

Title of the study: Development and Evaluation of a Novel Digital Product Development Tool

Name of department: Design, Manufacture and Engineering Management (DMEM)

## **Introduction**

Jack Frank Rutherford ([jack.rutherford.2019@uni.strath.ac.uk](mailto:jack.rutherford.2019@uni.strath.ac.uk)) is a Masters Student at the University of Strathclyde developing novel digital product development tools supervised by Dr Ross Brisco ([ross.brisco@strath.ac.uk](mailto:ross.brisco@strath.ac.uk))

Over three months, the researcher, Jack Frank Rutherford, partnered with the Design Engineering Team at the National Manufacturing Institute of Scotland (NMIS) to digitise their PD Toolkit. Following this collaboration, the researcher developed an application that facilitates the digital 6-3-5 ideation method alongside other digital PDTs.

The tool was tested with master's students at DMEM, University of Strathclyde and Design Engineers at NMIS. Three Design Engineers and nine DMEM students participated in the experiment. As the researcher is a university student, there was limited access to participants and available time of only one semester. The selected participants had a wide range of experience with the 6-3-5 ideation tool throughout their degree or career.

## **What is the purpose of this investigation?**

This investigation was used to determine the success of the digital tool compared with paper based use of the 6-3-5 method.

Participants were introduced to the 6-3-5 analogue paper-based method and the new prototype 6-3-5 digital PD tool via a sketching tablet. One Sketching tablet was used with two paper-based 6-3-5 templates. After each round, the paper-based templates and the sketching tablet rotated to allow each of the participants to use the digital PDT on the tablet

## **What happens to the information in the project?**

Public data will be stored on the Strathclyde servers PURE.

The University of Strathclyde is registered with the Information Commissioner's Office who implements the Data Protection Act 1998.

**Contact details:**

Principle Investigator: Dr Ross Brisco

Department of Design, Manufacture and Engineering Management

University of Strathclyde

James Weir Building

75 Montrose St

Glasgow

G1 1XJ

Telephone: 0141 574 5294

Email: [Ross.Brisco@strath.ac.uk](mailto:Ross.Brisco@strath.ac.uk)

This investigation was granted ethical approval by the Department of Design, Manufacture and Engineering Management Ethics Committee.

If you have any questions/concerns, during or after the investigation, or wish to contact an independent person to whom any questions may be directed or further information may be sought from, please contact:

Secretary to the University Ethics Committee

Research & Knowledge Exchange Services

University of Strathclyde

Graham Hills Building

50 George Street

Glasgow

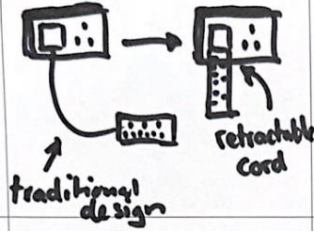
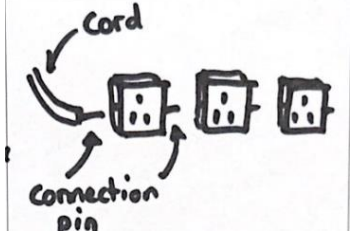
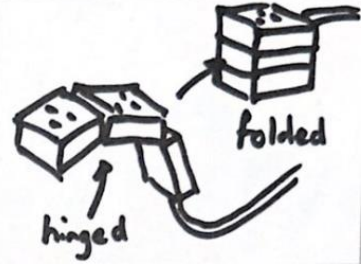
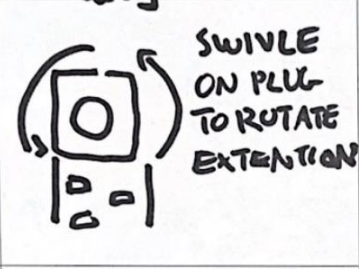
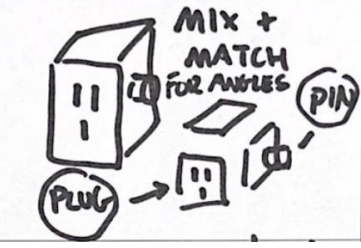
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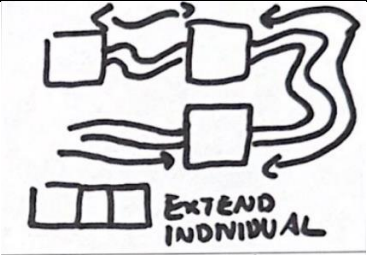

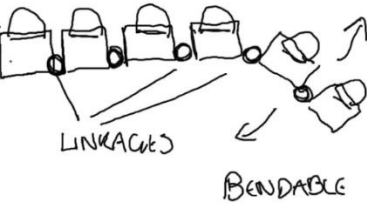

Telephone: 0141 548 3707

Email: [ethics@strath.ac.uk](mailto:ethics@strath.ac.uk)

