

CREATIVE ENGINEERING DESIGN

(창의적공학설계)

Current trends...

- ❑ *These days, factual knowledge is available online 24/7 via smartphones.*
- ❑ *“60% of the today 15-year olds are likely to work in jobs that do not exist yet.”*
(World Bank Report, 2018) – How to prepare for the unknown...?
- ❑ *Due to the ongoing digitization, robotics and machine learning, up to 50% of all work activities might be automated by 2030 (McKinsey, 2018)*

21 st century key skills	
✓	Common sense
✓	Creativity
✓	Communication (analog/digital)
✓	Critical thinking
✓	Interdisciplinary cooperation
✓	Entrepreneurship
✓	Social/environmental ethics

Educational goals...



CREATIVITY

Creative concept

Technical solutions



COMMUNICATION

Team presentation

Project management



APPLIED ENGINEERING

Design > 3D model

Making & assembly

GOODBYE 'HAGWON', HELLO ENGLISH!

ACTIVATE YOUR ENGLISH!

BASIC ENGINEERING TERMS!

ENGLISH-SPEAKING ENVIRONMENT!

REDUCE YOUR SHYNESS IN USING ENGLISH!



English proficiency REQUIRED!

Equivalent to TOEIC level B1, min. 550 pts ([intermediate](#))

CED **INITIAL** timeline

Unit	Stage	1 st block	2 nd block	Assignments
1	Lectures (video)	Introduction	Creative problem solving	Video (1)
2		Technical design	3D modeling	Video (2)
3	Creative process	Idea generation	Evaluation, visualization	Idea matrix, sketches
4		Design process	Design practice	Drawing
5		Refinements	3D modeling practice	3D model
6		Briefing on presentations	Preparations	PPT
7		Team presentations	Team presentations	
8	Implementation	Intro to making	File preparation	1 st print job
9		Job files	Printing	
10		Job files	Printing	
11		Intro to assembly	Paint jobs, assembly	
12		-	More finish/assembly	
13		-	Testing & final fixes	Finish prototype
14		Review	PT demonstrations	PT drop off
15	Feedback	Feedback sessions	Feedback sessions	

CED health guidelines (not limited to the Corona virus)

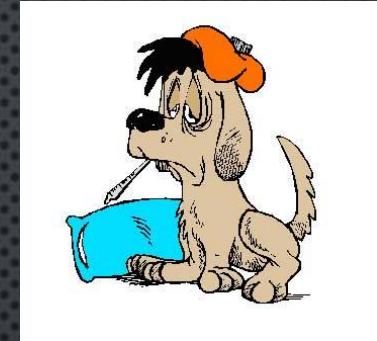
Preventive measures:

Wash your hands before the class starts

Wear a mask during the lecture as long as deemed necessary

We provide good ventilation and disinfect desktops

Use your own laptop/phone instead of classroom equipment



Feeling sick/unwell:

Even if you have only mild symptoms, do not attend the class

Call 1339 and see a doctor, get medication if necessary

Send me doctor's certificate by e-mail to update your records



Briefing on health & safety.

Training on tools/machines.

Protective equipment.

Stay focused.

OUR AIM: ZERO ACCIDENTS AGAIN THIS TERM!



WHILE YOU ARE IN THE CED LAB:

- >> USE IT FOR EVERYTHING THAT HELPS YOU WITH YOUR PROJECT**
- >> AVOID USING IT FOR ACTIVITIES THAT ARE NOT RELATED**

CREATIVITY AND CREATIVE PROBLEM SOLVING

What is creativity?



A SCIENTIFIC DEFINITION [STERNBERG & LUBART 2010]:

A SCIENTIFIC DEFINITION [STERNBERG & LUBART 2010]: "CREATIVITY IS THE ABILITY TO PRODUCE WORK THAT IS BOTH **NOVEL** (I.E. ORIGINAL, UNEXPECTED) AND APPROPRIATE (I.E. USEFUL AND 'ADAPTIVE TO TASK CONSTRAINTS'*)."

*I.E. FEASIBLE

A practical definition [wikipedia.org, Feb 2020]:

"Creativity is a phenomenon whereby something **new and somehow valuable** is formed. The created item may be intangible (such as an idea) or a physical object (such as an invention)."

R. J. Sternberg, T. I. Lubart: The Concept of Creativity: Prospects and Paradigms. In: Handbook of Creativity, Chapter 1, p.3ff. Cambridge University Press 1999

What is creativity?

PRACTICAL APPROACH...

Good
idea

+

Good
idea



ARE INTELLIGENT PEOPLE MORE CREATIVE?

GENERALLY AGREED FINDINGS [STERNBERG & O'HARA 1999]

1. CREATIVE PEOPLE = ABOVE-AVERAGE IQs (>120)
2. IQ > 120: WEAK OR NO CORRELATION WITH INTELLIGENCE.
3. THIS CORRELATION VARIES WITH THE FIELD.



A CERTAIN BASELINE IS REQUIRED TO COME UP WITH IDEAS, TO EVALUATE THE QUALITY OF THOSE IDEAS, AND TO EFFECTIVELY COMMUNICATE THOSE IDEAS TO OTHERS.

R. J. Sternberg, L. A. O'Hara: Creativity and Intelligence. In: R. J. Sternberg: Handbook of Creativity, chapter 13. Cambridge University Press 1999



WHAT KINDS OF MOTIVATION EXIST... AND HOW ARE THESE LINKED TO CREATIVITY?

