Mechanical Engineering Design II

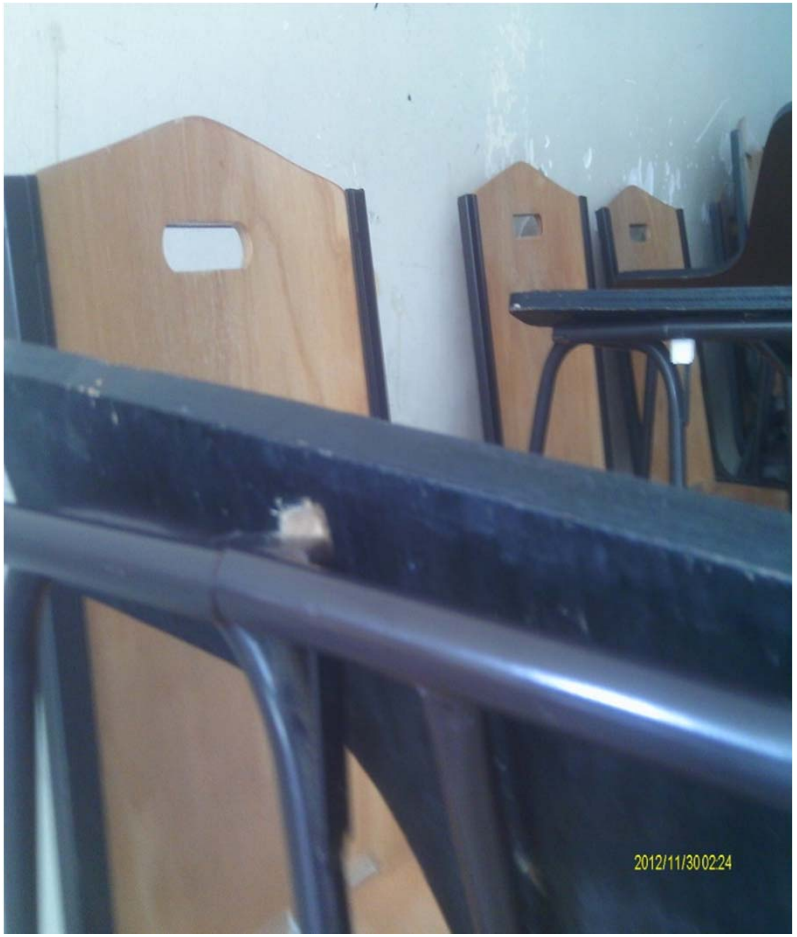
Ninth & Tenth Lectures

Decision Making

Portable Chair

Problems of Existing Design:

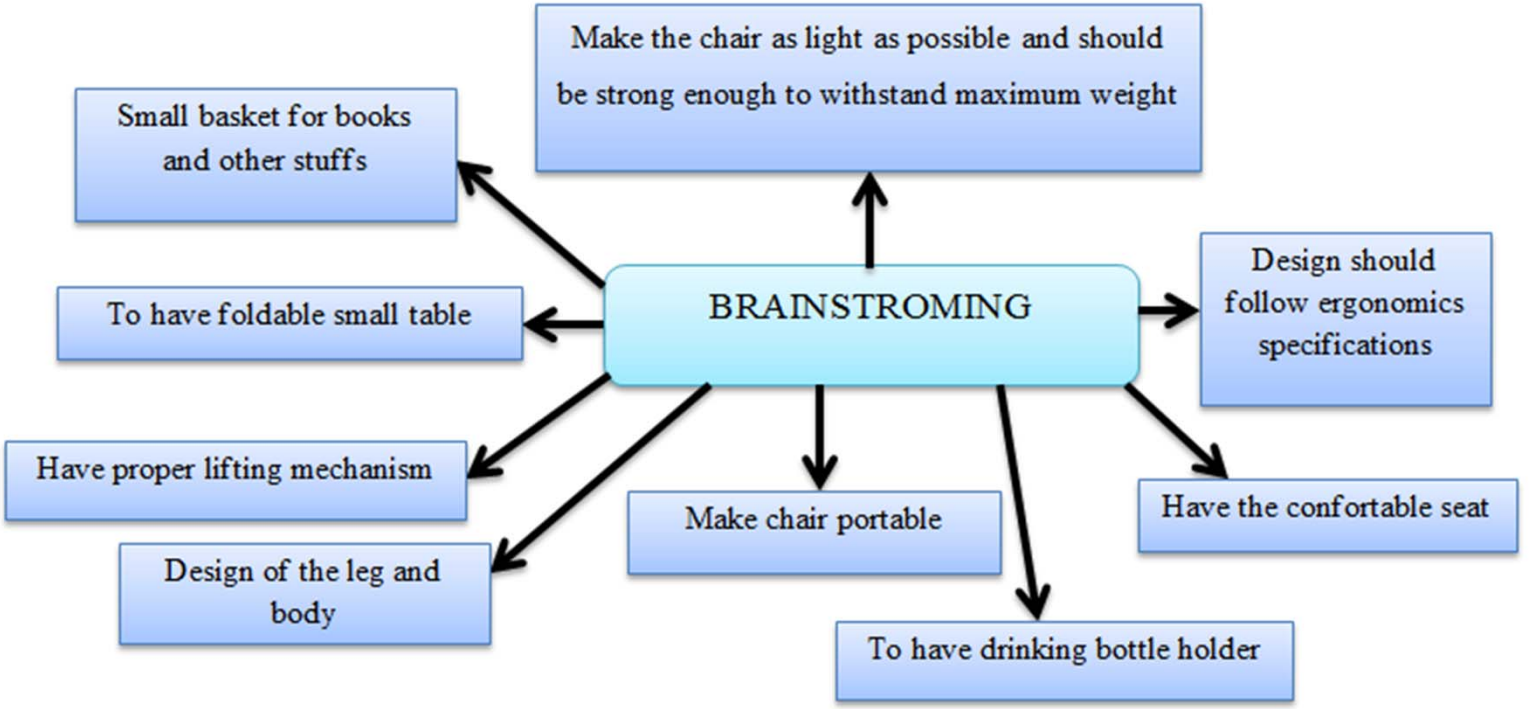
Bending of holding frame



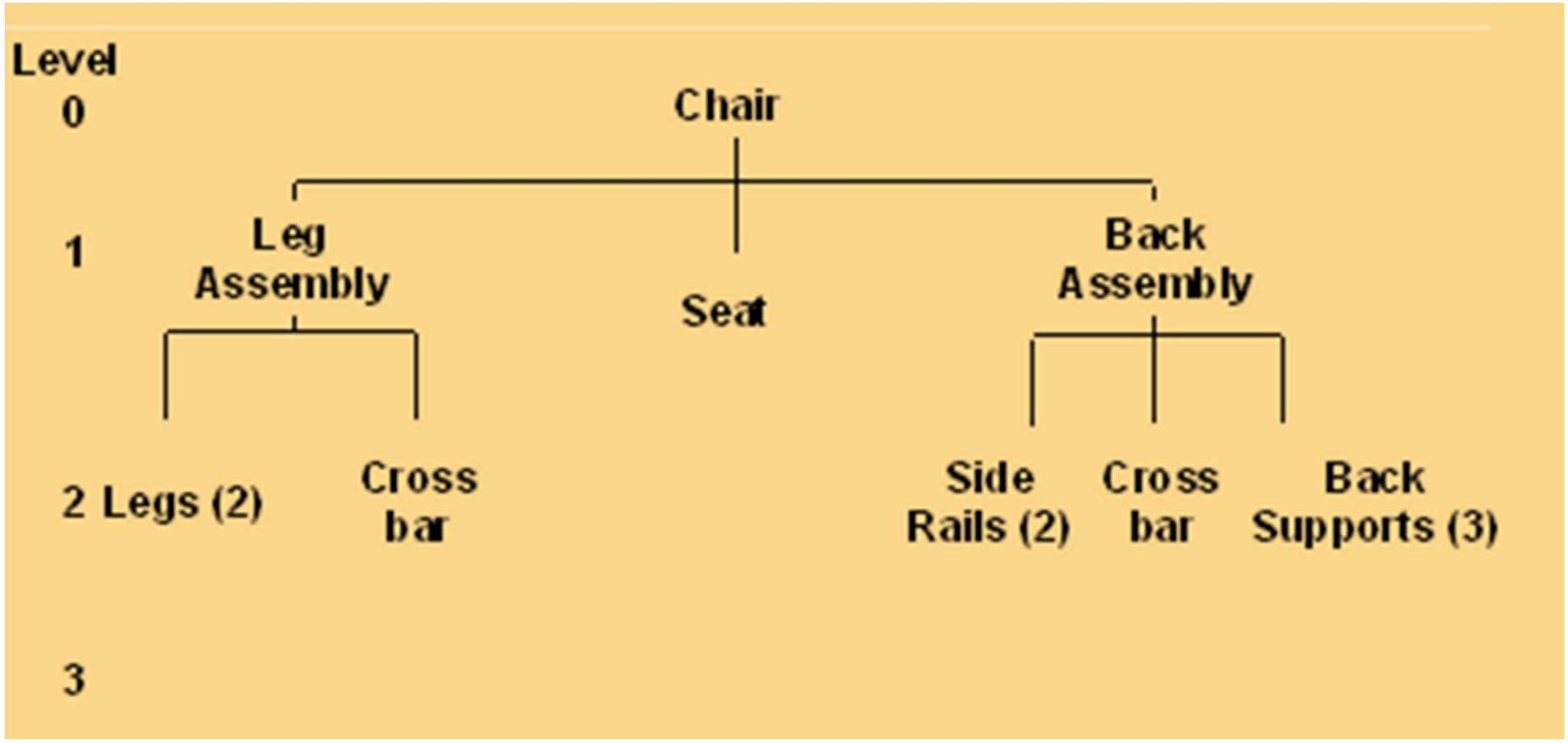
Broken small table

Paper is used to eliminate the shaking of the small table