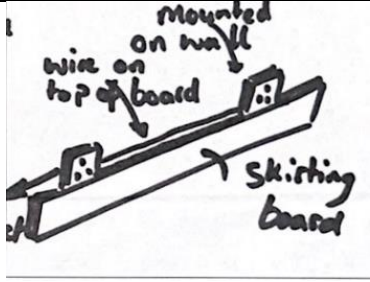
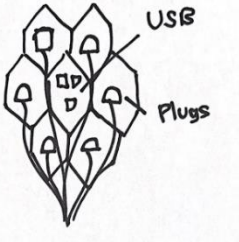
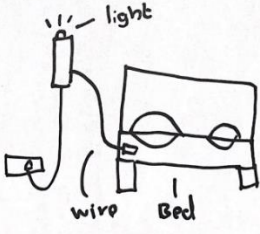
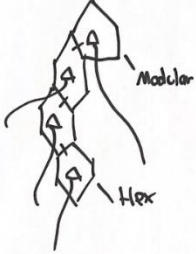
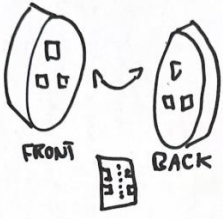
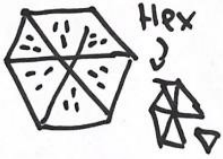
## 6-3-5 Concept Generation Results

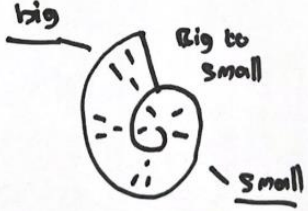
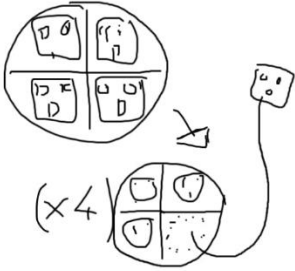

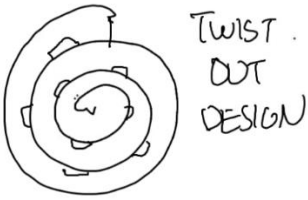
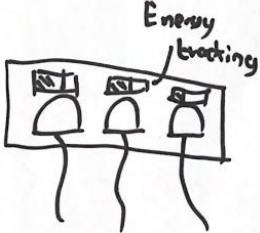
### Results of focus group 1

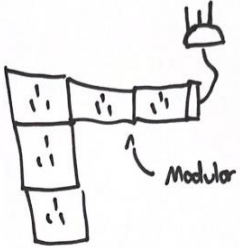
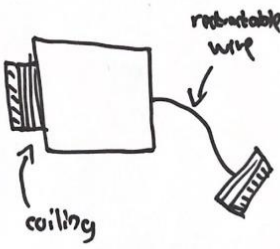
Focus Group 1						
Participants: Three Design Engineers (A, B & C)						
Round	ID	Concept	Digital /physical PDT	Participant	Time elapsed	Score
Round 1	1		Physical	A	97	8
	2		Physical	A	93	8
	3		Physical	A	98	10
	4		Physical	B	91	7
	5		Physical	B	97	7

6	 <p>EXTEND INDIVIDUAL</p>	Physical	B	93	7
7	<p>TRUNKAL PLUG?</p>  <p>USB PLUG</p>	Digital	C	98	8
8	<p>CATERPILAR PLUG?</p>  <p>LINKAGES BENDABLE</p>	Digital	C	105	6
9	<p>VS OCTOPUS USB HUB</p>  <p>ENERGY BY REVERSAL TENTACLES ARE USB CABLES</p>	Digital	C	108	6

Round 2	10		Digital	A	95	8
	11		Digital	A	98	8
	12		Digital	A	92	5
	13		Physical	B	88	11
	14		Physical	B	89	9

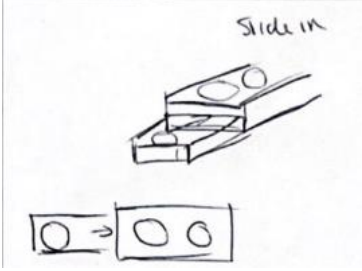
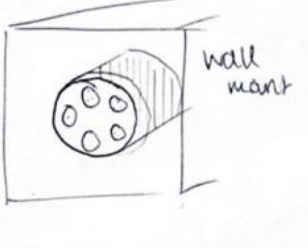
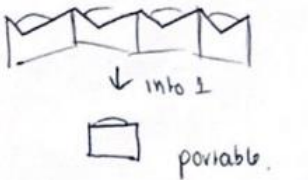
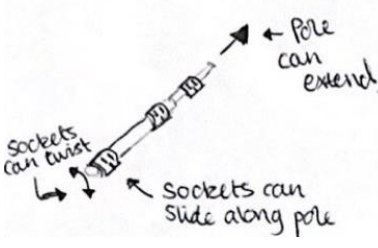
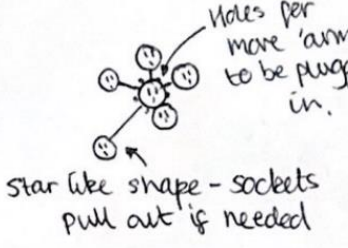
Round 3	15		Physical	B	102	9
	16		Physical	C	97	8
	17		Physical	C	91	6
	18		Physical	C	89	7
	19		Physical	A	104	5
20		Physical	A	87	9	