Intrinsic motivation

Activities that are interesting, satisfying, or challenging

Focus on the challenge and the enjoyment of the work

Beneficial to creativity

Extrinsic motivation

Activities in order to meet some external goal (e.g. exam score)

Focus on external direction, recognition and reward

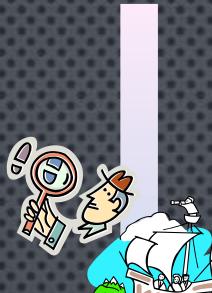
Harmful to creativity



M. A. Collins, T. M. Amabile: Motivation and Creativity. In: R. J. Sternberg: Handbook of Creativity, chapter 15. Cambridge University Press 1999

The creative problem solving process

1. Problem Definition



... to define a goal

2. Idea Generation



... on how to solve the problem

3. Creative Evaluation



... for more practical solutions

4. Idea Judgment



... identify the best solution

5. Solution Implementation



... to bring in the harvest

Step 1 – Problem definition

PROBLEM (문제)

Greek: “pro” = forward

“blem” (ballein) = to throw sth.

Difficulty

Opportunity

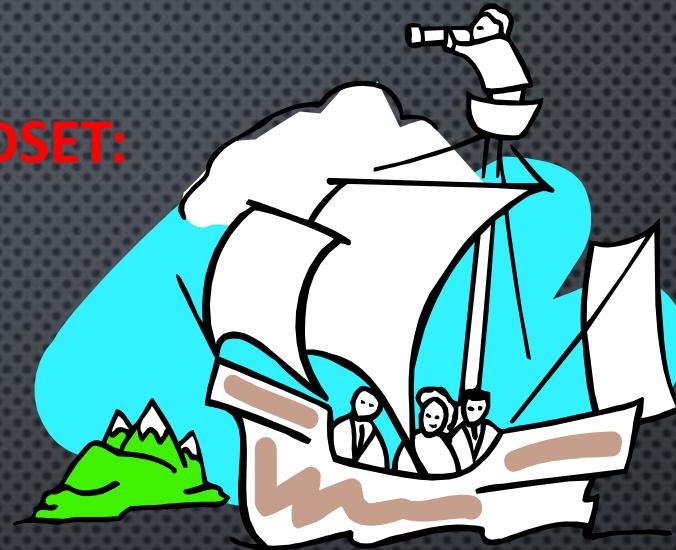
Defining a problem...

OPPORTUNITIES > EXPLORER'S MINDSET:

THE CONTEXT OF A PROBLEM

AN EYE FOR THE "FAR VIEW"

INITIATE A KNOWLEDGE CREATION PROCESS



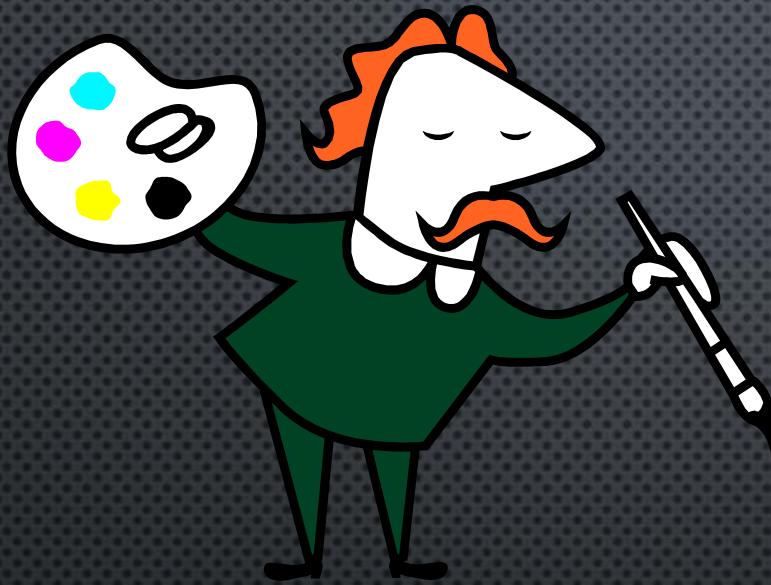
Difficulties > Detective's mindset:

deals with crisis

analyses root causes

collects as much related info as possible

Step 2 – Idea Generation



ARTIST'S MINDSET:

IMAGINATION AND FEELINGS
ONLY FEW RESTRICTIONS APPLY
MOSTLY RIGHT-BRAIN DOMINATED

Creative thinking techniques...

Brainstorming, Mindmapping, Idea matrix, etc.

Brainstorming

=> FORCED MENTAL ACTIVITY OF COMING UP WITH NEW IDEAS

=> WORKS BEST WHEN 3-10 PEOPLE INVOLVED

The four rules of brainstorming [E. Lumsdaine 1999]:

- 1 – Generate as many solutions as possible.
- 2 – Wild ideas are welcome.
- 3 – “Hitchhiking” is encouraged.
- 4 – No criticism is allowed.



