**Progress report 2: Detailed design report (DDR)**

Goal: Present the detailed development of your selected design. While the robot may not be complete by this point, most of the design for major elements should be finished, or nearly so. This report needs to present the details of these elements so that a reader can understand their structure, operation, and integration as a system and could use this report to accurately evaluate the performance and cost of the design.

To meet these requirements, this report needs to present enough detail that a competent person could write code, purchase components, manufacture parts, and assemble a working prototype based on the information contained in the report.

Page limit: Max 20 pages (not incl. Title page or appendices). Appendices are permitted for detailed calculations, drawings, schematics, bills of materials. If you feel that there are other things that need to be in an appendix, you'll need to come and talk to me about it – but they will need to be very relevant to the design and this type report eg. I don't want to see sensor datasheets, I can easily get these myself if you provide the part numbers.

Suggested structure:

**Exec summary**: Summarises the report (1 page max) – should include any key results/outcomes, which may be numerical.

**Introduction**: Briefly describes the project (provides context for the report) and outlines what the reader can expect to find in the rest of the report. Relates this report to the outcomes of the Conceptual Design Report (CDR). You may want to present more specifics about the design problem, as it relates to the selected concept. If you have deviated significantly from the concept you proposed in the CDR, you should explain/justify the change here.

**Design Description**: Probably best to split into subsections, e.g. Overview, sub-systems/modules.

Describe the overall robot, how it will function to achieve the tasks. Present and briefly describe the subsystems, their role in the overall system, and how they connect/interface with each other and why they were implemented in mechanical, electronic, or software domain (if appropriate). Diagrams are very useful here, eg. Physical and functional architecture block diagrams.

Describe and provide details of the various sub-systems/modules and how they function. You don't need to provide code, but FSM's, flow charts, drawings etc are essential to meet the goals of the report. Key calculations or the results of calculations shown in the appendices should be presented and discussed in relation to the operation/design of important sub-systems.

You may also want to include any additional requirements specification for elements specific to this design. These may be presented for individual sub-systems/modules and can relate back to the requirements you presented in the Conceptual Design Report. For example, you could specify a minimum weight detection range, or maximum time taken to collect a weight. Remember that requirements should be able to be tested.

**Evaluation**: An evaluation of key performance metrics based on this detailed design. This should include fairly detailed calculations (eg power usage, response times), results of test experiments (eg. Target detection, reliability, response time). You can also add descriptions/quantitative assessment of the performance of your 'prototype' during functional assessment, or your own testing.

**Further Development**: As your robot is not finalised at this stage, you can propose and describe areas where you feel that your robot could be developed or improved. These should be realistic, achievable goals, rather than nice, but unrealistic (eg. 'Implementing a warp-drive').

**Contribution statement**: As you did for the CDR.

Marking: The following table provides a guide to how we will assess these reports. Use it to judge which sections are the most important and where to use your pages.

| Marks | Description |
|---|---|
| 5 | Exec summary |
| 10 | Introduction |
| 35 | Design Description + supporting appendices |
| 25 | Evaluation + supporting appendices |
| 5 | Further development |
| 20 | Overall flow and content of the report |

Marks within these sections will be heavily influenced by the following factors:

Content:

- Concision/ brevity, but with detail is important. Say what is important and why it is important.
- Drawings of structural components. Components that were supplied to you should be included, but do not need high levels of detail. Components you have designed and manufactured should be dimensioned (not necessarily to a manufacturing standard, but include the important dimensions).
- Exploded view drawings can be helpful to show how everything fits together. These can be related to physical and functional architecture block diagrams.
- Circuit board schematics that you have designed should be included, along with a description of the circuit board function.
- Bill of materials – all components included on the robot, with part-numbers, quantity, and costs where available/appropriate.
- Detailed calculations for the system/sub-systems to characterise its performance and show that they should meet the requirements you presented in the conceptual report, or to justify the size/capacity of a component – speed, power, lifting capacity, torque etc
- Experimental results of prototype testing, especially for aspects that are hard to calculate, eg from 100 tests where you placed a weight within +/-20 deg and 0-50cm in front of the robot, it correctly identified the weight 95 times.
- If you use scores for comparison (eg FOM tables), you need to have some justification for the values you use, rather than arbitrary numbers. Don't write "Design 1 is faster than Design 2, therefore I give them 10 and 1 points, respectively." You need to base the evaluation on measurable, repeatable, and justifiable values, eg "Design 1 takes 12 seconds to pick up and store a weight, while Design 2 takes 37 seconds. The maximum allowable time is 50 seconds, so we apply a score: Score = max_allowable – actual. Thus, Designs 1 and 2 score 38 and 13 points respectively."
- In your report, be sure to include a number of relevant methods from lectures: FSM's, flow charts, algorithms for control, or strategy (not code, but detailed enough to explain what is going on), fault containment maps (if you have fault tolerance), architectural block diagrams. But, be

sure that these methods are actually useful and discussed/referred to in the report in a meaningful way – don't just plonk them there because you 'need' to.

Presentation:

- Ensure that the writing is coherent – can too easily become disjoint when several people are contributing. Make one person responsible for the overall report. Their job is to read the assembled writing and make sure it flows together.
- We will be taking more note of grammar and writing style in this report. Written communication will form a very important part of your futures, as a professional engineer, post-grad, or even before then for CV's cover letters, and work reports. You need to be able to write well for clients, colleagues, manufacturers, suppliers, potential employers, journal papers, etc. Start perfecting your writing now. Useful references for report writing and style can be found in the library and on the internet:
    - A very good summary for writing design reports can be found: http://www.me.umn.edu/education/undergraduate/writing/How-to-write-a-Design-Report.pdf
    - Also, the library has some good resources: http://www.sciencedirect.com.ezproxy.canterbury.ac.nz/science/book/9780750646369
- This is a report summarising the design and estimated/tested performance of your system. It is not a chronology of how you did things. So, don't write: "We sat down and discussed possible options and Ursula thought that a pink actuator would be the best option as she has an irrational hatred of the colour orange…" Instead: "A pink actuator was selected for its superior chromatic performance."
- Photographs can be useful for illustrating points about design or requirements.
- While you're writing this, try to see the report from the point of view of a client, or another engineer trying to prototype or evaluate this system. Which aspects are particularly important? Are all the important aspects described in enough detail? Are your reasons for selecting components, or implementing some function in a certain domain clear?