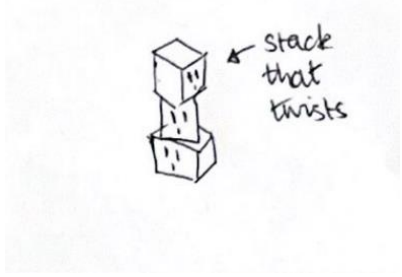
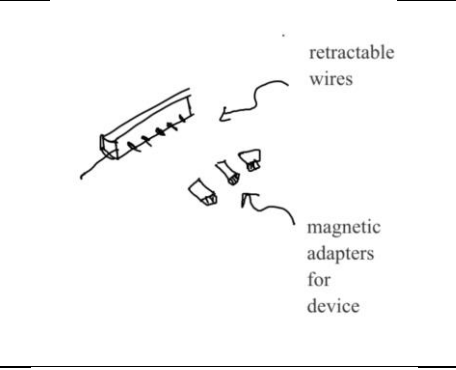
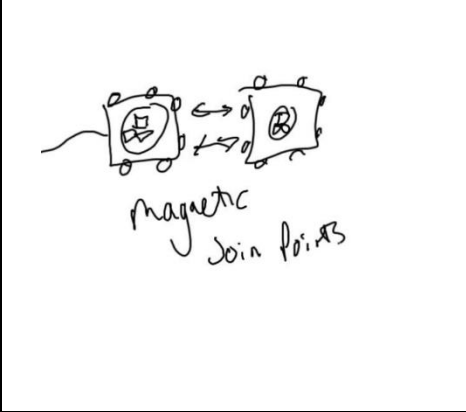
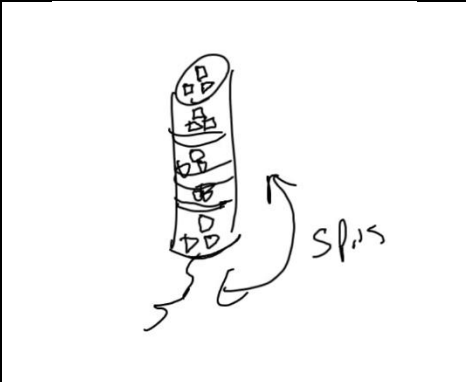
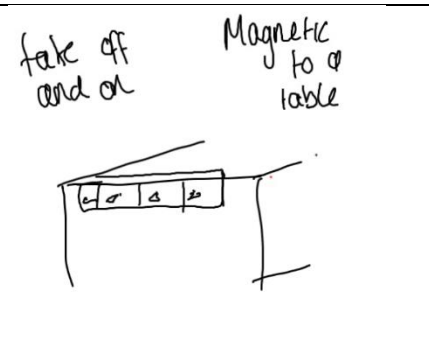
21		Physical	A	90	6
22		Digital	B	110	5
23		Digital	B	106	7
24		Digital	B	92	5
25		Physical	C	87	8

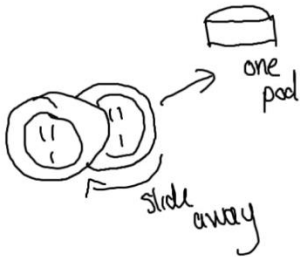
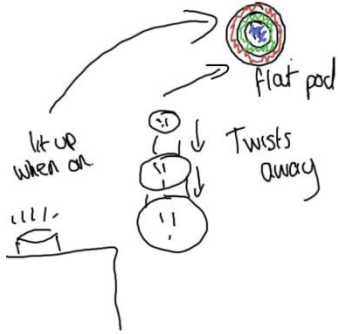
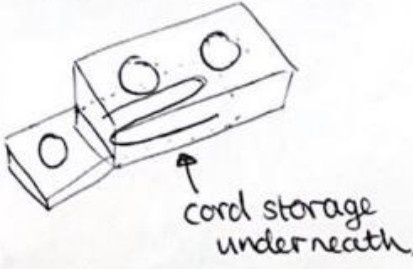
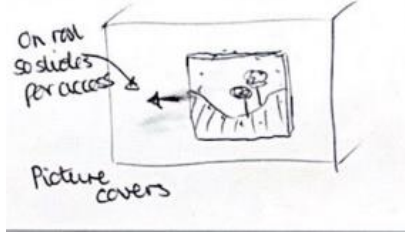
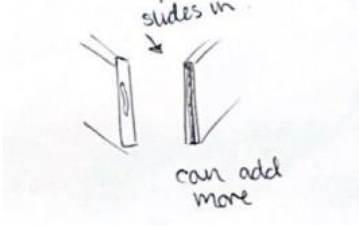
26	 <p>A hand-drawn diagram of a modular device. It consists of a vertical stack of three rectangular modules on the left, connected to a horizontal row of three similar modules on the right. A cable with a three-pronged plug is attached to the end of the horizontal row. An arrow points from the word "Modular" to the horizontal row of modules.</p>	Physical	C	82	6
27	 <p>A hand-drawn diagram of a device. It features a central rectangular box. To the left of the box is a vertical stack of rectangular coils, with an arrow pointing to it labeled "coiling". To the right of the box is a cable that ends in a rectangular connector with a grid of small squares. An arrow points from the text "retractable wire" to the cable.</p>	Physical	C	95	7