Mindmapping

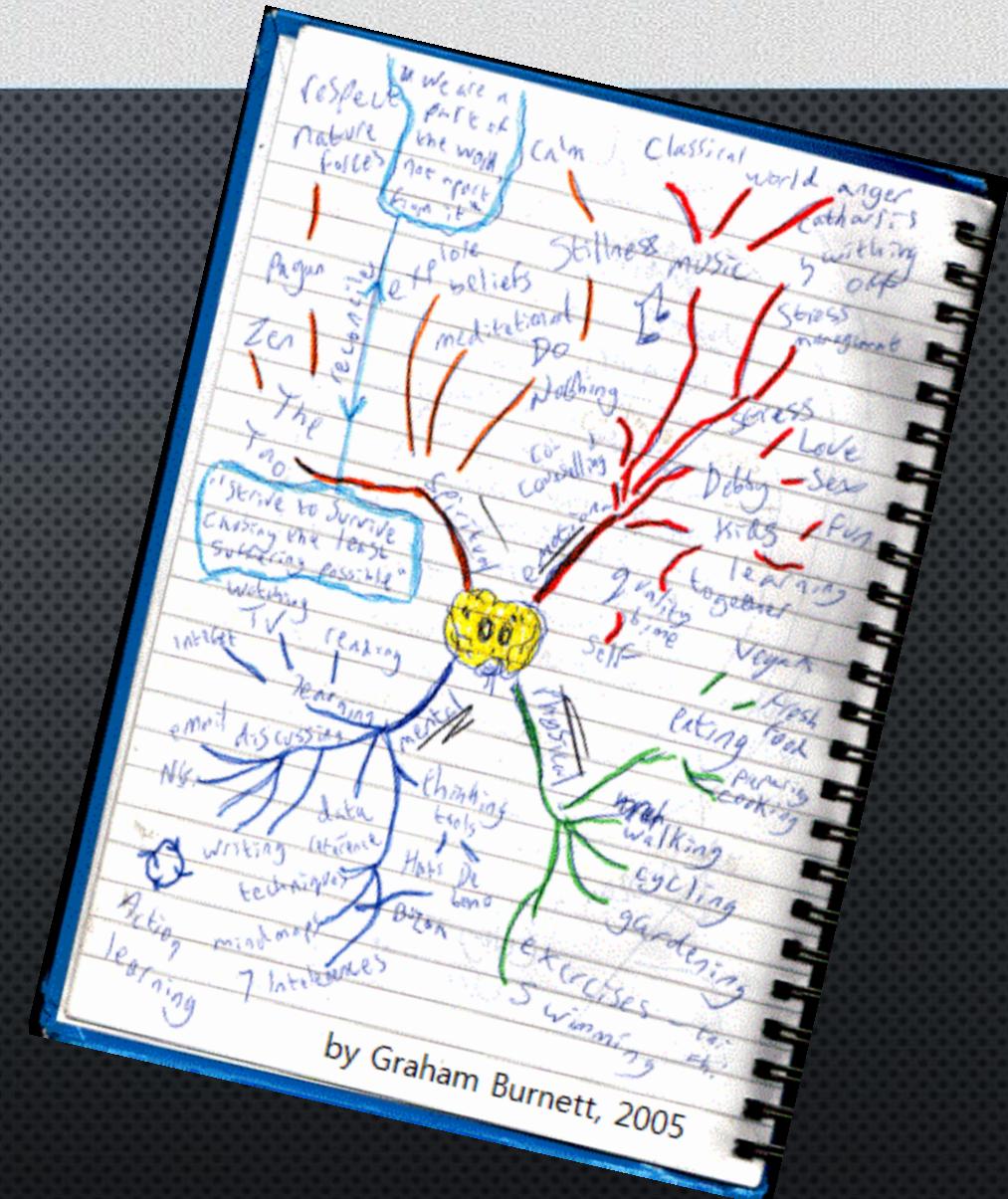
DIAGRAM TO VISUALIZE INFORMATION AROUND A CENTRAL TOPIC

SEVERAL IDEAS ADDED AROUND THE TOPIC AND SORTED IN CATEGORIES

DIFFERENT COLOR ASSIGNED TO EACH BRANCH

LESSER CATEGORIES SHOWN AS SUB-BRANCHES

KIND OF A SPIDER DIAGRAM



Idea matrix

	skills hobbies	graphic design	3D visuals	cartoons/ illustration	animation	video course creation
Tang Soo Do (Korean Karate)						
Dogs/dog walking						
Blogging						
Doodling ideas						
Podcasts						

blank

	skills hobbies	graphic design	3D visuals	cartoons/ illustration	animation	video course creation
Tang Soo Do (Korean Karate)	graphic design for martial arts clubs. Personalize Martial arts products Design gifts/t-shirts for martial artists	Create potential products Designs for martial arts	Create and sell martial arts cartoons on products Create club mascots Create a cartoon book funny side of martial arts	Create explainer videos for martial arts clubs or people selling equipment.	Help martial arts experts create online courses. Teach martial artists how to create a course	
Dogs/dog walking	Target dog based businesses for graphic design Design dog products	Help pet in their pet Create a blog	Create illustrations of people and their dogs. Create illustrations dog breeds and sell or dog shows. Create humorous dog books with cartoons	Create animated adverts for dog businesses	Help dog trainers and groomers create video courses	
Blogging	Create a blog about graphic with a local target	Create a blog for local experts and sell their courses	Create and sell kinetic text animations using key points from a blog post.	Create video course on blogging. Interview best bloggers. Offer video course creation to bloggers who don't have courses.		
Doodling ideas	Offer a doodling service at live events, to cover key points of	-	Create animations for people showing how their idea developed into a product	Create a course on using doodles to get ideas. Help people plan out their courses with doodles storyboards		
Podcasts	Create graphic design podcast to encourage business and give ideas to potential clients.	Start a podcast on very simple 3D self courses	Create illustrations for podcast covers/images	Create animations to turn an audio podcast into a video	Help podcast creators create a course	

A table with one set of criteria in the top row, the other set of criteria in the left column. Then try to find connections...

