment model numbers etc)

ii) Record what you expected to see as well as what you observed.

iii) In the case of an unexpected measurement, action etc. note the procedure to be taken to determine the cause.

iv) Record any calibration procedures you may need to undertake.

6.6.5 Computer

i) Record details of the computer system you used.

ii) Record the version number of any software you used.

iii) Ensure you back up your data on a regular basis. If possible the backup should be to a memory stick. It is recommended that you should back up at the end of a session's work and archive at the end of each week.

6.6.6 Meetings

i) You should hold regular meetings (at least once a week) with your fellow group members to discuss progress and identify any tasks which are running late. One person in the group should keep minutes of the meeting in and produce a copy for the other group members.

ii) If you are commissioned to do anything as a result of the meeting, record what the directive is and when it has to be done by.

6.6.7 Hints

i) Leave a few pages at the front of your logbook for a table of contents.

ii) Number the pages in your logbook.

iii) Use the back of the logbook for any general notes such as log on procedures, calibration procedures and data sheets etc.

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7. REFERENCES AND GUIDED READING

7.1 General Reference Areas:

i) Management organisation including : risk analysis, decision theory, project management, leadership, communication, meetings etc. **E658.4**

ii) Production management including : production planning and control, quality control, quality and reliability management, the management of innovation and creativity, the management of product design and development. **E658.3**

iii) Psychology including creativity and lateral thinking. **D153.35**

iv) British Standards including : standards for engineering specification and design. **T6**

7.2 Specific References:

i) Project Planning, Monitoring and Control

a) "Project Management" Dennis Lock. Gower Press, 2nd Ed., 1977.

b) "Critical Analysis and other Project Network Techniques" KG Lockyer. Pitman, 4th Ed., 1984.

ii) Technical

a) "Practical Electronics for Inventors", Scherz and Monk, McGraw-Hill.

b) "The Arduino Cookbook", Margolis, O'Reilly.

7.3 Technical References

A short series of lectures on technical aspects relating to the design project will be given by various members of staff at the times indicated on your timetable for Semester 2. During these lectures you will be issued with definitive references and other directed reading material to enable you and your group to make rapid progress.

8. TIMETABLE OF LECTURES, PRACTICAL WORK AND DEADLINES

Weeks 1 & 2	Technical lectures given at 11.00am on Wednesdays. Constitution of the various groups circulated to students. Specific technical requirement of the system circulated to each group.
Weeks 3 - 11	9:00 – 12:00 Monday and 9.00 - 12.00 Wednesday - practical project work.
3.30pm Thursday, week 4	**Functional Requirements Spec and Project Plan to be handed in**. (Horton Student Support Office Dropbox)
Week 7	**9.00 - 12.00 Wednesday - Mid-project Review and assessment**.
3.30pm Thursday, week 7	**Individual Mid-project Report to be handed in for assessment**. (Horton Student Support Office Dropbox)
Week 11	**9.00-12.00 Wednesday - project demonstrated to and assessed by staff**.
Week 12	**Group presentations arranged and assessed by staff**.
3.30pm Thursday, week 12	**Individual logbooks and Group Final Reports handed in for assessment**. (Horton Student Support Office Dropbox)

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Marking Scheme For The SDGP Log-book

a) Properly titled logbook (soft or hardbound)	
b) Table of contents at the front and all pages numbered	
c) Project plan (Gantt chart) showing schedules and subsystem development	
d) Secure attachment of additional material	
e) Legible writing, clear diagrams with a logical layout	
f) Statement of specific roles for each group member	
g) The records be made at the time of the work and not copied up later	
h) Block diagram of full system incorporating all sub-systems	
i) Flow charts for software, with details of last modifications ii) Assembly diagrams, breadboard layout etc: for hardware	
j) Each entry should have a time and date and include the following :-	
k) Statement of session objectives, progress and problems	
l) Indication of arguments and thoughts, with design evolution	
m) Record of meetings with attendance and summary	
n) Record of work done by sub-contractors	
o) Summary of other group members progress	
p) Suggestion for work in next session	
q) It should be clear that something has been achieved in every session	
r) Show all calculations, measured values and test data	
s) Clear indication of the effectiveness of the group work (or lack thereof!)	
t) Good records of test procedures and equipment used. Include a data section in the back of the logbook showing device pin-outs etc:	
Marking key: full √ , half ~ , none X	
Total	%

R.W.C Jan 2016

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