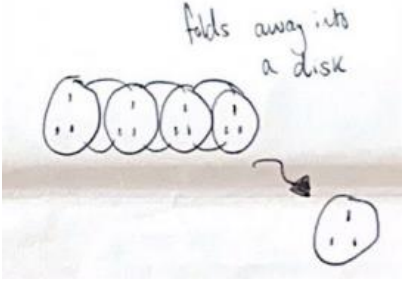
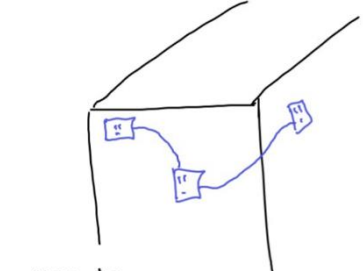
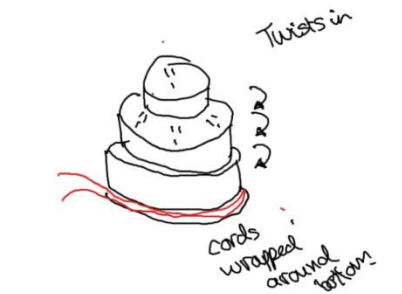
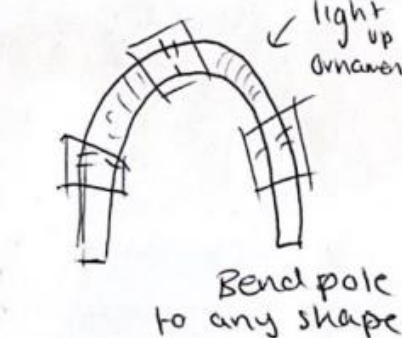
**Table 1. Results of focus group 2**

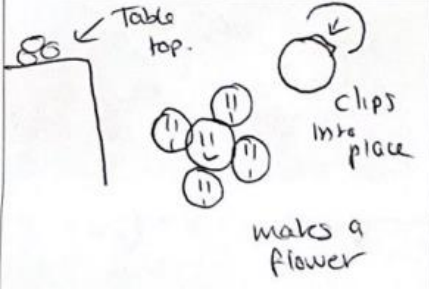
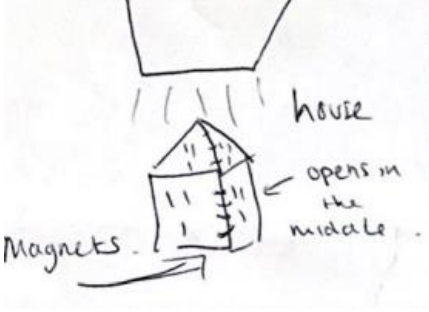
Focus Group 2 Participants: Three Students (D, E & F)						
Round	ID	Concept	Digital /physical PDT	Participant	Time elapsed	Score
Round 1	28		Physical	D	99	7
	29		Physical	D	94	6
	30	<p>'Dominoes'      Fold Away</p> 	Physical	D	104	7
	31		Physical	E	99	8
	32		Physical	E	104	7

	33	 <p>stack that twists</p>	Physical	E	100	8
	34	 <p>retractable wires</p> <p>magnetic adapters for device</p>	Digital	F	81	8
	35	 <p>magnetic join points</p>	Digital	F	65	7
	36	 <p>spins</p>	Digital	F	49	6
Round 2	37	 <p>take off and on</p> <p>Magnetic to table</p>	Digital	D	90	6

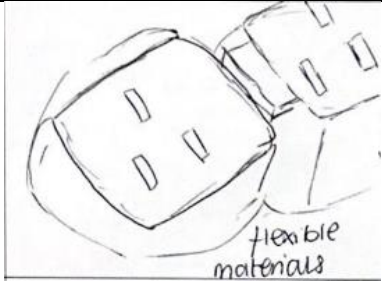
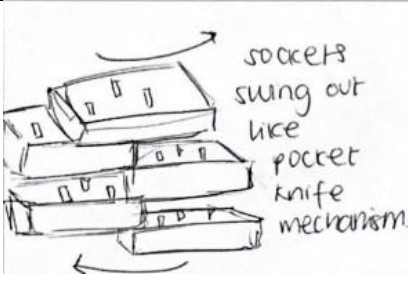
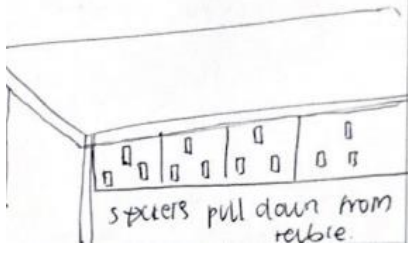
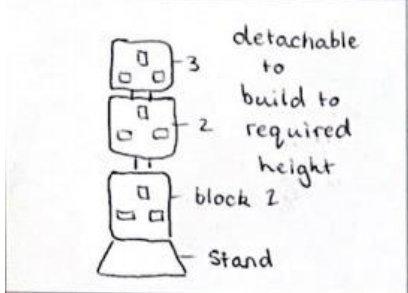
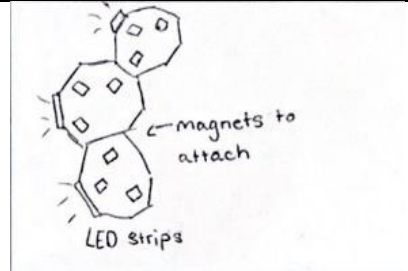
38		Digital	D	63	7
39		Digital	D	85	7
40		Physical	E	71	9
41		Physical	E	75	7
42		Physical	E	63	7