ideamedic.com/generate-ideas-idea-matrix/

completed

Step 3 – Idea Evaluation

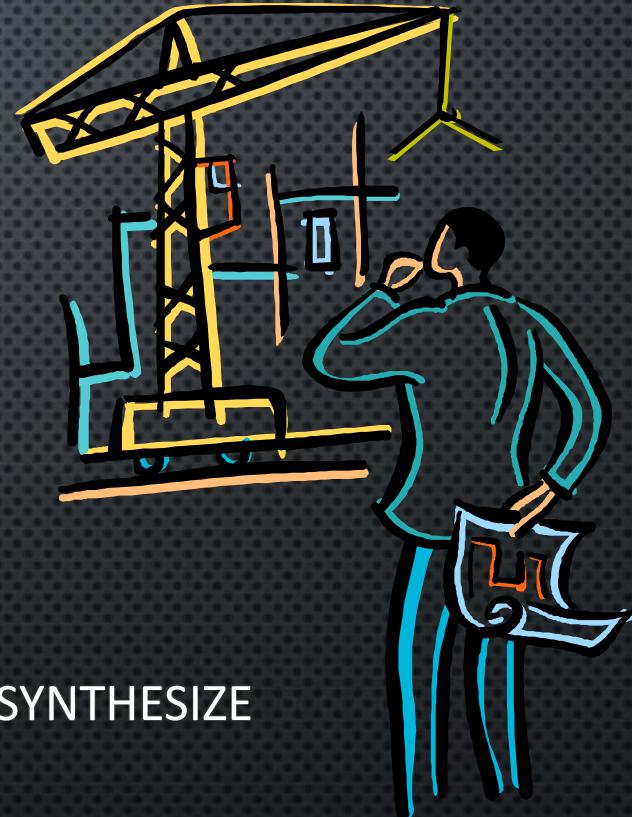
How to turn your initial, “crazy” ideas into better and more practical concepts?

ENGINEER'S MINDSET:

PUT IDEAS TO PRACTICAL USE

DESIGN, BUILD, CATEGORIZE, COMBINE, DEVELOP, SYNTHESIZE

CONCEPTUAL & ANALYTICAL SKILLS



How to evaluate your initial ideas?

The four rules of creative idea evaluation [Lumsdaine 1999]:

- 1 Look for **quality** and better ideas.
- 2 Make “wild” ideas more **practical**.
- 3 Synthesize ideas to obtain more **complete** solutions.
- 4 Maintain a **positive** attitude and avoid critical judgment.



THE JUDGE'S MINDSET:

WANTS TO FIND THE BEST IDEA, NOT THE PERFECT IDEA (PRAGMATIC)

ASSESSES THE CIRCUMSTANCES WITH A CRITICAL, CONSCIOUS MIND (CRITICAL THINKING)

MAKES WISE DECISIONS BASED ON EVIDENCE AND PRINCIPLES (INDEPENDENT)

*“Good judgment comes from experience. Experience comes from poor judgment.”
(Proverb)*

Idea judgment tools

1] Judgment by instinct... rely on your gut feeling (subjective!). Works best for clear or simple scenarios, or where analytical skills are not helpful.

2] Analytical approach... lists several evaluation criteria (factors that influence the problem) against the options you have. Optionally, the criteria can be weighted according to their importance.

3] If you don't have time...

Judgment by vote

Judgment based on a single criterion

Example of an Advantage/Disadvantage Matrix:			
List of Criteria	Concepts		
	'Lasagne'	'Pomodoro'	'di Mare'
Creative	+	0	+
Looks cool	+	0	+
Simple operations	0	+	+
Time input	0	+	0
Easy to explain	0	+	+
Total	+	2	3
	0	3	2
			1

THE PRODUCER'S MINDSET:

WANTS TO TAKE ACTION, GET THINGS DONE
GOOD PLANNER, MANAGER AND COMMUNICATOR



Depending on the project, the implementation phase can take long:

“The most difficult thing in the world is to put your ideas into action.”

Johann Wolfgang von Goethe, German poet

Project management

- ⇒ TEAM management
- ⇒ QUALITY management
- ⇒ RISK management
- ⇒ COST management
- ⇒ TIME management

Typical time wasters

- ❖ Wrong priorities
- ❖ Bad planning (meetings, outputs)
- ❖ Being unorganized
- ❖ Procrastination (Habit of postponing tasks)
- ❖ Lack of interest/communication

