System Design Project 2016—Course Guide[*]

Under construction: Subject to revision at any time

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1 Introduction

The System Design Project (SDP) is a group-oriented practical for 3rd year students. For this year the task is to use Lego plus an on-board Arduino controller to build a robot which can play two-a-side football, based loosely on the Robocup competition small size league.

Week	Date			Item
1	9am	Wed	13 Jan	Lecture: Introductory briefing
2	11am	Tue	19 Jan	Workshop: Robot design
2	11am	Wed	20 Jan	Workshop: Robot hardware
2	11am	Fri	22 Jan	Lecture/tutorial: System architecture
3	2pm	Wed	27 Jan	Milestone 1: Move and kick
3	4pm	Fri	29 Jan	Performance Review 1
4	4pm	Mon	1 Feb	Report drafts due[1]
4	2pm	Wed	3 Feb	Round robin friendly 1
5	2pm	Wed	10 Feb	Milestone 2: Using vision
5		Fri	12 Feb	Performance Review 2
[6	*Mon–*	*–Fri*	*16–20*	*Innovative Learning Week]*
8	2pm	Wed	2 Mar	Milestone 3: Co-operate
8		Fri	4 Mar	Performance Review 3
9	4pm	Mon	7 Mar	Report drafts due[??]
9	2pm	Wed	9 Mar	Round robin friendly 2
10	2pm	Wed	16 Mar	Friendly, assessed
10		Fri	18 Mar	Performance Review 4
12	2pm	Wed	30 Mar	Seeding Friendly
12		Thu	31 Mpar	Final Day presentation practice
12	9am	Fri	1 Apr	Final Day
–	4pm	Wed	20 Apr	Final reports due
–		Thu/Fri	21/2 Apr	Performance Review 5

[*]A summary of this guide is available at the course home page, but in case of any accidental disagreement, this document is definitive.

The class is divided into groups of 6 or 7, supervised by a mentor, who is a senior student or a member of staff. The mentor offers advice, monitors progress, and marks reports; it is not the mentor's job to give technical advice, nor to lead or manage the group—identification of roles, as well as assignment to them, is up to the group.

The two pitches, in Forrest Hill 3.D03 and 3.D04 and the 3.D02 lab space is allocated to SDP all day throughout Semester 2. Milestones, round robins and friendly matches are scheduled for 2–4.30pm Wednesday.

Garry Ellard, the course technician, is available 9am-1pm and 2-5pm Mon-Fri.

Assessment involves

- group marks for *product*, that is, the performance of the robots in three milestone tests, in an assessed friendly match, and in a final tournament, along with documentation of your work;

- and individual marks for *process*, that is, how well each team member participated and contributed.

Complete details of assessment are given below in section **??**.

Each group is responsible for the development of a single robot. Groups are paired up to form *teams*.

The robot development process is driven by a series of *milestone tests*, which engage progressively more sophisticated sensing and action capabilities, and facilitated by three early workshops/lectures (see timetable above).

Milestone testing occurs 2–3.30pm Wednesday in weeks 3, 5, and actual[2] 8. Two friendly matches, in round-robin format, will occur 2–3.30pm Wednesday in weeks 4 and 9. The friendly in week 10 will be modelled on the final tournament, with a group phase followed by knock-out, and will be assessed. The Final Day presentations and tournament take place Friday of actual week 12, with presentation practice on the day before. The whole group should be present for these activities.

Each group will have a number of distinct tasks to work on including robot design, vision, other sensing, planning, motion, strategy, comms and co-ordination. You may want to build a simulator for your system. As well as physical tests, you may wish to test parts of the system in simulation, or play your robots against each other, for real or in simulation.

Throughout the term each group will be developing two documents: A *User Guide* and a *Technical Specification*. You will submit drafts of these after the 1st and 3rd milestones, and get preliminary feedback on them. In their final versions, taken together, they will constitute your group's final report, which will be assessed.

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[1]Drafts of *User Guide* and *Technical Specification* due
[2]That is, counting ILW as week 6

Before the first milestone, you should have an initial architecture of your system and a plan for the remaining work. By the first milestone, you should select a team name and logo; include these in your first performance review summary.

This year's students will have access to last year's projects, and similarly you will be asked to allow future years to build on your work. Groups are expected to make judicious use of previous years' work, and not to reinvent everything from scratch.

Notifications about course activities from the course team will be sent by email, using the `sdp-students@inf.ed.ac.uk` mailing list. Questions can be raised on that list. Groups are free to use any other form of communication they wish to.