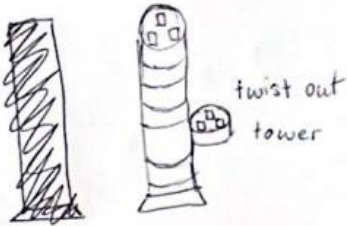
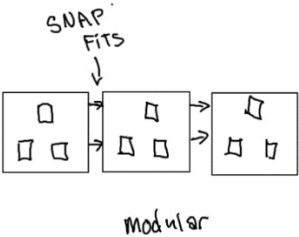
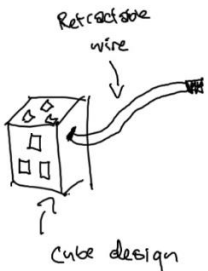
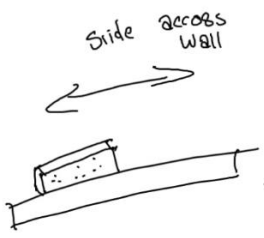
Round 3	43	<p>Pole can bend and flex.</p>	Physical	F	68	9
	44	<p>Just wires with attachable device specific ends</p>	Physical	F	75	7
	45	<p>magnets to join more on</p> <p>can come apart</p>	Physical	F	79	9
	46	<p>modular to change shape and direction of pull out</p>	Physical	D	107	7
	47	<p>LED screen shows power statistics</p> <p>- could show forage to full charge</p>	Physical	D	104	7

48	 <p>folds away into a disk</p>	Physical	D	98	8
49	 <p>Magnets can be separated.</p>	Digital	F	131	5
50	 <p>Twists in</p> <p>cords wrapped around bottom</p>	Digital	F	162	7
51	N/A	Digital	F	N/A	0
52	 <p>light up ornament</p> <p>Bend pole to any shape</p>	Physical	E	58	9



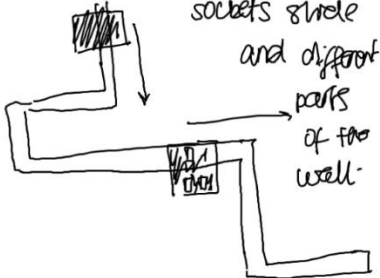
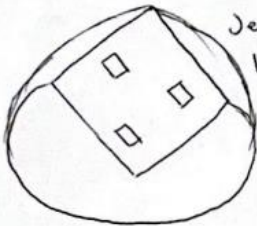
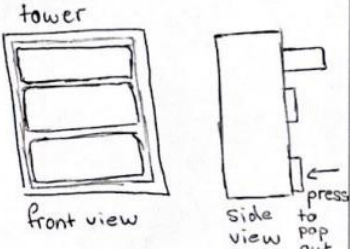
53		Physical	E	60	9
54		Physical	E	64	9

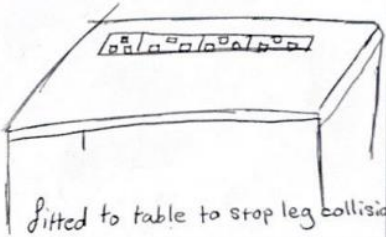
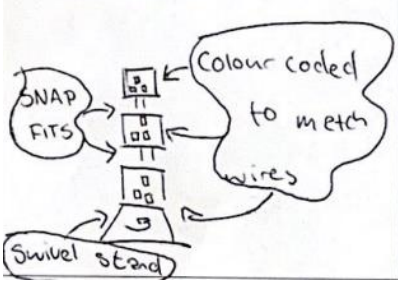
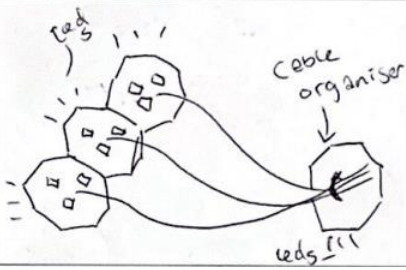
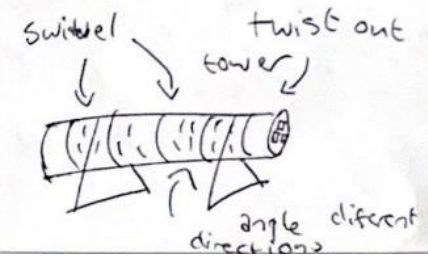
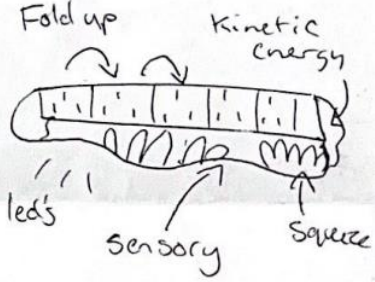
**Table 2. Results of focus group 3**