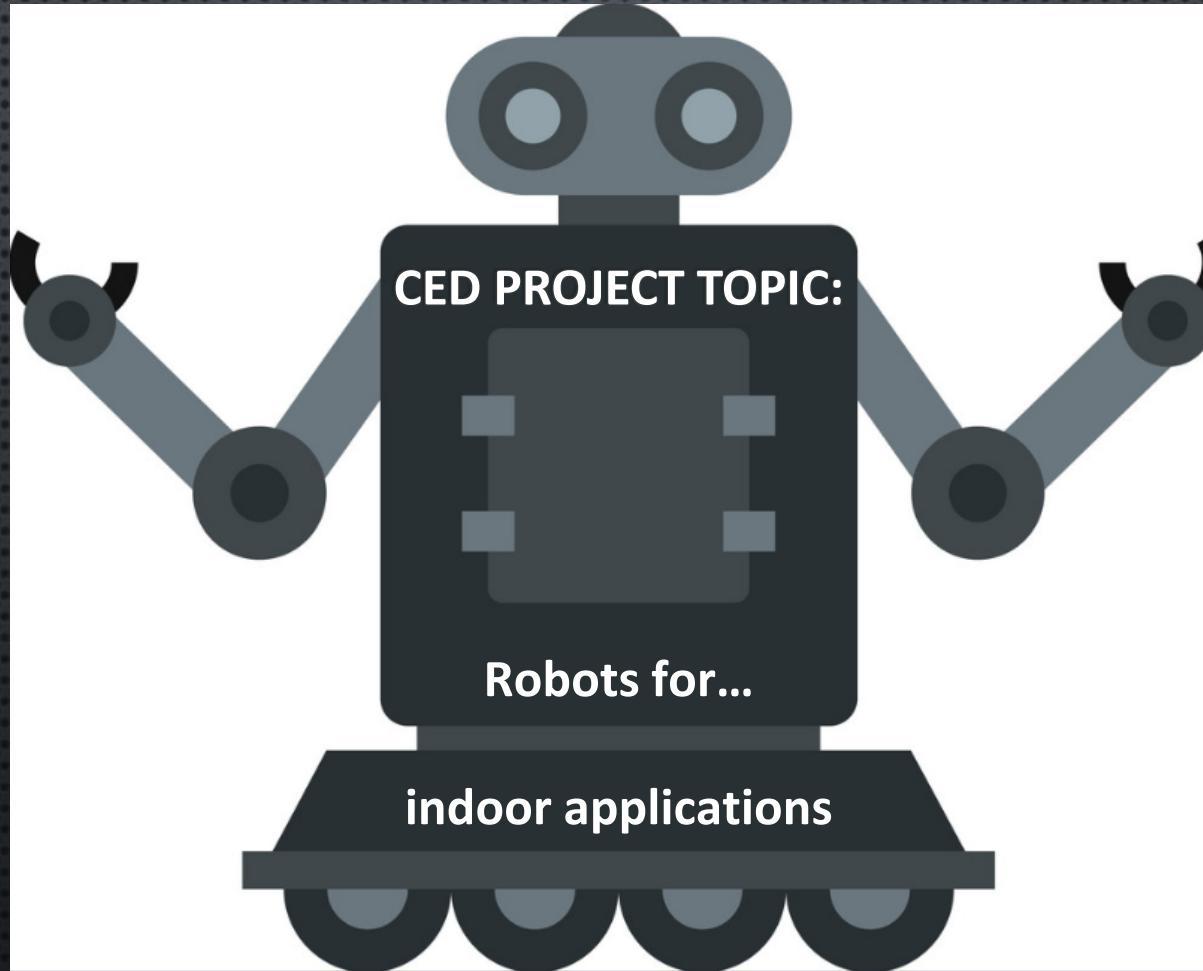
TIME management

Further reading (creative problem solving)

E. Lumsdaine, M. Lumsdaine, J. W. Shelnutt:
Creative Problem Solving and Engineering Design.
McGraw-Hill, Inc. 1999. p. 177-312
Library: 620.0042 L959c

홍현필, 김대석, 박성균:
창의공학설계입문
서울: GS인터비전, 2011.
Library: 620.0042 홍752 ㅊ

Your project topic



VectorStock.com/14373089

Indoor robots – technology trends

Vacuum robots commercially available from many brands...



*iRobot Roomba, Neato,
Ecovacs, LG, Samsung,
Electrolux, etc...*

techhive.com/article/3269782/smart-appliance/best-robot-vacuum-cleaners.html

*More robots under
development at Amazon,
Alphabet/Google, Huawei,
etc.!*

Assistant robot prototypes for domestic and commercial use by Samsung, LG, and others.

Robot Maid



Kuri / Mayfield

Serving Robot / Porter Robot / Shopping Cart



[LG “CLOi” work robot series for hotels,
airports, and supermarkets]

Health care bots by Samsung



“Bot Air” / “Bot Care” / “Bot Retail”

What kind of bots can YOU think of?



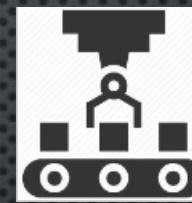
Services/businesses



Healthcare/elderly



Buildings/maintenance



Construction/factories



Farming/livestock

*Indoor robots are best for tasks
that are **SIMPLE, REPETITIVE,**
and require MOBILITY*

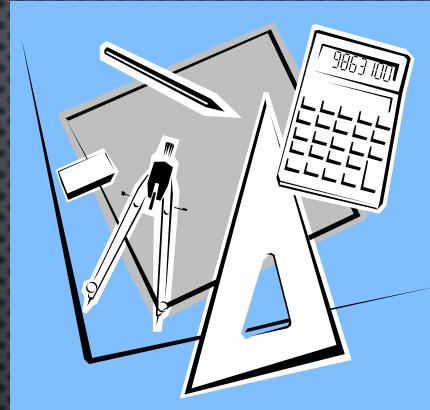
UNIT 2:

- >> INTRODUCTION TO CREATIVITY & CREATIVE PROBLEM SOLVING
- >> A FEW THOUGHTS ABOUT ROBOTS

NEXT:

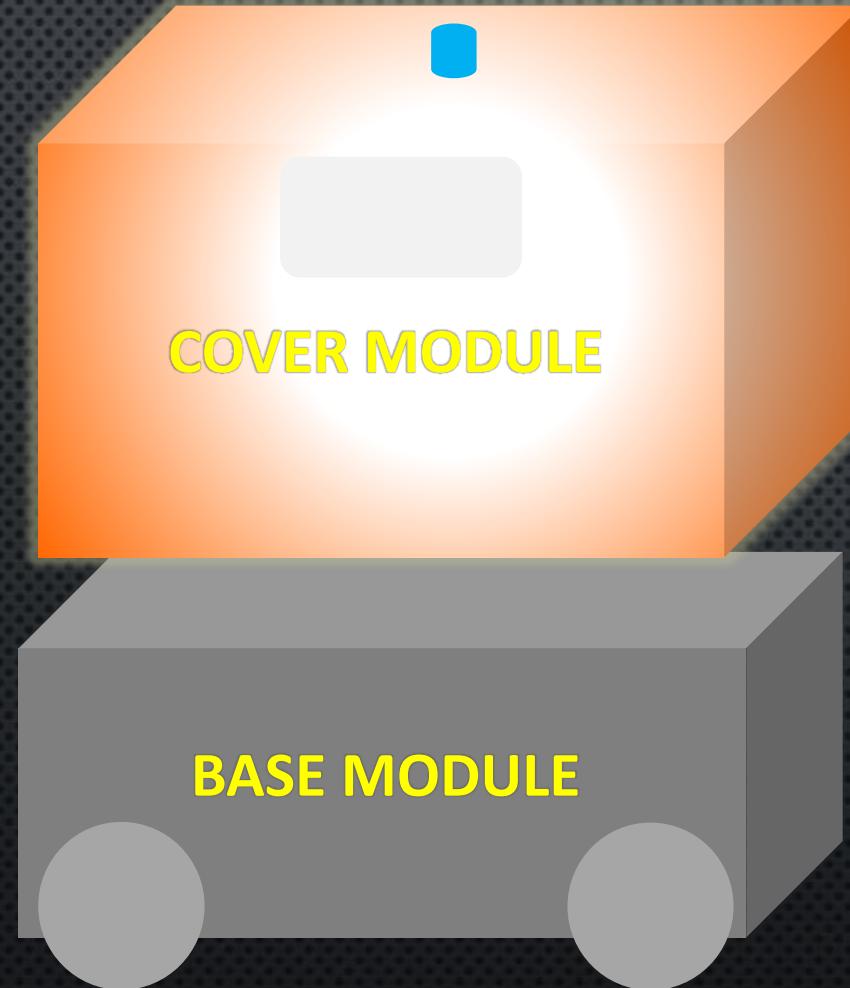
- >> TECHNICAL DESIGN ISSUES





INTRODUCTION TO TECHNICAL DESIGN ASPECTS

Design breakdown...

