

PROJECT 1

DESIGN OF HAND OPERATED CONTROL KNOBS BASED ON VARIOUS KINDS OF HAND GRIPS

Under the supervision of Professor **G. G. RAY**

by

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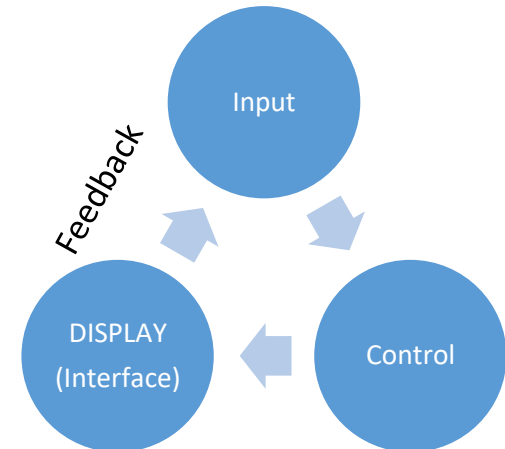


Figure 1: Nuclear control room



Figure 2 : Aircraft cockpit

1. Human designed machines to accomplish things with less effort
2. Humans make their presence to machines through control devices



FUNCTION OF CONTROLS: *“Transmit control information to some device/ mechanism/ system”*

TYPES OF CONTROLS:

1. Control information (Continuous vs Discrete)
2. Force Requirement (Hydraulic vs Mechanical, Hand vs Foot Operated)
3. Mode of operation (Sliding, Pushing, Rotating etc.,)

DESIGNING CONTROLS:

1. Available Space
2. Control Placement
3. Engineering Feasibility

FACTORS INFLUENCING THE CONTROL DESIGN:

1. **USER:** Body dimensions, hand size, hand strength, dexterity, age of user, training.
2. **WORKPLACE:** Location, physical layout, body posture
3. **DEVICE:** Function, weight, grip surface, dimensions

MATCHING USER EXPECTATION:

“Activation must be as intuitive as possible based on past experience.”