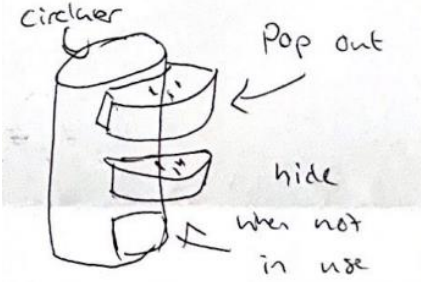
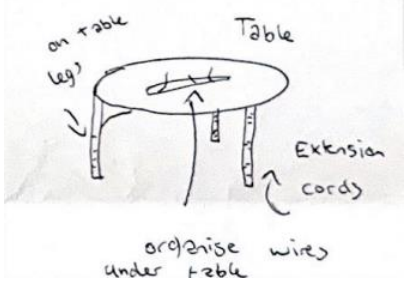
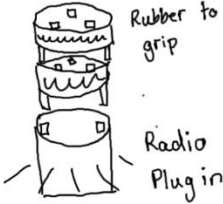
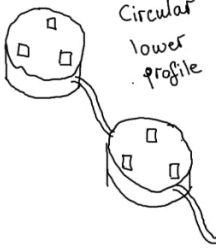
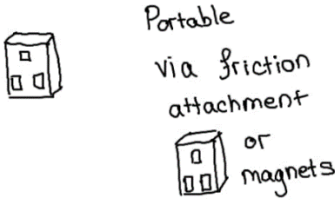
Focus Group 3 Participants: Three Students (G, H & I)						
Round	ID	Concept	Digital /physical PDT	Participant	Time elapsed	Score
Round 1	55		Physical	G	67	9
	56		Physical	G	74	9
	57		Physical	G	69	7
	58		Physical	H	97	9
	59		Physical	H	103	8

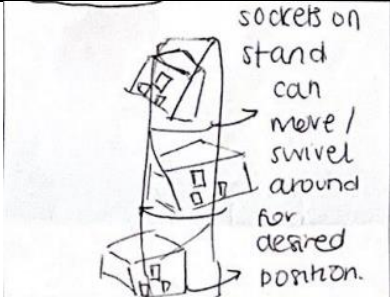
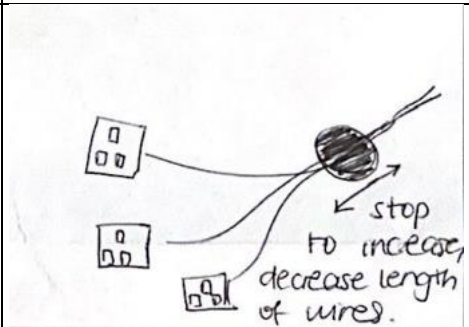
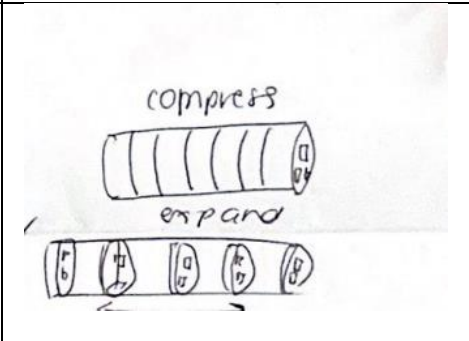
60	 <p>twist out tower</p>	Physical	H	104	6
61	 <p>SNAP FITS</p> <p>modular</p>	Digital	I	99	10
62	 <p>Retractable wire</p> <p>cube design</p>	Digital	I	88	9
63	 <p>Slide across wall</p>	Digital	I	87	7



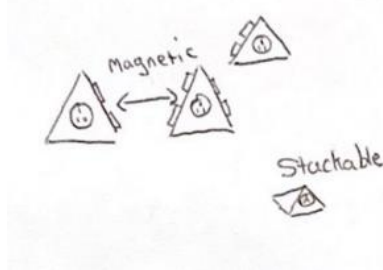
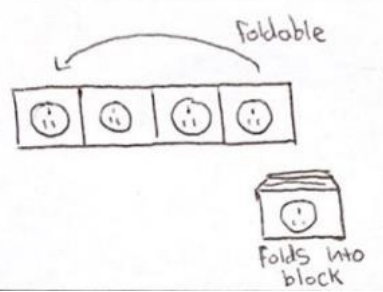
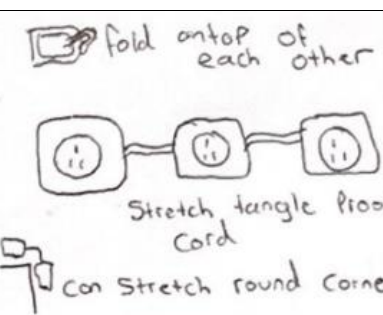
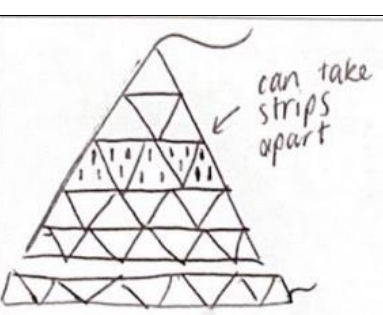
Round 2	64		Digital	G	104	5
	65	 <p>multiple connecting tubes to increase length.</p>	Digital	G	99	8
	66	 <p>sockets shade and different parts of the well.</p>	Digital	G	96	8
	67	 <p>Sensory Jelly bag</p>	Physical	H	87	10
	68	 <p>tower</p> <p>front view</p> <p>side view</p> <p>press to pop out</p>	Physical	H	95	9