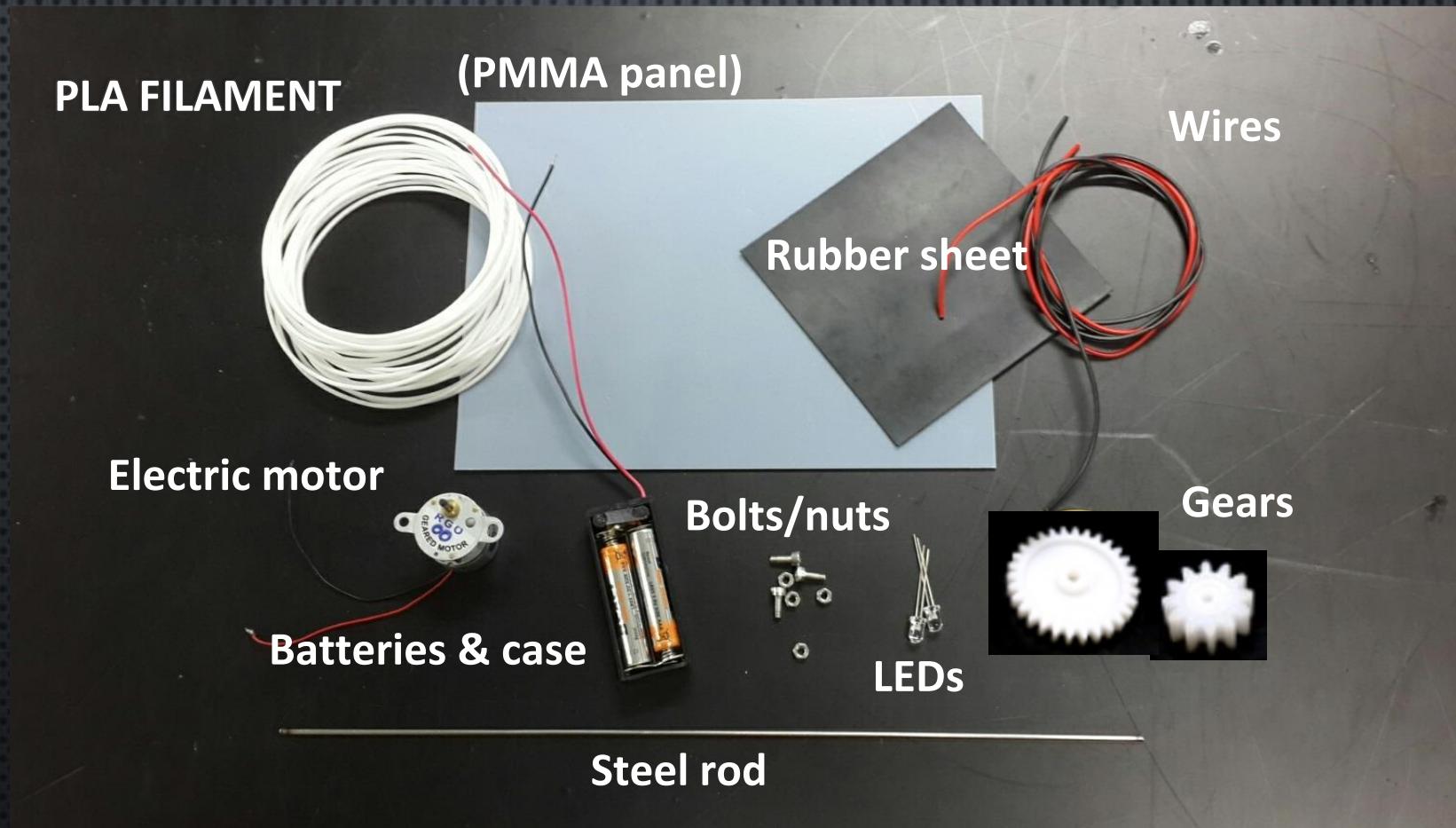


- Cover (shell)
- Features (your idea)
- User interface
- LEDs

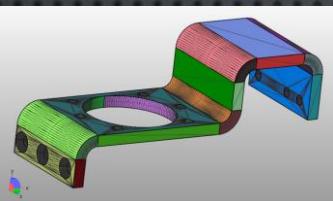
- Base panel/tray
- Axles & wheels
- Motor & gears
- Power source (battery)

Your parts & materials

Use parts as received OR transform into desired shape



Your tools



- CAD software → 3D modeling
- 3D printer → build your model

- Drill & cutting tools
- Paint shop
- Assembly tools



Design focus 1: Size matters

Too big

Heavy

Slow

Difficult to make...



Too small

No space

Crammed

Difficult to assemble...



Sweet spot

Not heavy

Not slow

Not crammed

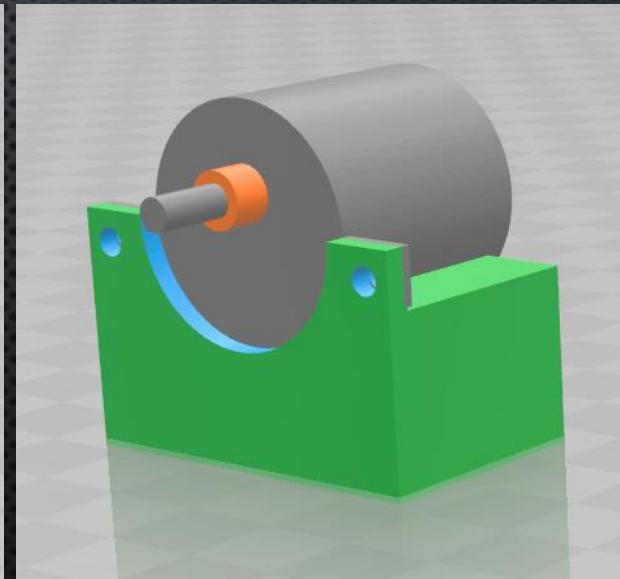
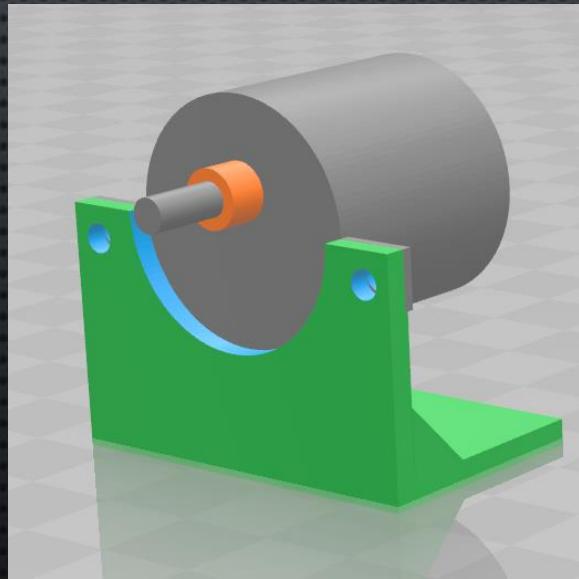
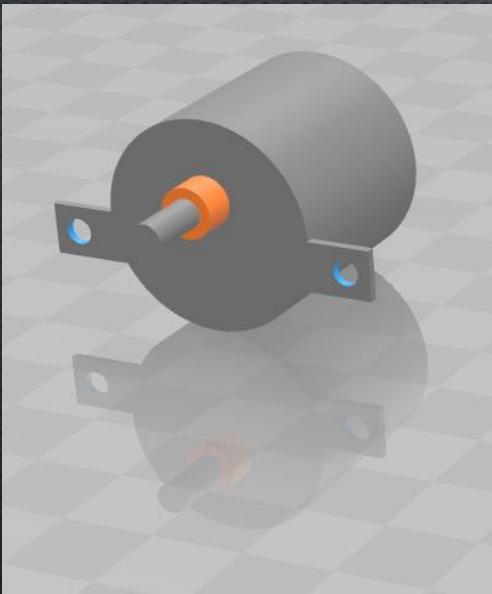
Easy to make

Easy to assemble

Design focus 2: Motor socket

How to attach the motor?

- ❖ L-shaped or U-shaped bracket
- ❖ Holes match shaft/screw diameters
- ❖ Many design options...

