

## **Group board meeting: The Sand·E Group**

Minutes for 2016–01–13

**Present:** A. Goodsell (Chair), M. Fry (Board member), L. Foglianti Spadini, A. Hyslop, A. Kallaivannan, R. Kent, C. Lau, A. Rutley, S. Searles-Bryant, S. Wright, L. Yeo

### **Announcements**

1. The assessment criteria for the peer-assessment component of the module have been chosen:

**Communication** “Exchanging ideas and updating others on progress/feedback.”

**Productivity** “Maximising your contribution within a given time frame.”

**Participation** “Willingness to engage in, and contribute to, the project.”

**Quality** “Clear work which significantly furthers the progress of the project.”

**Cooperation** “Prioritising effectively towards a common goal.”

**Reliability** “Do what you say you’re going to do; be trustworthy.”

Scores should be between 1 and 3 (less than expected; expected; exceeds expectations). These must be sent weekly to MF before 17.00 each Monday, starting Monday, January 25.

### **Allocation of roles**

1. AG will chair meeting and act as the team leader.
2. SSB will take minutes and act as the contact person for MF and the course coordinator.
3. RK will collate the peer-assessment scores and send to SSB to forward to MF each week.
4. CL will act as the group treasurer.

## **Project brief (MF)**

“The challenge is to develop a robot which can draw artwork on sandy beaches.”

1. The final product should be small enough to fit in a rucksack/suitcase. It should be manageable on public transport.
2. Examples of sand art at <https://www.flickr.com/photos/martinartman>.
3. The product can draw large-scale on a beach, or small-scale in a table-top sandpit.
4. The robot should be named
5. The specifics of what sorts of images the robot should draw are left for us to decide; the purpose and motivations for the project have not been specified.

## **Resources**

1. The project budget is £200.
2. A case can be made to the course coordinator to obtain extra funding (MF advises probably only up to £50).
3. The robot designed for this course a few years ago is available for parts. MF advises that the motors (value c. £100) are particularly useful.

**Next Meeting:** Tuesday, January 19, at 11:15 in MPEB 3.14a

## **Actions**

- > Discuss skills and divide responsibilities among team members (*all*)
- > Decide upon purpose and motivations for the product (*all*)

## **Group board meeting: The Sand·E Group**

Minutes for 2016-01-19

**Present:** A. Goodsell (Chair), M. Fry (Board member), L. Foglianti Spadini, A. Hyslop, A. Kallaivannan, R. Kent, C. Lau, A. Rutley, S. Searles-Bryant, S. Wright, L. Yeo

### **Old business**

1. The minutes of the previous meeting were approved.

### **Announcements & progress**

1. We now have bench space in Lab 3. No access 1300–1400 every day and 1400–1630 on Wednesdays. A 3d printer is available; a sketch must be made and shown to the technician. (RK)
2. Final report has been started on Overleaf. Team can edit at [www.overleaf.com/4075528rppsqb](http://www.overleaf.com/4075528rppsqb).

### ***Aims and motivations***

3. Motivation is to build a robot for education. The robot should be programmable by children; they set start/end points and waypoints and whether or not to draw in between. This teaches algorithmic thinking (*e.g.* age 6–9).

### ***Group structure and roles***

4. Roles which have been allocated.

(AR, AH) Art review: Looking into history of sand art; choose type of thing to draw.

(SW, AK) Robotics review: Look at movement/digging mech, materials, and history.

(SSB) Education review: Case for teaching children algorithmic thinking; existing ways in which this is achieved.

(AG, AH) Website: Project website.

5. Design outline: Areas of design which should be decided upon this week.

- Movement (SW, AK)
- Interface
- Guidance (LFS, CL)
- Construction materials (SW, AK)
- Digging mechanism (SW, AK)
- Electronics platform (CL, SSB)

### *Preliminary research*

6. Art review. (AR, AH)

Began as protest of commercialization of art in US. Motivations behind recent works are to bring attention to the environment.

There are many large scale sculptures using rakes, trowels. Smaller sand patterns use ropes; precise measurement is not emphasized. New movement of small-scale ‘sand-stories’ involving light projection.