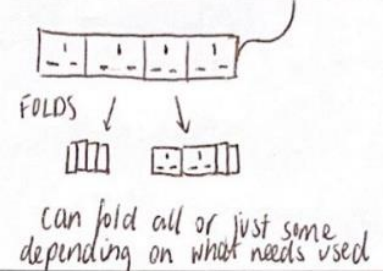
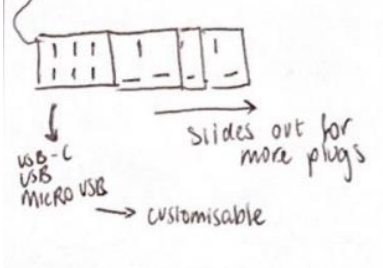
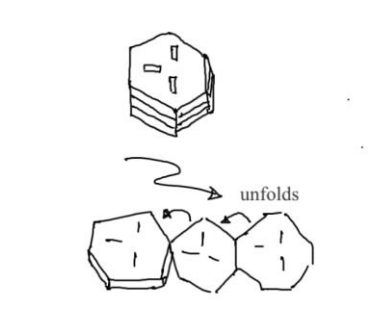
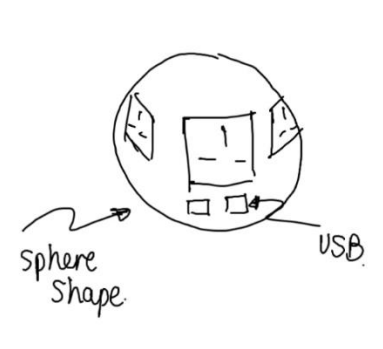
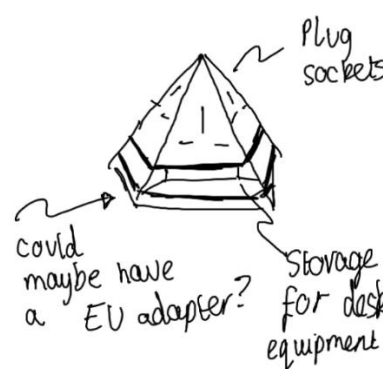
	69	 <p>Ditted to table to stop leg collision</p>	Physical	H	89	10
	70	 <p>SNAP FITS</p> <p>Colour coded to match wires</p> <p>Swivel stand</p>	Physical	I	89	9
	71	 <p>led's</p> <p>Cable organiser</p> <p>led's</p>	Physical	I	81	9
	72	 <p>Swivel tower</p> <p>twist out</p> <p>angle difercnt directions</p>	Physical	I	84	9
Round 3	73	 <p>Fold up</p> <p>Kinetic energy</p> <p>led's</p> <p>Sensory</p> <p>Squeeze</p>	Physical	G	82	9

74		Physical	G	95	8
75		Physical	G	88	9
76		Digital	I	99	9
77		Digital	I	89	10
78		Digital	I	96	9

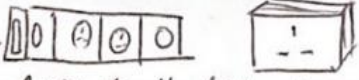
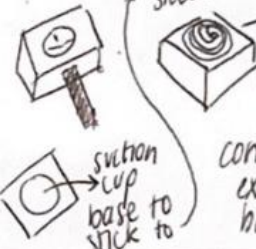
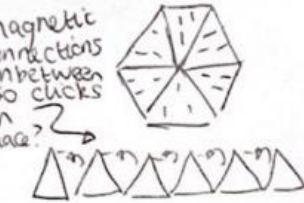
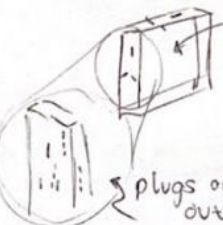

79	 <p>sockets on stand can move / swivel around for desired position.</p>	Physical	H	101	7
80	 <p>stop to increase, decrease length of wires.</p>	Physical	H	105	7
81	 <p>compress</p> <p>expand</p>	Physical	H	97	8