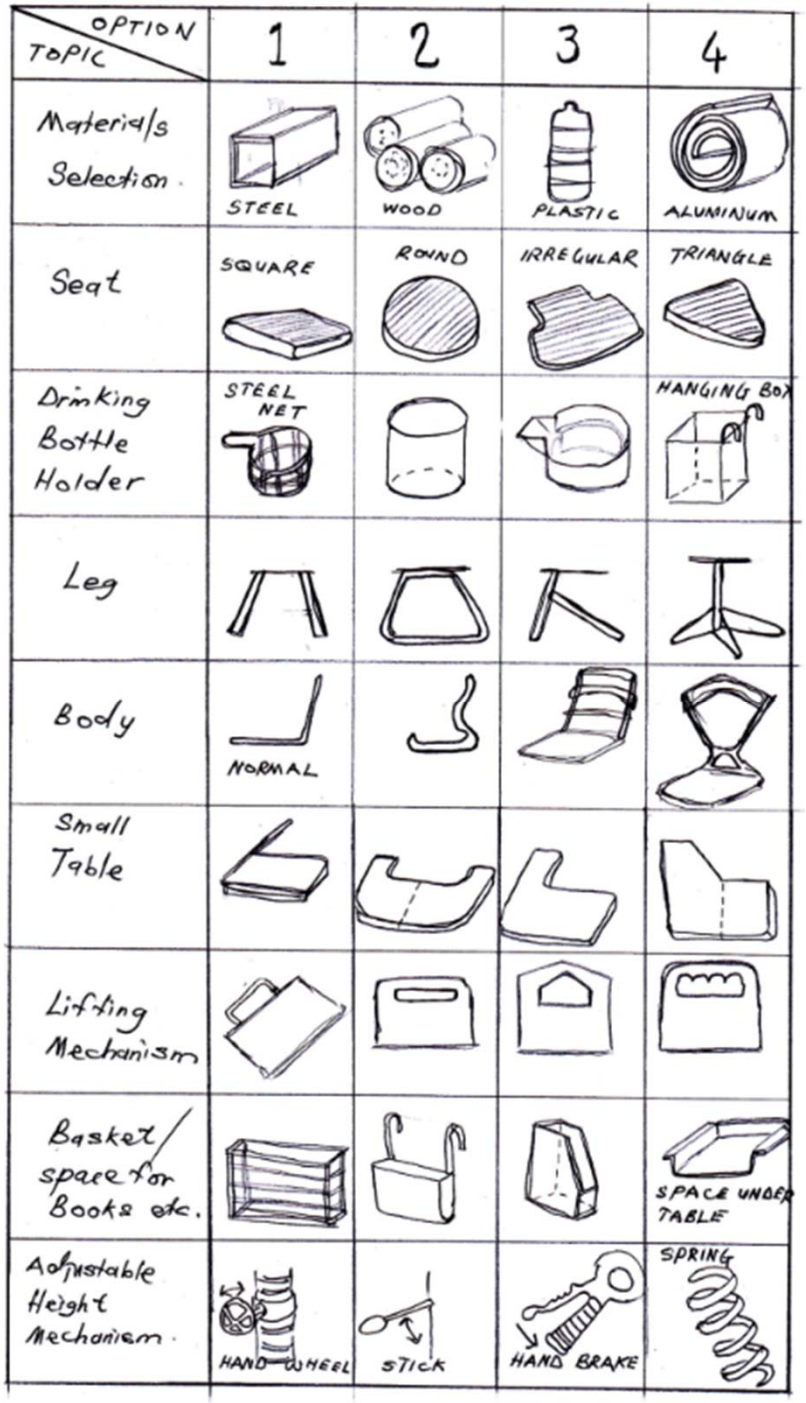
We used brainstorming method to generate as much idea as possible. It is the most common method used for generating ideas.



