Workshop Title	**Bits n Bots 1 (Intro to 3D Robot Design)**
Workshop developed by	Anna Gerber
Description	In this workshop participants will learn about physical robot design and will use 3D CAD software to develop a bumper bar contact sensor for a mobile NodeBot
Pre-requisites	None
Key learning Outcomes	At the end of this workshop participants will be able to design a 3D model for a 3D printable custom part
Engagement and Learning Strategies	This is a hands-on workshop – participants will design a part for a NodeBot by following the facilitator's example. Slides will be provided describing the theory covered.
Spaces and Equipment required	• Space: Lab 4 • Assembled NodeBot for demo • 3D printer for demo • Presenter laptop and projector for projecting slides • Computers installed with Sketchup 3D CAD Software with STL extension installed (optionally with TTL_Lib2 and Solid Inspector extensions installed) • Callipers and rulers for measuring part dimensions • Bits n Bots Robotics Kit for each participant (see attached Bill of materials spreadsheet for kits) • USB stick for collecting 3D models for printing • Stickers or post it notes for name tags
Risk Assessment	Hands-on exercises are alternated with slide presentations to avoid any problems from focusing on screen for long periods of time.
Getting set-up	Before the workshop: Facilitator should have assembled kits for each participant At the workshop: Kits and chassis materials are laid out at the front of the room, Computers are switched on

Step	Timeline	Activity	Tips for the Facilitator	Instructional Resources
1	00:00 – 0:05	Participants arrive and are greeted by facilitator	Ask participants to introduce themselves to the group.	Use stickers/post it notes for participants to write a name tag

2	00:05 – 00:15	Facilitator gives a brief overview of the blended course structure and gives a brief intro to contextualise 3D modelling of 3D printed robot parts	Discuss: • How robots move • How we will build our robot	Slides
3	00:15 – 00:30	• Participants each grab a kit and select chassis materials • Participants start to plan out the design of their robot	Some chassis materials e.g. holey plastic frames are provided – encourage participants to bring additional materials from home next session if they wish to decorate / enhance their robot. They can also 3D design and print their own design in later session.	
4	00:30 – 0:40	Intro to 3D Design for 3D printing: • 3D printing basics – how 3D printers work • What custom parts will we need for our robots (bumper, claw/arm, sensor mount… etc) • Principles for designing our sensor mount as a 3D printed part	• Briefly Describe the additive process (object is 3D printed in layers so unsupported drastic overhanging bits won't print well) • Describe raft • Consider weight / balance	
5	0:45 – 0:50	Exercise: Use 3D CAD software to load an existing design	Describe navigation: orbit (press wheel to orbit), pan (press scroll wheel plus shift), zoom (roll mouse wheel) - zooms towards cursor	Sample model e.g. bumper bar

6	0:50 – 0:55	Exercise: Designing a sensor mount: • Participants measure required dimensions and start to create a model from scratch • Open sketchup and go through the UI	• Use callipers, ruler to measure required dimensions – measure servo horn (32mm), mounting points, and ultrasonic sensor dimensions General Sketchup tips: • Break the design down into chunks/parts and work on each piece at a time • Use click and release with drawing tools rather than click and drag • Draw profile/outline in 2D first and then extrude using push pull tool to make 3D • triple click to select all connected geometries (e.g. to move or group) • if you have blue faces they are reversed - right click and reverse to fix this	Sample ultrasonic sensor model for reference

7	0:55 – 1:10	Draw the first piece of the ultrasonic sensor mount • Using the drawing tools (rectangle, circle) • Using the Eraser tool • Using the Guide tool • Using the Arc tool • Using the push pull tool • Creating Groups	• draw rectangle 50mm x 30mm (type measurements - displayed in bottom right of screen) • draw guide lines using guide tool • use circle tool to draw circles for “eyes” and cut out using sensor measurements • round the corners of the rectangle: draw guides, use arc tool • heal surface (eraser tool) by removing all excess lines • remove all guides (eraser or via menu) • use push pull tool to raise height of surface to 4mm • triple click to select all and right click > create group • note that this should be a solid group (check in entity info window) • if not, this means there are stray lines or holes - use Solid Inspector to identify problem areas • describe difference between components and groups	

8	1:10 – 1:25	Draw the next piece of the ultrasonic sensor mount • Using Line tool • Using Follow Me tool • Using Outer Shell command	• create a rectangle perpendicular at base of existing piece (50mm x 30mm) • round corners (as above) • use circle tool and eraser tool to cut holes through face for attaching servo (hole in center, two holes for screws for servo horn) • use push pull tool to extrude to 4mm thick • use line tool to draw chamfer angle on bottom side • use follow me tool to chamfer across bottom sharp corner/edge • Create group • Select both groups, right click and use Outer Shell to join	

9	1:25 - 140	Tweaking the model • Edit a group • Using tool inference features • Using offset tool	• use offset tool to create raised edge 3mm in to hold sensor edges • use rectangle tool to draw rectangle where pins go at top of sensor (8mm x 4mm) • use push pull tool and click on existing surface to drop down to same height • add your own customisations e.g. change shape of head , add text etc Check that object is solid before exporting to STL • remember: clean up stray lines using eraser • use X-ray view of faces to find stray lines	

10	1:40 – 1:50	Participants generate STL files for their parts and provide copies of the files to the facilitator	Suggest adding unique mark on parts to make identification easier Have a USB stick to pass around to get copies of the files or provide an email address for participants to send files if they wish to finish them off at home. Use participant name in file name. Get copies of sketchup files as well as STL because if there is a problem printing facilitator may need to fix the model. If participants are having trouble coming up with their own design they can use the sample part as is.	
11	1:50 – 2:00	Participants pack up their kits and label the bags with participant name.	Participants may leave their kits with facilitator, or take them home if they wish: need to bring them along to every session. Participants may wish to bring a larger box to keep their robot in next time as they will be starting to assemble robots in the next session and they will no longer fit in the bag	

What next?

Resources	Slides (participants will be provided with electronic copy)
Collaboration	Participants will be able to apply 3D design skills to adapt existing parts or to develop parts from scratch for printing on the 3D printers at The Edge – for this course this will include the sensor mounts and robotic claw/arm etc.