System function

On

Off

Right

Left

Increase

Decrease

Control Movement

Up, right, forward, pull

Down, left, rearward, push

Clockwise, right

Counter clockwise, left

Up, right, forward

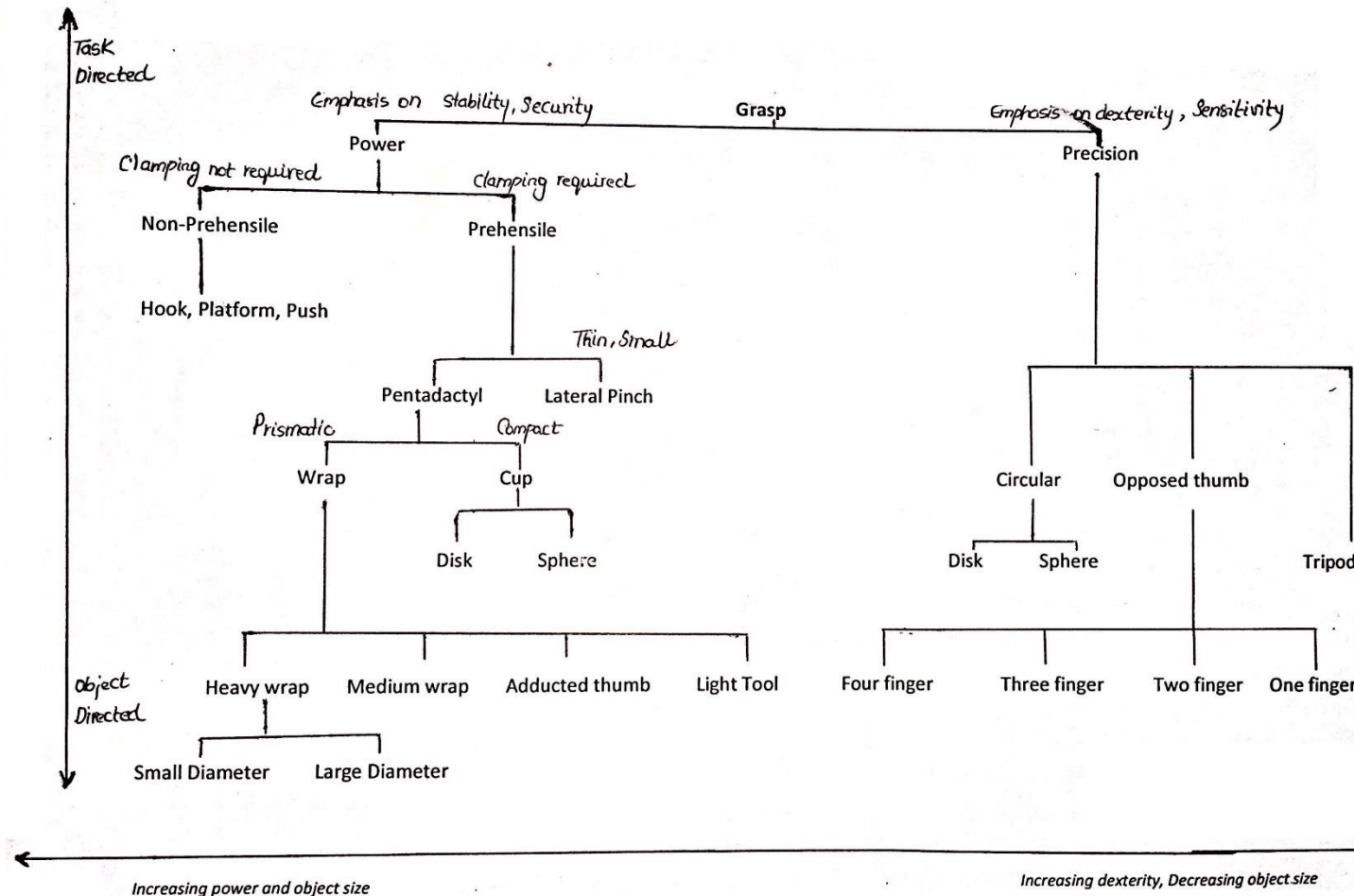
Down, left, rearward

ATTRIBUTES OF CONTROLS:

1. Speed of operation
2. Response time
3. Precision requirement
4. Force Requirement
5. Feedback (Resistance, illumination, control position)
6. Relative discriminability
7. Colour
8. Accidental activation
9. Displacement
10. Scale(Major, minor, intermediate)
11. Pointers (Mounting, contrast)
12. Labelling
13. Texture (Smooth, knurled)
14. Dead space
15. Backlash
16. Control response ratio
17. **Types of Grip**

GRIP:

1. Task determines the type of grip and action of hand
2. Grasp changes if force changes in middle of the task
3. Grasp choice may be dictated by geometry of the part



DESIGNING OF CONTROLS:

1. Types of controls designed:

- Sliders
- Joysticks

2. Types of Grips:

Sliders:

Single finger



Two finger



Lateral pinch



Power grip



Joystick:

Spherical



Modified spherical



Thumb

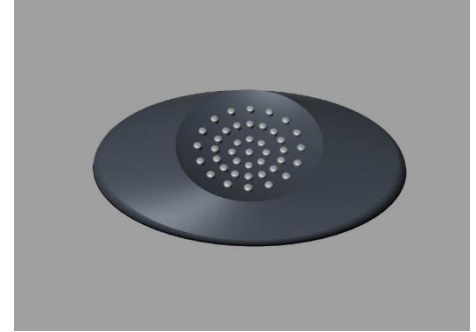
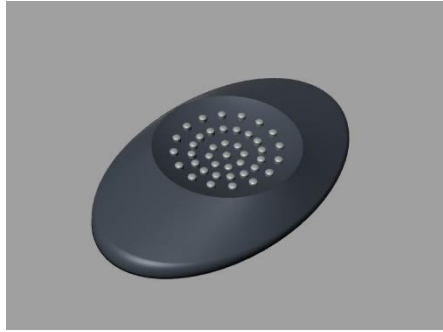
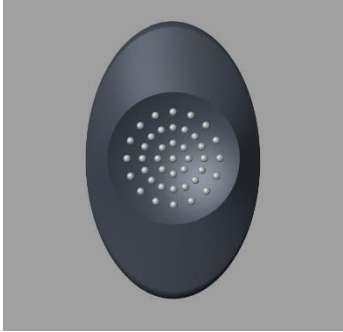