7. History of robotics review (incl. preliminary survey of methods of movement and digging mechanisms). (SW, AK)

- (a) Drawing mechanics: most viable options are rakes/teeth and rollers.
- (b) Locomotion: problems include purchase on sand and not ruining the drawing. Tracks ruin previous drawing; best option looks like SandBot: three wheels.
- (c) Brief summary of history of robotics
- (d) Materials: waterproof/sandproof towels exist, could be used to protect sensitive components.

8. Education review. (SSB)

Turtles have been used for education since 1960s. Drawing robots exist based on the Logo language; ink-and-paper equivalents of what we aim to build are very popular in primary schools.

The idea of teaching computation in primary schools has received enormous interest recently.

## 9. Electronics and guidance mechanisms (LFS, CL)

- (a) GPS and compass: compass necessary to determine direction of robot. Cost would be c. £50. Not sure if precision is adequate for our needs.
- (b) Laser grids: prebuilt modules are too expensive; should look into building our own. Ultrasound equivalent is too short-range.
- (c) Tethering: requires child to follow the robot.
- (d) Remote control (bluetooth): can use a mobile phone; range of 30 feet. Software exists for Arduino.

## 10. Electronics platform (SSB)

- (a) Arduino: best option for embedded systems; large community online for support. Cost < £50.
- (b) NETduino: similar to Arduino but uses .NET framework. Possibly easier to program (several team members know .NET languages).
- (c) Raspberry Pi: more a computer than for embedded systems. Used a lot for education.
- (d) Micro-controller: Requires all supporting circuitry to be built by us; more difficult to program. Possible but would require a lot of time.
- (e) A systems engineer role should be appointed to ensure compatibility of all components (software and hardware). LFS points out that power supplies will be an issue that needs some attention.

## **New Business**

### 1. Resources and examples (MF)

- (a) Rake: adjustable tines. Too large for our project but mechanism may be of interest
- (b) “Ed-bot”: small line-following robot built by MF’s son.

- (c) USB shield for Arduino: includes dongle for cordless Playstation controller
  - (d) Assorted servo motors.
- 2. Time management plan and Gantt chart. (AG)
  - (a) SSB thinks more troubleshooting/testing time should be added. AG says build phases include time for testing.
  - (b) First software task needs to be a tool to allow hardware to be tested manually.
  - (c) A second Gantt chart should be produced once the design has been completed and detailed development processes are known.
- 3. Discussion of material to be posted on the website. (AG)
  - (a) Demonstration of website.
  - (b) Mirrors report in sections with summaries of each part.
  - (c) In future will have photos and a video of the robot.
- 4. Peer-assessment scores need to be collected

**Next Meeting:** Tuesday, January 26, at 11:15 in MPEB 3.14a

### **Actions**

- > Add research to the report on Overleaf (*all*)
- > Investigate building our own LiDAR system for guidance. (*SSB*)
- > Collect peer assessment scores (*RK*)

## **Group board meeting: The Sand·E Group**

Minutes for 2016-01-26

**Present:** A. Goodsell (Chair), M. Fry (Board member), L. Foglianti Spadini, A. Hyslop, A. Kallaivannan, R. Kent, C. Lau, A. Rutley, S. Searles-Bryant, S. Wright, L. Yeo

### **Old business**

1. The minutes of the previous meeting were approved.
2. The report is now available to view in Dropbox at <https://goo.gl/1CujQq> or to view and edit in Overleaf at [www.overleaf.com/4075528rppsqb](http://www.overleaf.com/4075528rppsqb). These will be updated and kept synced with SSB's local copy roughly daily.
3. Peer assessment form has been filled out for this week

### **Announcements & progress**

1. We do not have access to our space in Lab 3 on Tuesdays unless we make special arrangements. We also only have half a bench.
2. Servos: We have 7 in the lab, MF may have more. Plan is to use 3 for the rakes.
3. Motors: 148:1 gear ratio. We have 4 in the lab from the stair-climbing project.
4. The code for the Physics study room (top floor of Physics Bldg) is 0921.