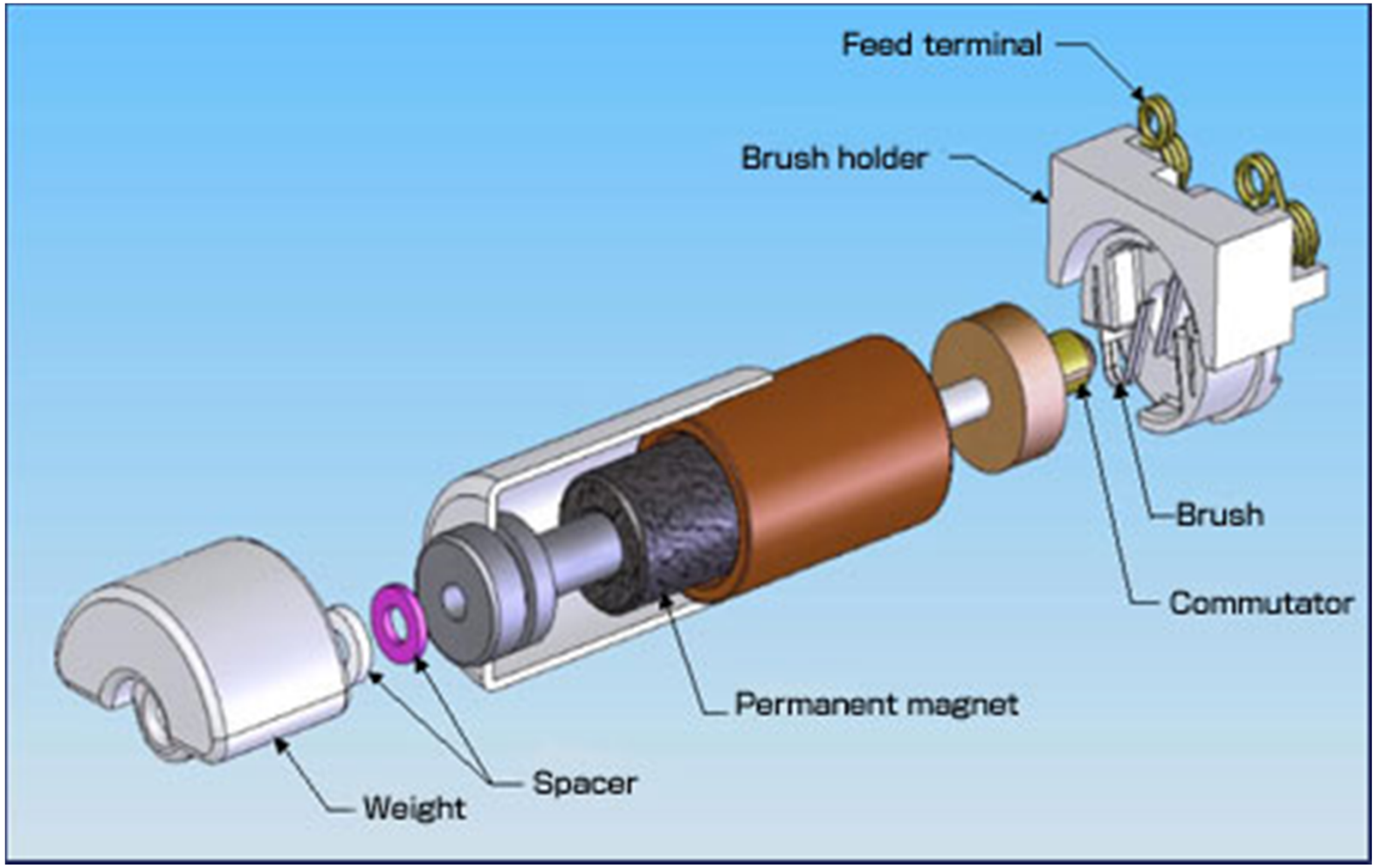
Design Tree

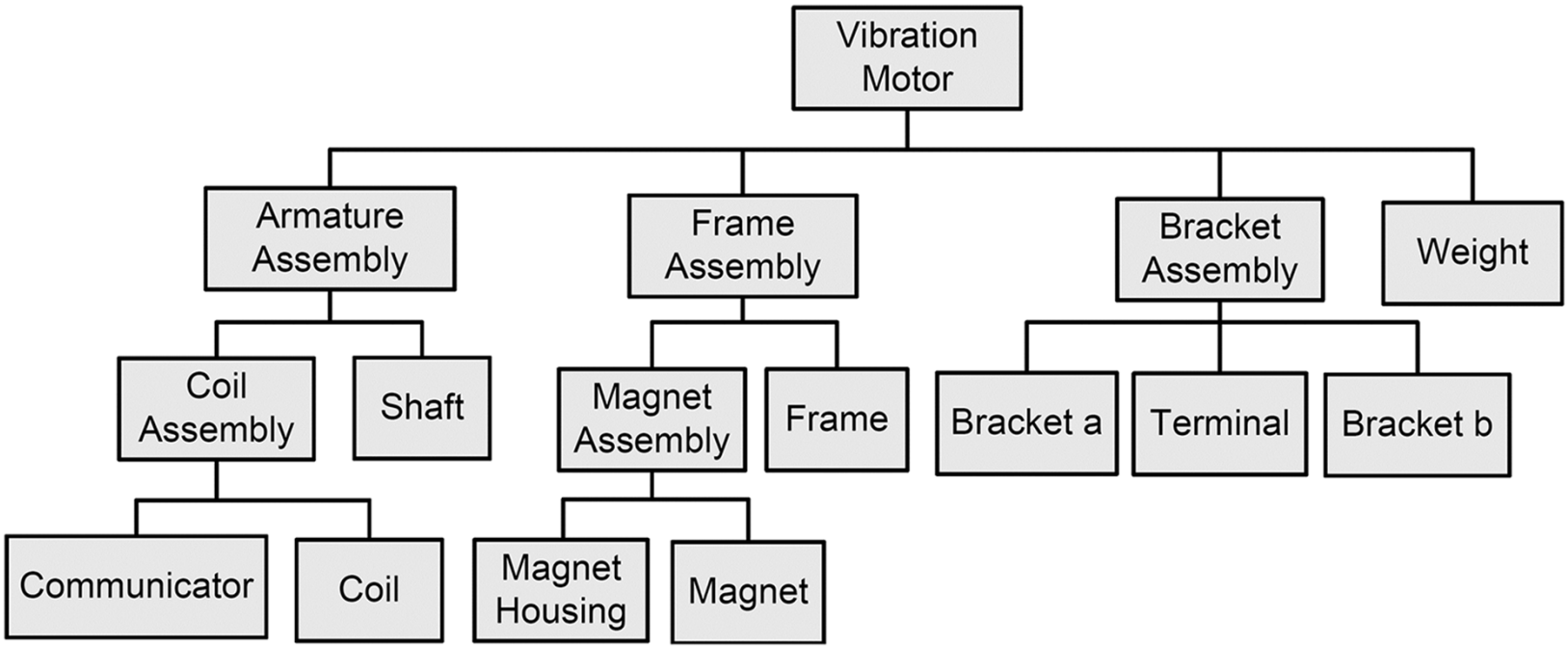

Level
0
Chair
1
Leg Assembly
Seat
Back Assembly
2 Legs (2)
Cross bar
Side Rails (2)
Cross bar
Back Supports (3)
3