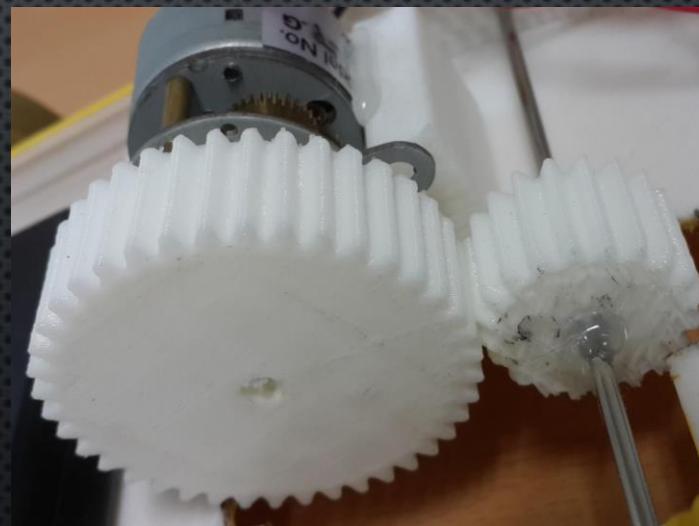
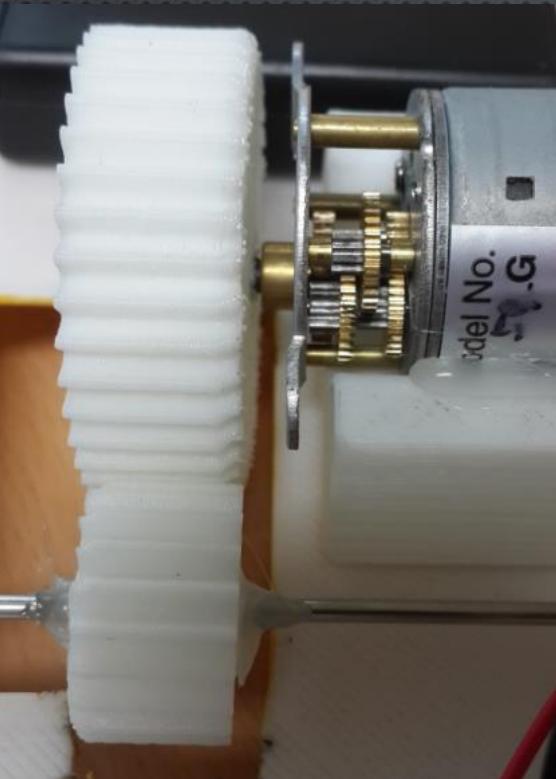


Design focus 3: Transmission

Motor shaft rotation -----> Axle rotation

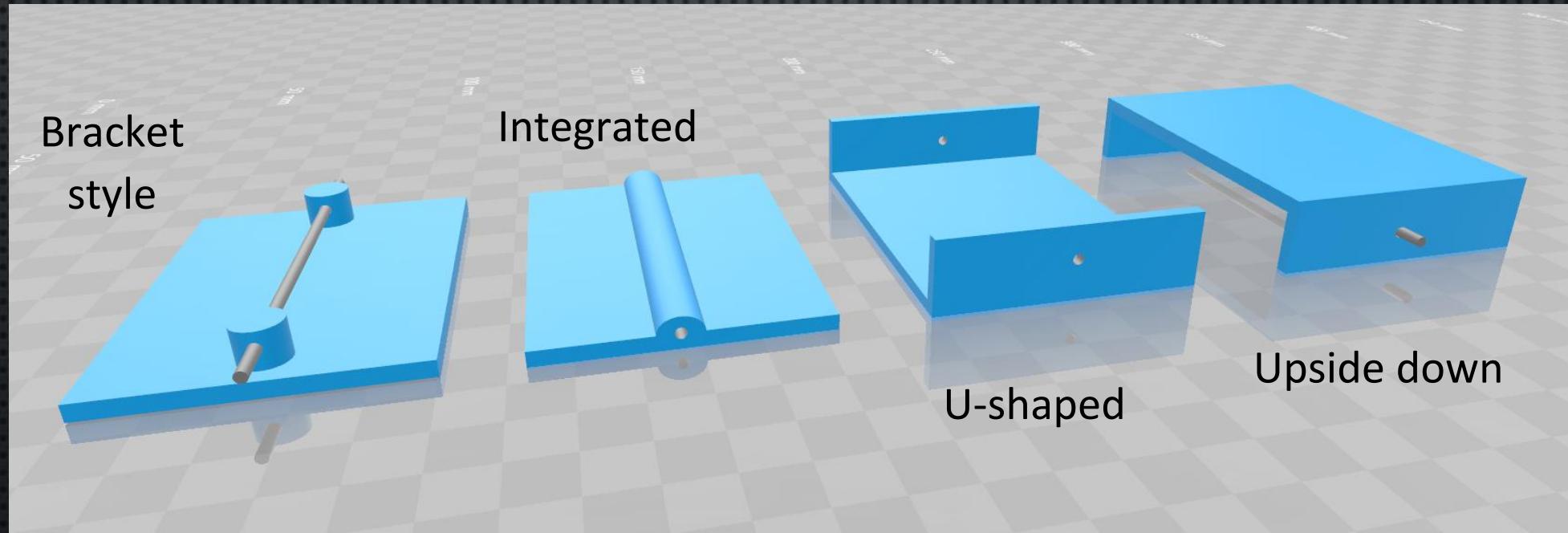
Many types → We use a geared system

Important: Horizontal alignment, shaft distance



Design focus 4: Axle supports

- ❖ Mounting-bracket / axle-holder feature
- ❖ Integrated in your car base
- ❖ Many design option (examples given below)
- ❖ Hole diameter = axle diameter + 0.2 mm
- ❖ Consider space for pulley/gear (driven axle)



Design focus 5: Wheel design



Rim parameters:



diameter



thickness



patterns

Focus 6: Feasibility considerations

- **3D modeling** → simple shapes, easy to model
- **3D printing** → part size matches printer size
- **Assembly** → Easy and accurate
- **In-service** → Easy battery change, part change



UNIT 3:

>> TECHNICAL DESIGN ISSUES

NEXT:

>> CREATIVE PROCESS (INDIVIDUAL PROJECTS)