Two finger

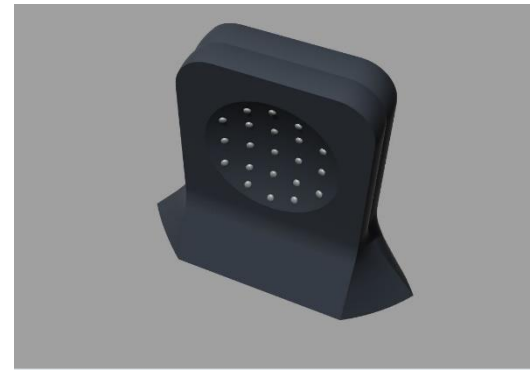


SLIDERS:

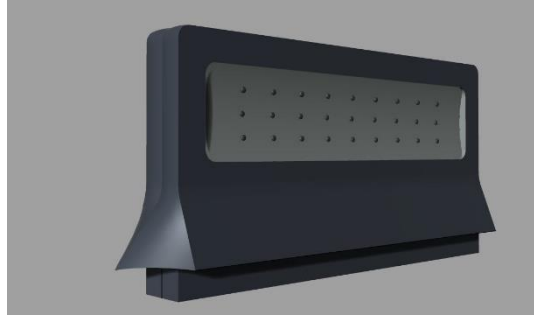
1. Single finger slider:



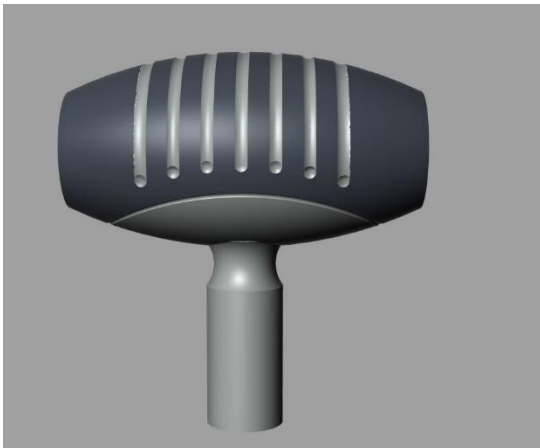
2. Two finger slider:



3. Lateral pinch slider:

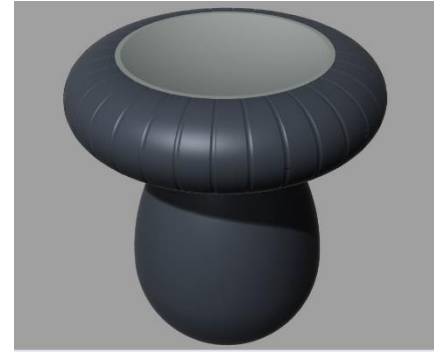
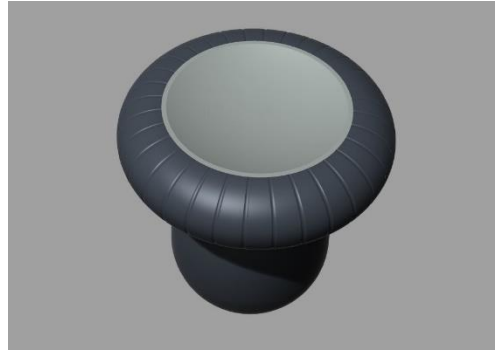


4. Power grip slider:



JOY STICKS:

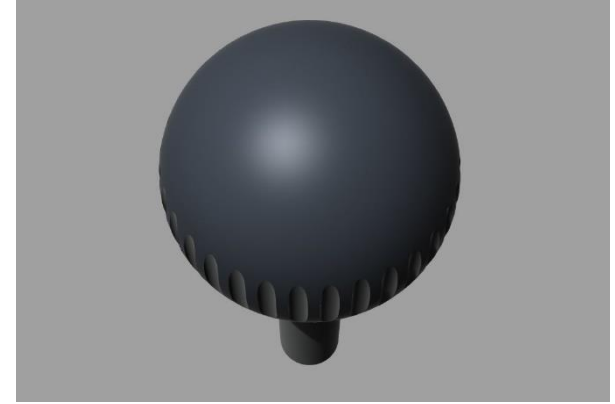
1. Thumb grip joystick:



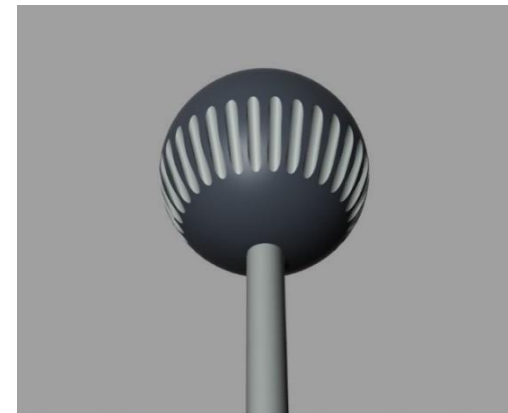
2. Two finger joystick:



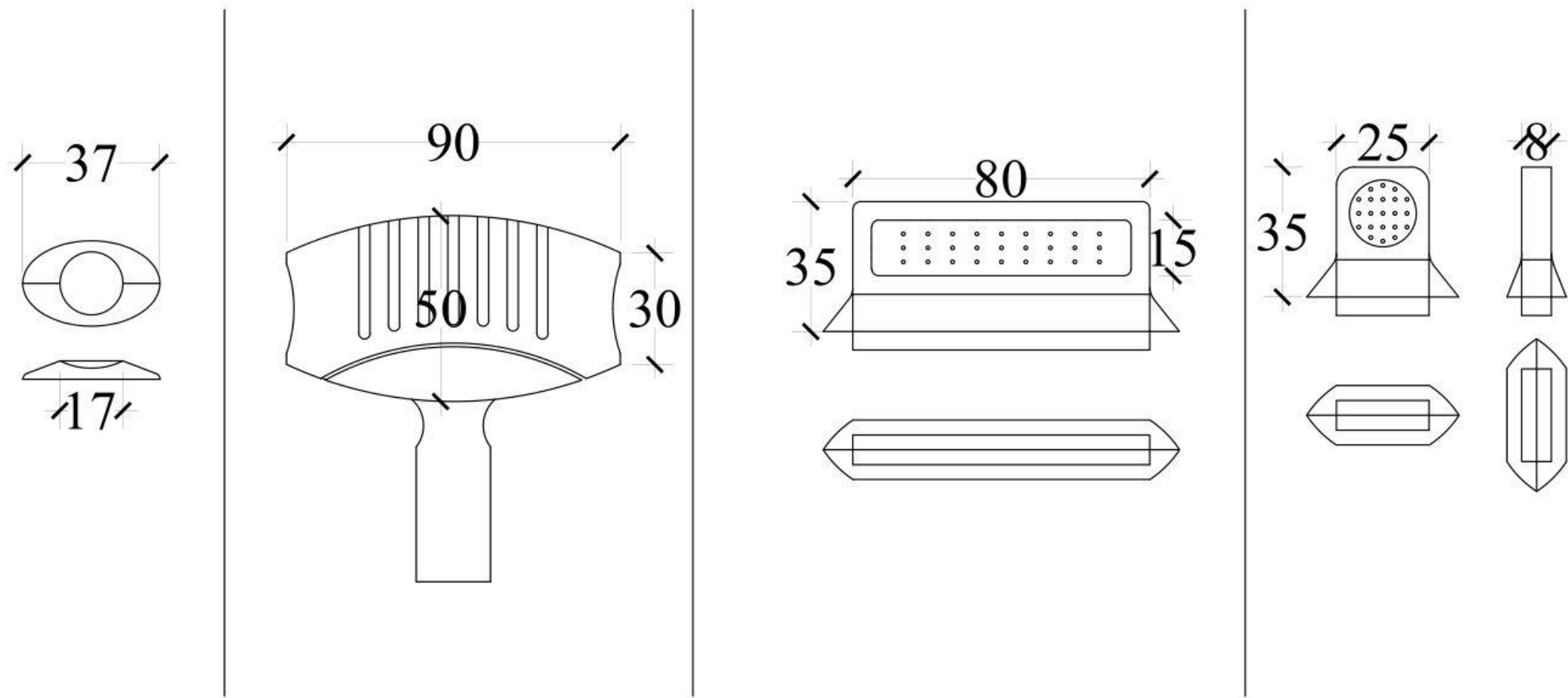
3. Spherical grip joy stick:



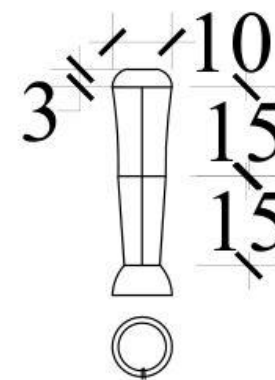
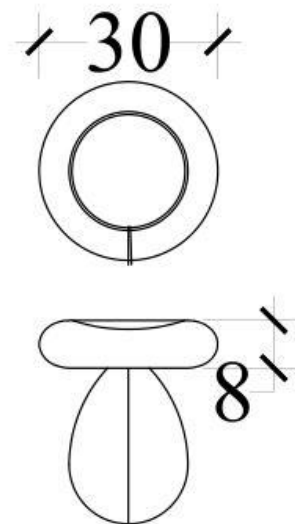
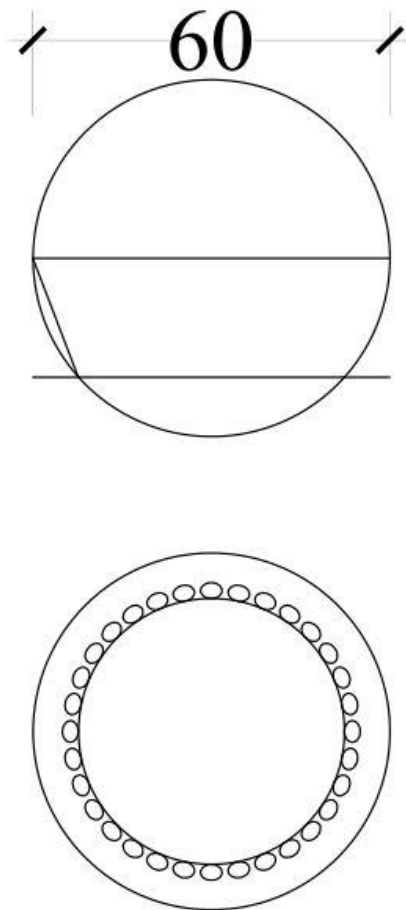
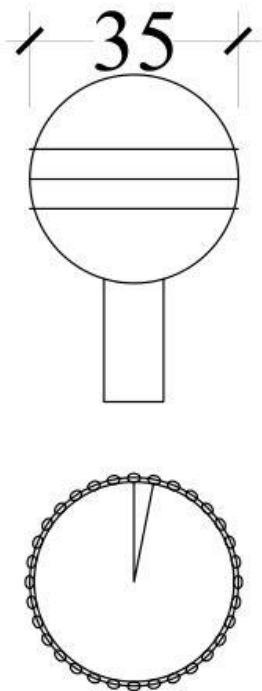
4. Modified Spherical Grip:



DIMENSIONAL DRAWINGS:



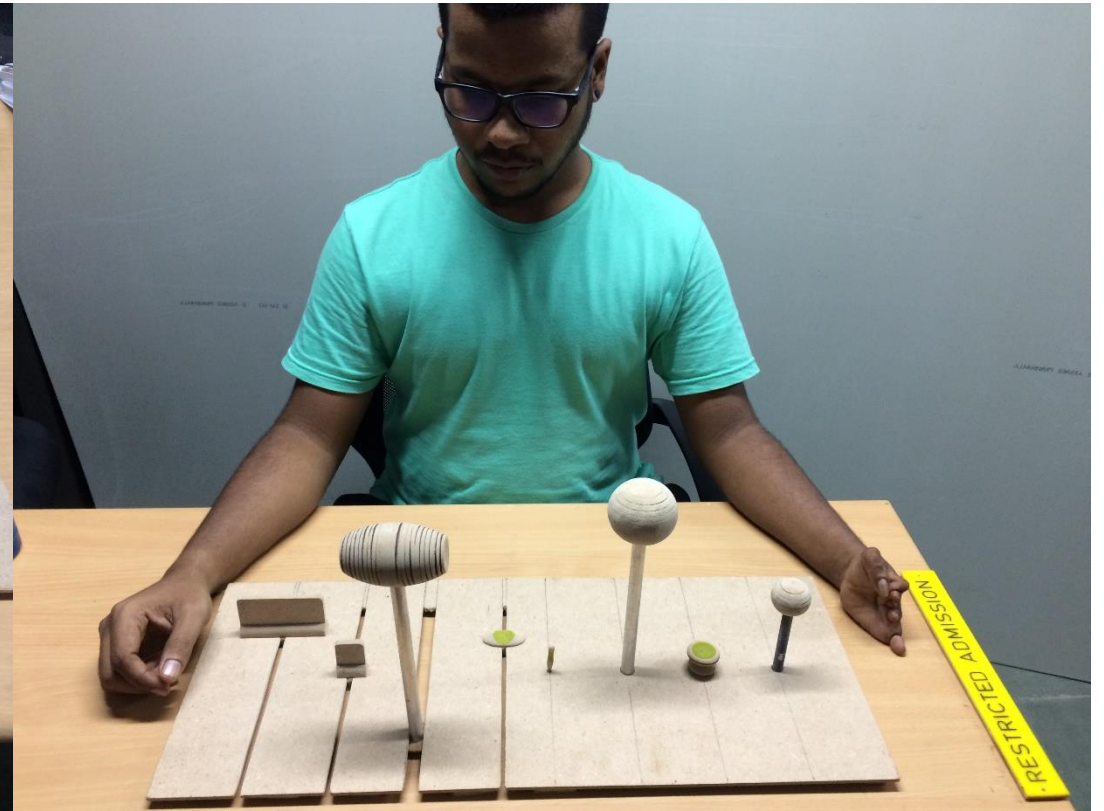
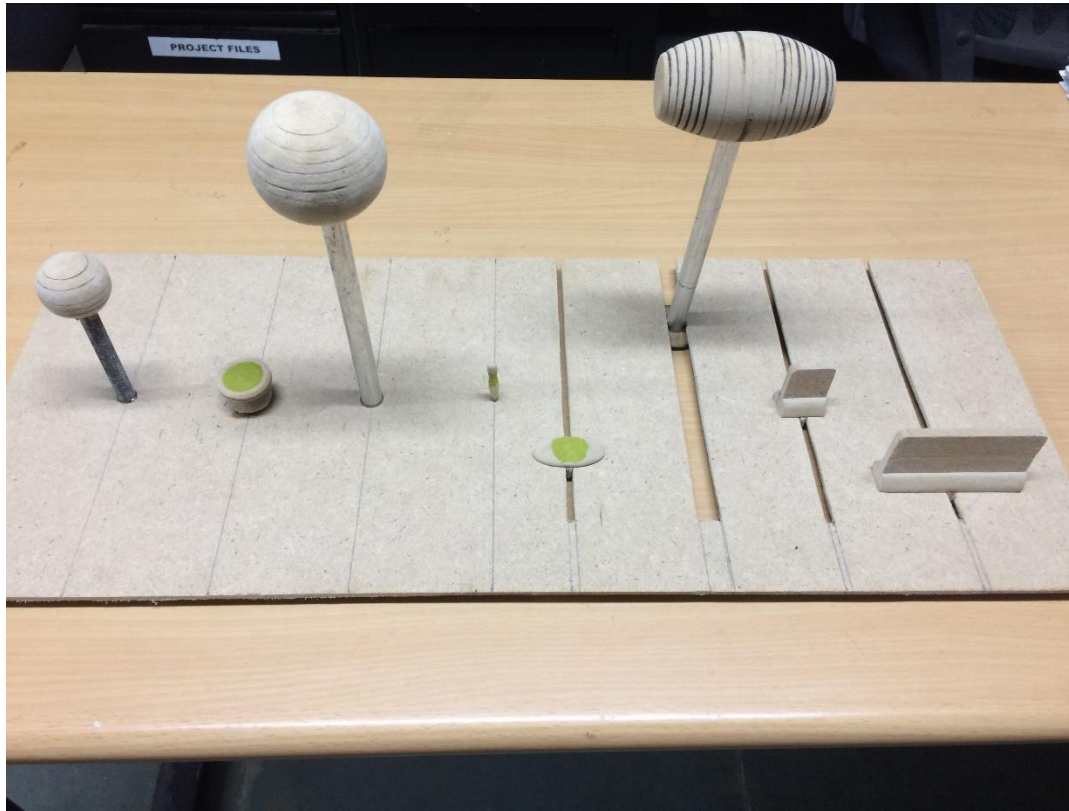
Note: All dimensions are in millimetres