### ***Electronics platform (SSB, SW, AH)***

5. The electronics platform outline. Discussion of exact requirements.
  - (a) We believe that we need the following for the project (from Adafruit in the US):
    - Arduino board: Arduino Uno (\$24.95)  
<https://www.adafruit.com/products/50>

- Motor control shield (\$19.95)  
<https://www.adafruit.com/products/1438>
  - GPS shield (\$49.95)  
<https://www.adafruit.com/products/1272>
  - Servo control shield (\$17.50)  
<https://www.adafruit.com/products/1411>
  - Compass breakout board (\$19.95)  
<https://www.adafruit.com/products/1746>
- (b) The GPS could be a breakout (<https://www.adafruit.com/products/746>) instead of a shield at a saving of \$15.
  - (c) The servo control board is unnecessary if only 2 servos are used since the motor shield board can handle these.
  - (d) The motors and servos should be powered separately from the control board. 2 PP3 (9V) batteries should be sufficient.
  - (e) The total cost for all of the components is a little over \$128, or £90, plus shipping.
  - (f) We would also need a few other components (bypass capacitors; cables; battery connectors) which could be sourced in the UK (*e.g.* Maplin).
  - (g) The Arduino (Genuino) 101 has built in accelerometer. This would be very useful for navigation and making the positioning more precise.

**Decisions** Procure Genuino 101 from Arduino in Italy. All shields and the compass breakout from Adafruit. RK will order through Lab 3. SSB will forward details to RK and CL.

### ***Robot design (AR, RK)***

6. CAD design made.
7. Use acrylic to manufacture (easy to work with; won't rust)
8. Could have an acrylic box over top for protection
9. Dimensions TBC
10. Discussion of whether two driven wheels should be at the front or the back



11. AG has a friend who will design a pretty box for us to be 3d-rpinted.
12. Suggestion from MF: consider using only 1 rake up/down to keep simple
13. Consider how much we can achieve this year; don't be over ambitious and perhaps leave some development for a further project.
14. We could recycle wheels from previous project (cable spools).
15. Safety regulations are extensive.

### ***Software (AG, LFS, LY)***

16. Started looking at Arduino boards but handed that off to electronics subgroup because it made more sense for them to do it.
17. LY has investigated generating images (fractal-type diagrams) without using GPS. It is feasible to draw images without a positioning system even with possible turning and moving errors accounted for (computer simulations). This would be a good avenue to pursue if GPS and current plans fail. (MF: minimum goal should be to have a spiral-drawing robot tethered to a centre-point.)
18. LY has found a website for simulating Arduino output for some code (<https://123d.circuits.io/>). We can also connect simulated circuits, readings *etc.* for simulation of the whole system. We should start a project on this website to simulate our code.

### **New Business**

1. Jobs to be assigned in group general meeting tomorrow.

**Next Meeting:** Tuesday, February 2, at 11:15 in MPEB 3.14a

### **Actions**

- > Written work to be sent to SSB for compilation (*all*)
- > Aims and Motivations sections to be written up (*AG*)

- > Investigate procurements options for shields (***SSB, AH, SW***)
- > Buy Arduino controller board (***RK, SSB***)
- > Buy other electronics (***RK, SSB***)

## **Group board meeting: The Sand·E Group**

Minutes for 2016-02-02

**Present:** A. Goodsell (Chair), M. Fry (Board member), L. Foglianti Spadini, A. Hyslop, R. Kent, C. Lau, A. Rutley, S. Searles-Bryant, S. Wright, L. Yeo

**Absent:** A. Kallaivannan (*apologies*)

### **Old business & announcements**

1. The minutes of the previous meeting were approved.
2. The robot has been officially named Sand·E (Sand Education, or Sand Art ‘n’ Design Experiment).
3. The components discussed last week have been ordered from RS.

### **Progress**

#### ***Modelling and robot chassis***

1. Cardboard models of the robot and the electronics have been built. (discussion)
  - (a) motors are on underside of chassis
  - (b) on this model the large, driven wheels are at the front.
  - (c) a more robust, moving prototype will be built this week.
  - (d) the electronics box can be bought (see below)

**Decisions** The two driven wheels should be on the front; the drawing mechanism on the back with the single caster wheel. This will avoid “trolley syndrome”, where the leading caster wheel will lead the rear wheels astray.

