

# **BEST DESIGN PROCESS**

## BEST DESIGN PROCESS

The four main phases of design are:

<b>Phase</b>	<b>What You Get</b>	<b>Example</b>
Conceptual Design	Concept	Four wheels, scoop, scissor arm
Preliminary Design	Model or mockup	Cardboard model of concept
Detailed Design	Prototype	Robot from kit parts
Production Design	Product	Refined robot from kit parts

In the BEST suggested schedule, you have **1 week** for each phase.

## CONCEPTUAL DESIGN

HOW DO YOU COME UP WITH A CONCEPT? There are 8 steps.

STEP 1: LIST ALL REQUIREMENTS FOR THE ROBOT. This list is generated after **reviewing the rules** and developing a general **strategy**. Draw a picture of the playing field and sketch strategies.

Example:

- Meet weight requirements
- Meet size requirements
- Negotiate course
- Have high reach
- Easy to operate
- Pick up gamepieces

STEP 2: BREAK DOWN LIST INTO NEEDS AND WANTS

<b>Requirement</b>	<b>Need or Want</b>
Meet weight requirements	Need
Meet size requirements	Need
Negotiate course	Want
Have high reach	Want
Easy to operate	Want
Pick up gamepieces	Need

**STEP 3: SET DESIGN TARGETS FOR EACH REQUIREMENT:**

<b>Requirement</b>	<b>Need or Want</b>	<b>Design Target</b>
Meet weight requirements	Need	Less than 24 lbs
Meet size requirements	Need	Less than 23x23x23
Negotiate course	Want	Climb 5 inch ledge
Have high reach	Want	Reach 50 inches
Easy to operate	Want	One function per motor
Pick up gamepieces	Need	Pick up soup can and lawn chair

**STEP 4: SELECT THE RELATIVE IMPORTANCE FOR ALL WANTS USING PAIRWISE COMPARISON**

	Negotiate Course	High Reach	Easy to Operate	Total	Weight
Negotiate Course	1 1			2	2/3
High Reach	0	1		1	1/3
Easy to Operate	0	0		0	0/3
			Total	3	

STEP 5: LIST ALL ROBOT FUNCTIONS

MOVE TO SCORING AREA

OBTAIN GAME PIECE

SECURE GAME PIECE

LIFT GAME PIECE

STEP 6: DEVELOP CONCEPTS FOR EACH FUNCTION

	<b>FUNCTION</b>	<b>CONCEPT (MAKE SKETCH)</b>
A	MOVE TO SCORING AREA	Chassis with wheels, chassis with treads, frame with wheels
B	OBTAIN GAME PIECE	Jaw, scoop, velcro
C	SECURE GAME PIECE	Spring, lock, rubber band
D	LIFT GAME PIECE	Lever arm, fork lift, scissor lift

## STEP 7: ASSIGN A LETTER AND NUMBER TO EACH CONCEPT

(Make a sketch of each)

A1 – Chassis with wheels

A2 - Chassis with treads

A3 - Frame with wheels

B1 – Jaw

B2 - Scoop

B3 – Velcro

C1 – Spring

C2 – Lock

C3 – Rubber Band

D1 – Level arm

D2 – Fork lift

D3 – Scissor lift

STEP 8: EVALUATE CONCEPTS USING:

1. Feasibility – can this be done?
2. Go / No Go – does it meet all needs?
3. Decision Matrix – does it meet wants?

Feasibility

<b>Concept</b>	<b>Feasible?</b>
A1 – Chassis with wheels	Yes
A2 - Chassis with treads	Yes
A3 - Frame with wheels	Yes
B1 – Jaw	Yes
B2 - Scoop	Yes
B3 – Velcro	No
C1 – Spring	Yes
C2 – Lock	No
C3 – Rubber Band	Yes
D1 – Level arm	Yes
D2 – Fork lift	No
D3 – Scissor lift	Yes

Go – NoGo (needs only)

<b>Requirement</b>	<b>A1</b>	<b>A2</b>	<b>A3</b>
Meet weight requirements	Yes	Yes	Yes
Meet size requirements	Yes	Yes	Yes
Pick up gamepieces	Yes	Yes	Yes

<b>Requirement</b>	<b>B1</b>	<b>B2</b>	<b>B3 not feasible</b>
Meet weight requirements	Yes	Yes	
Meet size requirements	Yes	Yes	
Pick up gamepieces	Yes	Yes	

Etc...

Decision Matrix (wants only)

+ means that concept is better at meeting the requirement than the datum

- means that concept is worse at meeting the requirement than the datum

s means that concept is the same at meeting the requirement as the datum

<b>Requirement</b>	<b>Weight</b>	<b>A1</b>	<b>A2</b>	<b>A3</b>
Negotiate course	.66	Datum	-	S
Have high reach	.33	Datum	+	-
Easy to operate	0	Datum	+	-
Total Plus			2	0
Total Minus			1	2
Overall			1	-2
Weighted Plus			.33	0
Weighted Minus			.66	.33
Overall Weighted			-.33	-.33

The above chart shows A1 to be the preferred concept for the “A” function (move to scoring area)

Continue this for all functions. The end result will be an overall concept.

**Example:** Chassis with wheels, jaw, rubber band lock and lever arm.

## **PRELIMINARY DESIGN**

STEP 1: Take the concept and sketch an overall configuration. Do not worry about the details at this point. Label the major components.

STEP 2: Sketch each of the major components on a separate sheet. Put enough information on the sketch so that the component can be made from a piece of cardboard. Try to keep the overall size requirement in mind.

STEP 3: Make cardboard pieces from the sketches and assemble.

STEP 4: Evaluate the model and ensure it meets all of the requirements. Make modifications as needed. Try it on the course and ensure it fits in the 24x24x24 inch box.

You now have a model of the robot.

## **DETAILED DESIGN**

STEP 1: Disassemble the cardboard model and mark-up each sketch to show the final dimensions. Also indicate on the sketch the material that will be used to make the real part.

STEP 2: Create sketches for parts that are not on the model such as wheel mounts, motor mounts, etc. Consider lifting requirements, torque available from motors, etc.

STEP 3: Create an overall assembly sketch of all parts. Label each part.

You now have a detailed design of the robot.

Fabricate each part from the sketch and assemble the robot. You now have a prototype robot.

## **PRODUCTION DESIGN**

STEP 1: After testing the prototype, make changes as required.

STEP 2: Once the robot is in its final configuration, make detailed drawings of each part.