2 Milestones

Milestone testing will take place on one of the pitches, to be notified in advance. Each milestone consists of two or three tasks, with each task to be attempted three times. For milestone 1, each group will be tested separately. For milestones 2 and 3, the two groups of each *team* will be tested together, but will be marked separately. Points are awarded per task as follows:

- 2 or 3 points: Perform the task reliably (all trials).

- 1 or 2 points: Perform the task unreliably (on some trials).

- 0 points: Fail to perform the task at all.

A typical group will earn 4 points out of a possible 6 for each milestone.

The milestone tasks are as follows (subject to revision up to a week before the test date):

- *Milestone 1: Robot basics: walking, talking, kicking* [This milestone applies to each robot in a team independently] Demonstrate basic control of movement and kicking and communications

    - The robot must be able to move to a specified (relative) position
    - It must be able to do placed kicks of specified distances (to a good approximation)
    - You must be able to send a specified message from a remote computer to your robot

3 Assessment

The mark for each student depends in equal parts on

- their contribution to their group and team throughout the semester (*process*)

- the performance of their group/team in the milestones and the final day and the quality of their final reports (*product*).

Individual process marks are assigned by mentors (out of 50%), with input from the student themselves as well as their group, in five performance reviews (after the three milestones, the assessed friendly tournament and the final report deadline).

A *group's* product marks (out of 50%) are assigned based on their robot's performances in the milestones, the assessed friendly and the final day and to the quality of their two final reports.

An *individual's* product mark (out of 50%) is a scaled version of their group's product mark, where the scale factor is based on their process mark.

3.1 Group product marks

The breakdown of the group product mark is as follows:

three milestones at 6% each:	18%
one assessed friendly:	6%
final day tournament performance	6%
final report *Technical Specification*:	16%
final report *User Guide*:	10%

See below in section **??** for details on report marking.

3.2 Performance reviews and process marking

After each of the milestones, the assessed friendly and the final report deadline, each group will conduct a performance review of its members. The group's mentor and a mentor from another group will be present and conduct the review. The review will consider both group progress overall and the contribution made by each group member.

[More details forthcoming]

3.3 Individual product marks

Group members get a scaled version of their group's product mark. A student whose process mark shows that their contribution was *high* will get the group mark scaled *up*, while a student whose contribution was *low* will get the group mark scaled *down*.

[More details forthcoming]

3.4 Submission

Final reports are due 4pm Thursday the first week after spring break. All reports must be submitted online using `submit sdp` on DICE—do `man submit` for detailed documentation. Always keep an untouched copy, preferably in a repository (git, mercurial, svn, cvs, . . .), of every report you submit.

Submit as follows:
`> submit sdp final [your filename]`
Where `[your filename]` is the name of your report file. The report filename *must* be `group-[g]-guide.{html,pdf}` for the User Guide and `group-[g]-spec.{html,pdf}` for the Technical Specification, and `[g]` is the group number. All reports *must* be in either (X)HTML or PDF.

Reports should be submitted by a group member nominated for this purpose, and notified to the group mentor and to `sdp-demonstrators@inf.ed.ac.uk` at the time of submission.

4 Friendlies

Friendly games are your opportunity to assess the behaviour of your robot working with the other robot in your team and competing against opponents in a real game. Friendly games consist of a tournament, similar to the final day tournament. Both pitches will be used, and you will only find out which on the day. Performance (as judged by two judges, *not* on finishing position) in one of the friendlies will count toward your mark, as follows:

- 6 points: Play creatively, demonstrate impressive ball skills, coordinate between attacker and defender

- 4.5 points: Play well, pass and receive the ball to some extent

- 3 points: At least some signs of differentiation between attacker and defender

- 1.5 points: Better than nothing, but not by much

- 0 points: Play very badly, or not at all

Performance in the final friendy will determine your position in the final day tournament ladder.

5 Final Day

The final day consists of presentations, one per team, a tournament, and a prizegiving ceremony. The panel of judges consists of visitors from industry plus the course organiser (Henry), the course technician (Garry) and the course TA (Katharina). In previous years we have had industrial visitors from Accenture, Amazon, Cisco, Citi, Freescale, Google, IBM, and Kal. Edinburgh's honour is a stake, and we expect you to make a good impression!

Presentations. Presentations will be made in an auditorium, to an audience consisting of the panel of judges and SDP students. You are expected to turn up for presentations other than your own! You may designate a small number of presenters, but all of both groups should be available to answer questions about components they worked on. The presentation should cover the design of your robots, focussing on their innovative features and promoting the accomplishments of your team. You will have 15 minutes, including time for setup and questions and changeover. You are advised to rehearse; the auditorium is available the day before the Final Day for this purpose.