2. SSB has found a suitable box and on/off switch. Would require:
  - “Hammond Project Box Light Grey 125x100x90mm” £6.29 from Maplin (N26HG)
  - “Miniature 6A AC 230V Rocker Switch DPDT” £2.09 (YX65V)
  - 2× “Maplin Cable Exit Gland 15mm with Sleeve” £3.89 (JZ43W)

### ***Software***

3. AG, LFS, LY have got motors running in the online simulator.

### ***Website***

4. There is some content on the website, but it is not yet live.

### **New Business**

1. LFS, RK, and LY have not yet contributed to the report. Now we have finished a lot of the initial design SSB would like to get those sections finished.

### ***Feedback from MF***

2. There seems to be an imbalance in the contributions from different members of the team (4 people seem to be contributing more than others). AG confirms that our team meetings on Wednesdays are very different, and everybody is contributing fairly.

**Next Meeting:** Tuesday, February 9, at 11:15 in MPEB 3.14a

### **Actions**

- > Contribute research to report (*LFS, RK, LY*)
- > Write up design work (*all*)
- > Build a second prototype (*RK, CL, AK, AR*)
- > Calculate how long a PP3 will last driving the motors and investigate other battery options (*SSB*)
- > Find out how to recoup expenses for components (*SSB, AG*)
- > Download some of Martin Artman's photos for the website & report (*SSB*)

## Group board meeting: The Sand·E Group

Minutes for 2016-02-09

**Present:** S. Searles-Bryant (Chair), M. Fry (Board member), L. Foglianti Spadini, A. Hyslop, A. Kallaivannan, R. Kent, C. Lau, A. Rutley, S. Wright, L. Yeo

**Absent:** A. Goodsell (*apologies*)

### Old business & announcements

1. The minutes of the previous meeting were approved.

### Progress & discussion

#### *Building the robot*

1. We have all of the components that have been ordered, including a battery for the motors
  - (a) MF suggests last year's wheels are too big. Team confirm and plan to cut them down.
  - (b) The new battery has come; it is surprisingly light (designed for flying robots).

AH concerned the capacity is not enough (20 mins). SSB replies 20 minutes is only at maximum efficiency. Estimates around 1 hour of overall beach drawing time. Also suggests we can use more batteries since they are so light.
  - (c) Complication: charging the new battery. SSB in conversation with supplier to determine charging pattern (constant current, then constant voltage to finish).
  - (d) We still need the acrylic for the chassis. AR will source; it will cost £23 (2/3 days shipping) for a piece that is shaped.
  - (e) RK shows a picture of new prototype of the robot chassis. AR points out that the wheels need to be narrower; this will affect the design of the drawing mechanism. RK suggests

IoM can cut the wheels for us.

MF suggests we should wrap the wheels to improve grip on sand.

- (f) AR has a prototype drawing mechanism attached to a servo. Group suggest that two arms per servo should be used. The method by which the servos will be attached to the chassis needs consideration.

### ***Robot control***

- 2. We have put together the Genuino and the motor control shield and we have been able to get the motors moving.
- 3. We had trouble with the code for the servo control.

### ***Website***

- 4. The website is live at <http://group-5.github.io/sand-e/>.

## **New Business**

### ***Timeline for building the robot***

- 1. The electronics can be assembled inside a box. RK: The box for electronics is in the lab.
- 2. A production plan should be written by the group this week.

### ***Mid-term review***

- 3. We have been assigned to review Group 6.
- 4. SW and LFS have volunteered to go to one of their meetings and interview members of the team for the review.
- 5. SSB will contact the group's board member to arrange this.

There will be no board meeting next week because it is reading week.