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Testing rig:

The setup is placed at elbow height vertically above the ground.



User testing:

A total of 15 users are considered for user testing to discover 100 % of the usability problems (*Ref: "Nielsen, Jakob. Mathematical model of usability problems. Elsevier, 1994."*)

Evaluation Factors for each control:

- **Intuitiveness of grip:** How intuitive is grip based on shape of the control
- **Force:** Degree of force required to operate with respect to other controls
- **Precision:** Degree of precision of control with respect to other controls
- **Time:** Comfortable usage for a longer duration of time

RESULTS:

1. JOY STICKS

GRIP	GRIP INTUTIVENESS(%)	FORCE (RANK)	PRECISION (RANK)	COMFORT (RANK)
THUMB GRIP	66%	3	2	2
TWO FINGER GRIP	87%	4	1	1
SPHERICAL GRIP	93%	1	4	3
MODIFIED SPHERICAL	87%	2	3	4

2. SLIDERS

GRIP	GRIP INTUTIVENESS(%)	FORCE (RANK)	PRECISION (RANK)	COMFORT (RANK)
SINGLE FINGER	100%	4	1	1
TWO FINGER	87%	3	2	3
LATERAL PINCH	87%	2	3	4
POWER GRIP	100%	1	4	2

Conclusion:

- Grasp changes if the amount of force, precision required changes.
- Shape of control knobs changes drastically for same mode of operation for different force and precision requirements.

References:

1. Sanders, M. S., & McCormick, E. J. (1993). Human factors in engineering and design (7th ed.). New York, NY, England: Mcgraw-Hill Book Company
2. Kinkade, R.G. (1985). Human factors guide for nuclear power plant control room development. United States: IEEE Service Center.
3. Hunt, Darwin P. *The coding of aircraft controls*. AIR FORCE AEROSPACE MEDICAL RESEARCH LAB WRIGHT-PATTERSON AFB OH, 1953.
4. Patkin, Michael. "A checklist for handle design." *Ergonomics Australia On-Line* 15.Suppl (2001).
5. Cutkosky, Mark, and Paul Wright. "Modeling manufacturing grips and correlations with the design of robotic hands." *Robotics and Automation. Proceedings. 1986 IEEE International Conference on*. Vol. 3. IEEE, 1986.
6. Loughborough, ICE Ergonomics. "Consumer products-more by accident than design?." *Human Factors in Consumer Products* (1997): 127.
7. Harih, G., and A. Čretnik. "Interdisciplinary approach to tool-handle design based on medical imaging." *BioMed research international* 2013 (2013).
8. Lewis, Winston G., and C. V. Narayan. "Design and sizing of ergonomic handles for hand tools." *Applied ergonomics* 24.5 (1993): 351-356.

Image 1: <http://www.pbs.org/wgbh/nova/tech/nuclear-control-room.html> accessed on 02-07-2018

Image 2: <http://aviationknowledge.wikidot.com/aviation:cockpit-airplane> accessed on 02-07-2018

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THANK YOU