Tournament. The tournament will take place in the lab, and have the same form as the friendlies. Initial placement in the competition will depend on performance at the seeding friendly. Time will be allocated on the Final Day for any required calibration.

Prizegiving. The judges will award a prize for the best overall team. The award is based on performance in the tournament, quality of design, and excellence of execution—it is likely to go to the winner of the tournament, but may go elsewhere. Additional prizes may also be awarded. Awards in previous years have included cash prizes, personal electronics and other goods contributed by the industry judges.

6 Reports

Two final reports are required from each group:

- *User Guide* No more than 6 pages, worth 10 (out of 50) marks

- *Technical Specification* No more than 12 pages, worth 16 (out of 50) marks

There are strict length limits on reports, as given above. Reports must use a 12pt font. (This document is in a 12pt font.) The font size is a serious requirement; use of a smaller font makes the report harder to read, and violates the intention of the page limits.

Reports have three purposes: to provide sufficient information to assess your work; to document for the group and yourself your design and what you have done; and to provide useful information for anyone who wants to build on what you have done in future.

Reports may contain detailed appendices beyond the page limit, particularly in aid of the last two goals; but markers are not required to read these appendices. A common mistake is to overuse the appendices— figures, tables, or other material that explains your work belongs in the main report, not an appendix. Large illustrations will not count towards the page limits.

7 Organisation

Successful completion of the project depends on effective management of the group's effort. One of the joys of SDP is watching individuals fuse together into an effective group, and this is something people remember long after the exercise has finished.

To ensure that your group remains cohesive, the entire group should meet formally with your mentor about once per week. Meetings without the mentor, and of subgroups concerned with individual components, may be needed at other times as well. During the final period, this may mean daily. Co-ordination meetings with the other group in your team will become increasingly important as the term progresses.

You should appoint a group coordinator or group leader. One responsibility of this person will be liaison with the mentor. You may wish to make this person responsible for strategic decisions, or you make wish to make decisions by consensus. Early tasks for the group will be deciding on an architecture of the system and appointing areas of responsibility. Evidence that good project management techniques have been employed will contribute to a good assessment.

Take steps to ensure that everyone has an assigned task. If each person decides separately what to do, there may be unproductive duplication of work. Build resiliency into the organisation; you don't want the robots to perform poorly because a single individual was unable to complete a task.

Given the long timescale, it is tempting to push SDP down in priority relative to other assignments with immediate deadlines, but this is a recipe for a poor outcome. We recommend that from the outset you diarise time regularly for SDP (and for other activities, come to that). Be sure to allow adequate time and effort for systems integration. Many projects have foundered during the final assembly phase—making subsystems work individually is much easier than making them all work together.

Groups have great flexibility in how they set their goals. A group that sets high goals and achieves them will earn high marks. A group that sets lower goals and achieves them may earn better marks than a group that sets high goals and achieves little.

8   Fair play

We expect all teams to compete in a spirit of fair play. Ingenious solutions are encouraged; unfair ones are not. For example, deliberately confusing the another robot's sensors is not allowed, nor is remote manual control of your robots. If you are unsure, please consult with your mentor. In unanticipated situations the verdict of the course organiser is final.

9   Problems

In rare cases an individual may be seen as failing to participate fully in the work of the group. In this case, please discuss the situation with your mentor early. Please be sensitive; there may be factors affecting the performance of group members that are not obvious.

Problems are best dealt with if brought to the attention of your mentor or the course organiser early. If there appear to be problems with the group dynamics or with an individual, please bring this to the attention of your mentor.

Mentors should meet with their groups weekly, and be available throughout the term. If you have an issue with your mentor, please bring this to the attention of the TA or the course organiser. The TA and course organiser are happy to speak with anyone, anytime.

10   Communication Skills

No matter what career you pursue, communicating well—in print and in person—is a key skill. Many people are poor communicators, and even excellent communicators can sharpen their abilities. The progress reviews and the final reports are a significant component of the assessment for SDP, and your marks for these in part depend on your ability to communicate well.

Here are four books that may prove useful. The first of these is particularly recommended, as it is short and inexpensive. (Less than £6—it could be the best investment you make in your undergraduate career!)

- William Strunk, Jr., and E. B. White, *The Elements of Style*, Longman, 1999 (Fourth edition). (First edition 1959.)

- Sir Ernest Gowers, *The Complete Plain Words*, Penguin, 2004 (Third revised edition).

- Edward Tufte, *The Visual Display of Information*, Graphics Press, 2001 (Second edition).

- Max Atkinson, *Lend Me Your Ears: All you need to know about making speeches and presentations*, Vermilion, 2004.