**Table 3. Results of focus group 4**

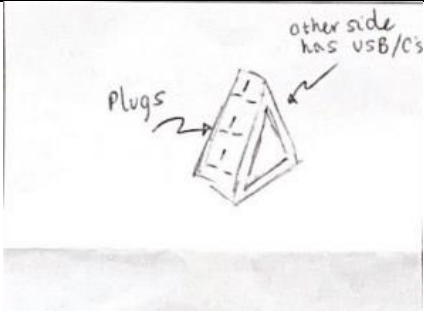
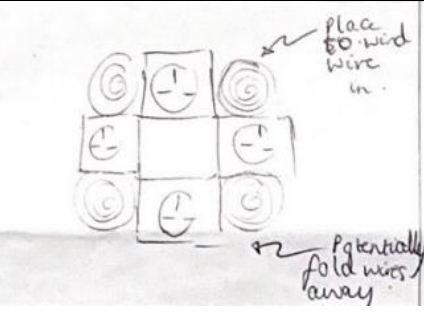
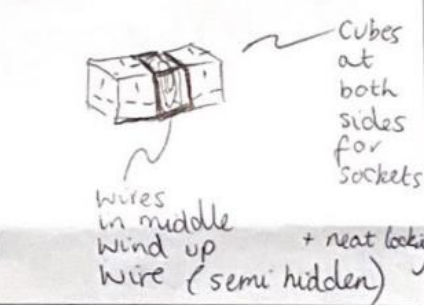
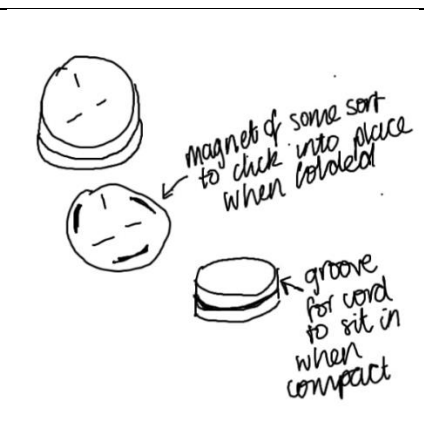
Focus Group 4 Participants: Three Students (J, K and L)						
Round	ID	Concept	Digital /physical PDT	Participant	Time elapsed	Score
Round 1	82		Physical	J	94	8
	83		Physical	J	91	8
	84		Physical	J	95	8
	85		Physical	K	99	8


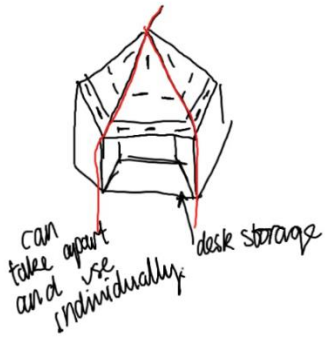
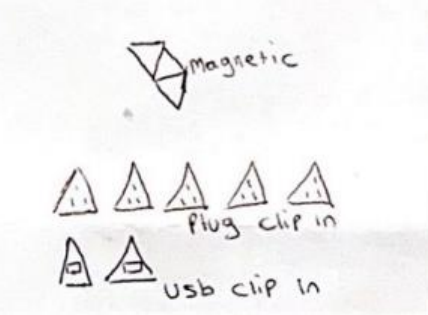
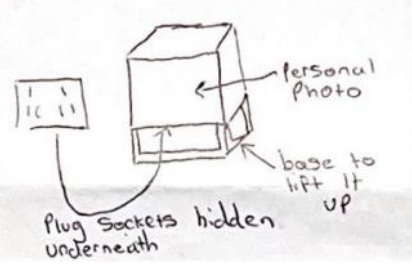
86	 <p>FOLDS ↓ ↓</p> <p>can fold all or just some depending on what needs used</p>	Physical	K	91	8
87	 <p>slides out for more plugs</p> <p>USB-C USB MICRO USB → customisable</p>	Physical	K	95	8
88	 <p>unfolds</p>	Digital	L	104	8
89	 <p>sphere shape</p> <p>USB</p>	Digital	L	93	8
90	 <p>plug sockets</p> <p>could maybe have a EU adapter?</p> <p>Storage for desk equipment.</p>	Digital	L	98	8

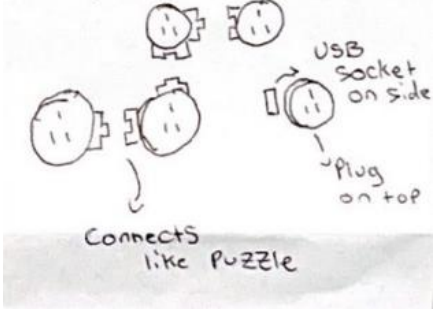
Round 2	91	<p>Circles for less Sharp Edges</p> <p>Cords to Make II More Flexible</p>	Digital	J	100	8
	92	<p>fangle free</p> <p>can clip on anywhere on sphere</p>	Digital	J	92	8
	93	<p>clip on usb socket</p> <p>desk storage</p>	Digital	J	99	8
	94	<p>usb of same kind</p> <p>magnet built into thickness of side</p>	Physical	K	98	8

95	 <p>Automatically folds when empty App connectivity to turn on/off Light indicates in use/not</p>	Physical	K	95	8
96	 <p>surface sides extendable cord contracts / extends into bases of sockets suction cup base to stick to</p>	Physical	K	102	7
97	 <p>Magnetic connections in between so clicks in place?</p>	Physical	L	81	9
98	 <p>Could insert something personal like a photo in the square? plugs on inside &amp; outside</p>	Physical	L	81	9
99	 <p>* Remember USB-C too!! Circular design moves away from 'bulky' look. USB at bottom of every socket.</p>	Physical	L	88	9



Round 3	100		Physical	J	91	8
	101		Physical	J	89	9
	102		Physical	J	95	8
	103		Digital	L	105	7

104		Digital	L	96	8
105		Digital	L	92	8
106		Physical	K	102	7
107		Physical	K	100	8

	108	 <p>The diagram shows four circular components. Two are connected side-by-side, with the text "Connects like puzzle" below them. A third component is shown with a "USB socket on side" and a "plug on top".</p>	Physical	K	92	8
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