**Next Meeting:** Tuesday, February 23, at 11:15 in MPEB 3.14a

**Actions**

- > Source acrylic for chassis (***AR***)
- > Give GitHub usernames to SSB or LY for access to website and project report (***all***)
- > Write production plan for the robot (***all***)
- > Contact Prof. Ford regarding the mid-term review (***SSB***)

## **Group board meeting: The Sand·E Group**

Minutes for 2016-02-23

**Present:** A. Goodsell (Chair), M. Fry (Board member), L. Foglianti Spadini, A. Hyslop, A. Kallaivannan, R. Kent, C. Lau, A. Rutley, S. Searles-Bryant, S. Wright, L. Yeo

### **Old business & announcements**

1. The minutes of the previous meeting were approved.

### **Progress & discussion**

#### ***Mid-term review***

1. Discussion of notes from interviews of Group 6.  
SW and LFS will write up.

#### ***Hardware***

2. AR has fixed some problems with the robot.
3. AR, CL, RK have attached the motors and wheels to the chassis. We will need new wheels eventually (AR has asked for spare wheels).
4. The wheels can be cut down to make the robot more compact.

#### ***Electronics***

5. SSB has cut holes in the housing and installed the components.  
One cable still has not been delivered so we were waiting on that. If it hasn't arrived yet then SSB will replace the connectors with spade terminals.

#### ***Software***

6. LFS: An algorithm is needed to determine the wheel turning



7. Discussion of turning on the spot v. turning whilst driving
8. The GPS shield does not appear to be working at all: it is not receiving any signal. AG will try to get it replaced to confirm a problem with the hardware.
9. LY has written code for turning but makes assumptions (*e.g.* flat ground). AG points out slow motor speeds, while initially concerning, will help to avoid slipping.
10. AG: The time constraint on the project means we do not expect to create a UI for children, but can design the software as if it will. MFS and SW point out that the UI can be part of a future project.

## **New Business**

### **Report**

1. Everything sent to SSB will be put into the report.
2. We will aim to have the report finished the weekend before the deadline.  
We will assign a group to edit the report nearer the deadline.

**Next Meeting:** Tuesday, March 8, at 11:15 in MPEB 3.14a

### **Actions**

- > Write up mid-term assessment of Group 6 (***SW, LFS***)
- > Replace GPS module (***AG***)

## Group board meeting: The Sand·E Group

Minutes for 2016-03-08

**Present:** A. Goodsell (Chair), M. Fry (Board member), A. Hyslop, A. Kallaivanan, C. Lau, A. Rutley, S. Searles-Bryant, S. Wright, L. Yeo

**Absent:** L. Foglianti Spadini (*apologies*), R. Kent (*apologies*)

### Old business & announcements

1. The minutes of the previous meeting were approved.
2. The website has been updated.

### Progress & discussion

#### *Sand·E moves!*

1. We have made Sand·E drive! (We have videos.)
2. The robot is currently not stable: it doesn't turn on a curve properly and cannot drive in a straight line. The axles aren't parallel and the wheels are slipping on the axles (they are not fixed together by anything but friction). We need to replace the axles; new wheels are begin delivered today. MF suggests a grub screw on the wheel and a flattened section (filed) on the axle to fix the wheel in place.
3. We had sketches to draw a square using GPS coordinates. The sketch did not run as expected; we believe that we need the compass to determine the robot's bearing whilst stationary.  
SW: we should test individual subsystems before trying to combine them.
4. MF suggests attaching chalk to the drawing mechanism to test the robot on land (in the Quad).

#### *Drawing mechanism*

5. AR has found some servo mounts on eBay which we can have before the end of the week.

6. The rakes can be 3d printed; AR will design these so SSB can get them printed in the Institute of Making (in the UV resin printers).

### ***Money***

7. AG has asked for more money. We have not yet had a response.

### **New Business**

#### ***Final report***

1. For the next few days, our priority should be writing the report.
2. We should begin editing the report this week. SSB, SW, and AH will start editing the report at the end of the week.
3. It will cost c. £12.50 to be printed (in greyscale) and bound (150 pages, 7p per page + approx. £2 for binding). We can split this cost between us.
4. MF asks that the report contains a matrix of what

#### ***Poster presentation***

5. Will need to be “A0 and of a form that would be accepted for a scientific conference.”
6. We need to determine how it will be printed and who will pay.
7. AR, AH, and AK will start to design the poster.
8. Datasheets can be included in an annex if they are short.

**Next Meeting:** Tuesday, March 15, at 11:15 in MPEB 3.14a

### **Actions**

- > Write the report (*all*)
- > Begin editing the report (*SSB, SW, AH*)
- > Begin designing the poster (*AR, AH, AK*)