Morphological Chart



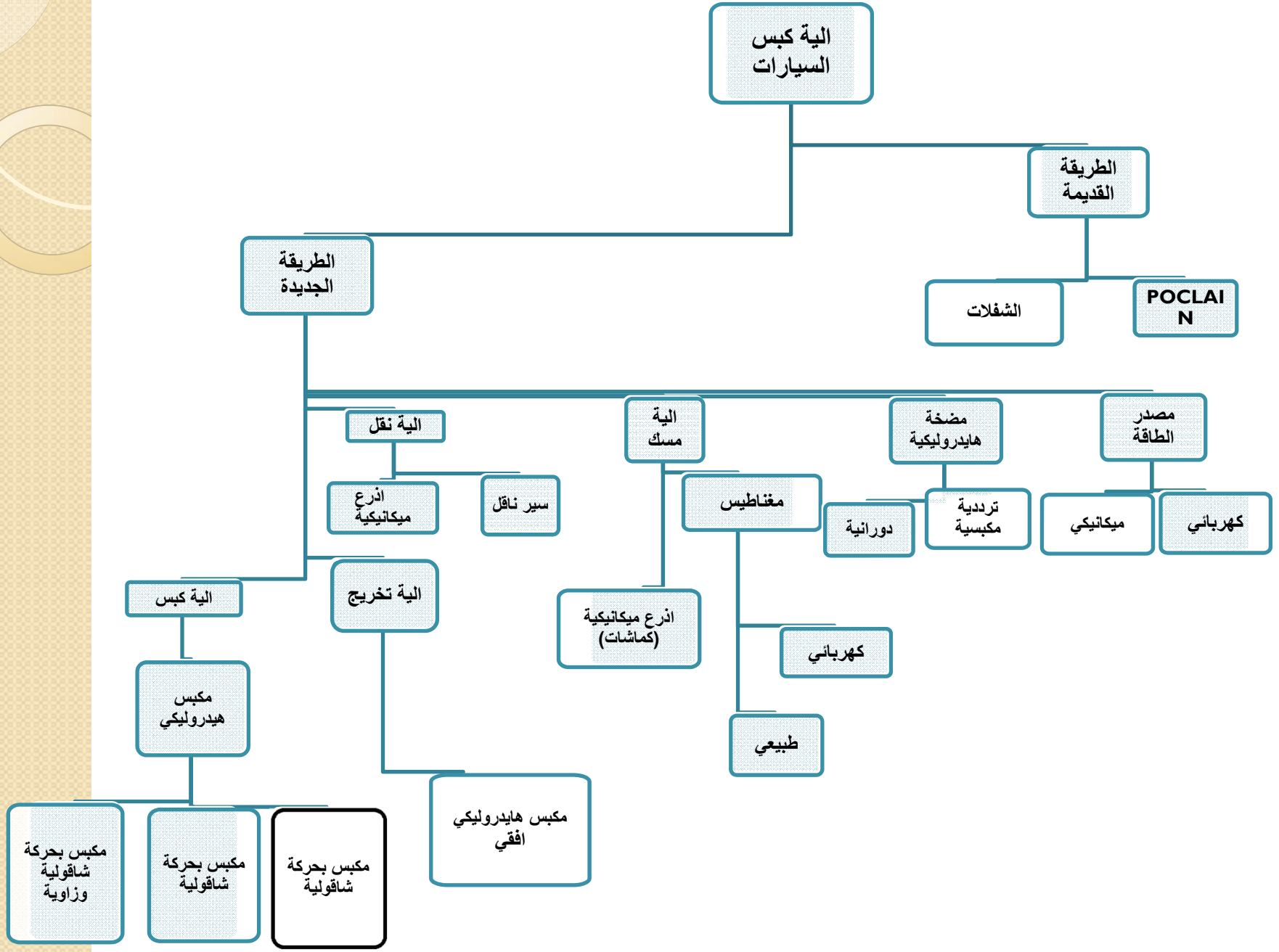
Example1. Vibration Motor



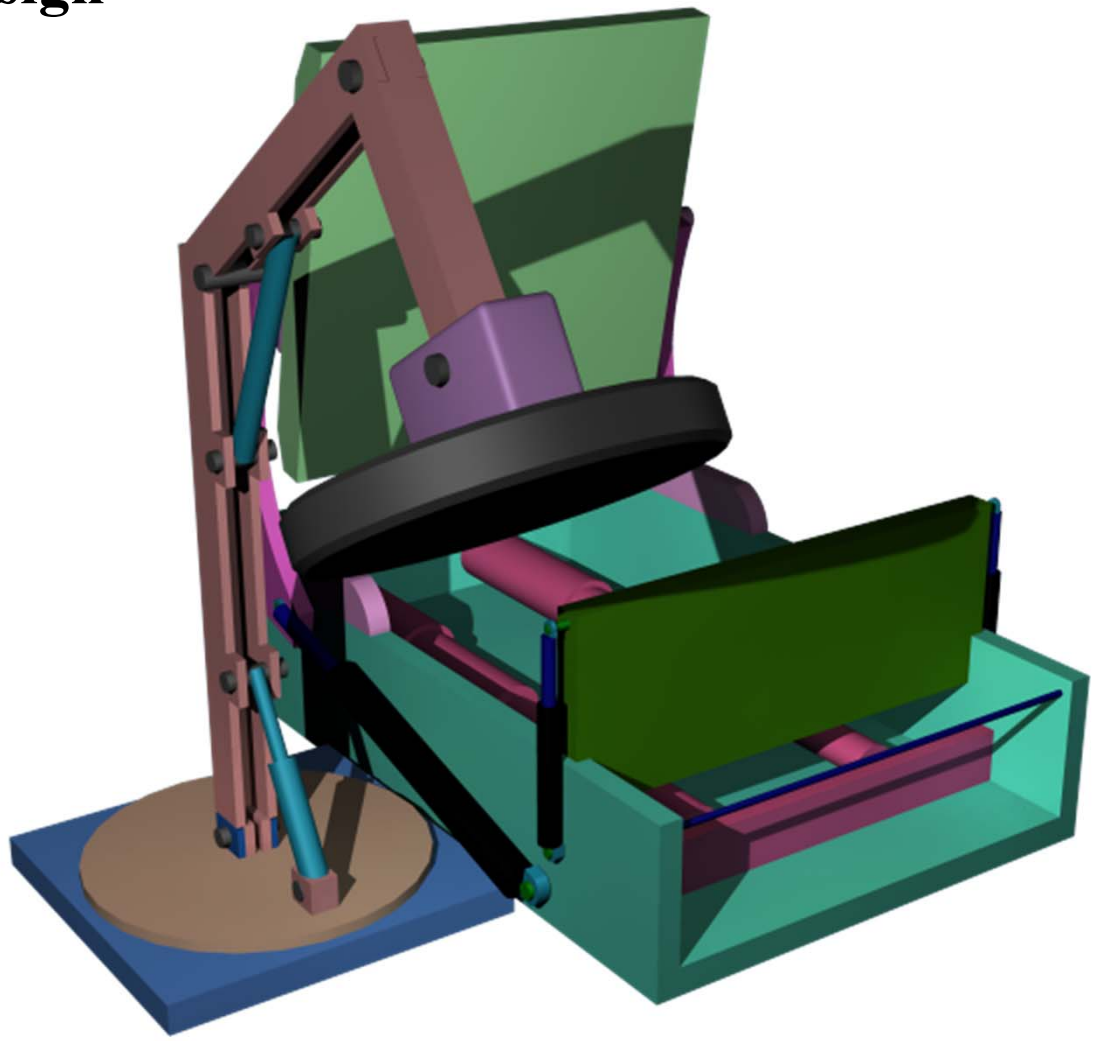

Vibration Motor
Armature Assembly
Frame Assembly
Bracket Assembly
Weight
Coil Assembly
Shaft
Magnet Assembly
Frame
Bracket a
Terminal
Bracket b
Communicator
Coil
Magnet Housing
Magnet

Example2.

Current solution


الية كبس السيارات
الطريقة القديمة
الشفلات
POCLAIN
الطريقة الجديدة
الية نقل
اذرع ميكانيكية
سير ناقل
الية مسك
مغناطيس
كهربائي
طبيعي
اذرع ميكانيكية (كماشات)
مضخة هايدروليكية
ترددية مكبسية
دورانية
مصدر الطاقة
ميكانيكي
كهربائي
الية كبس
مكبس هيدروليكي
مكبس بحركة شاقولية وزاوية
مكبس بحركة شاقولية
مكبس بحركة شاقولية
الية تخريج
مكبس هايدروليكي افقي

Final Design

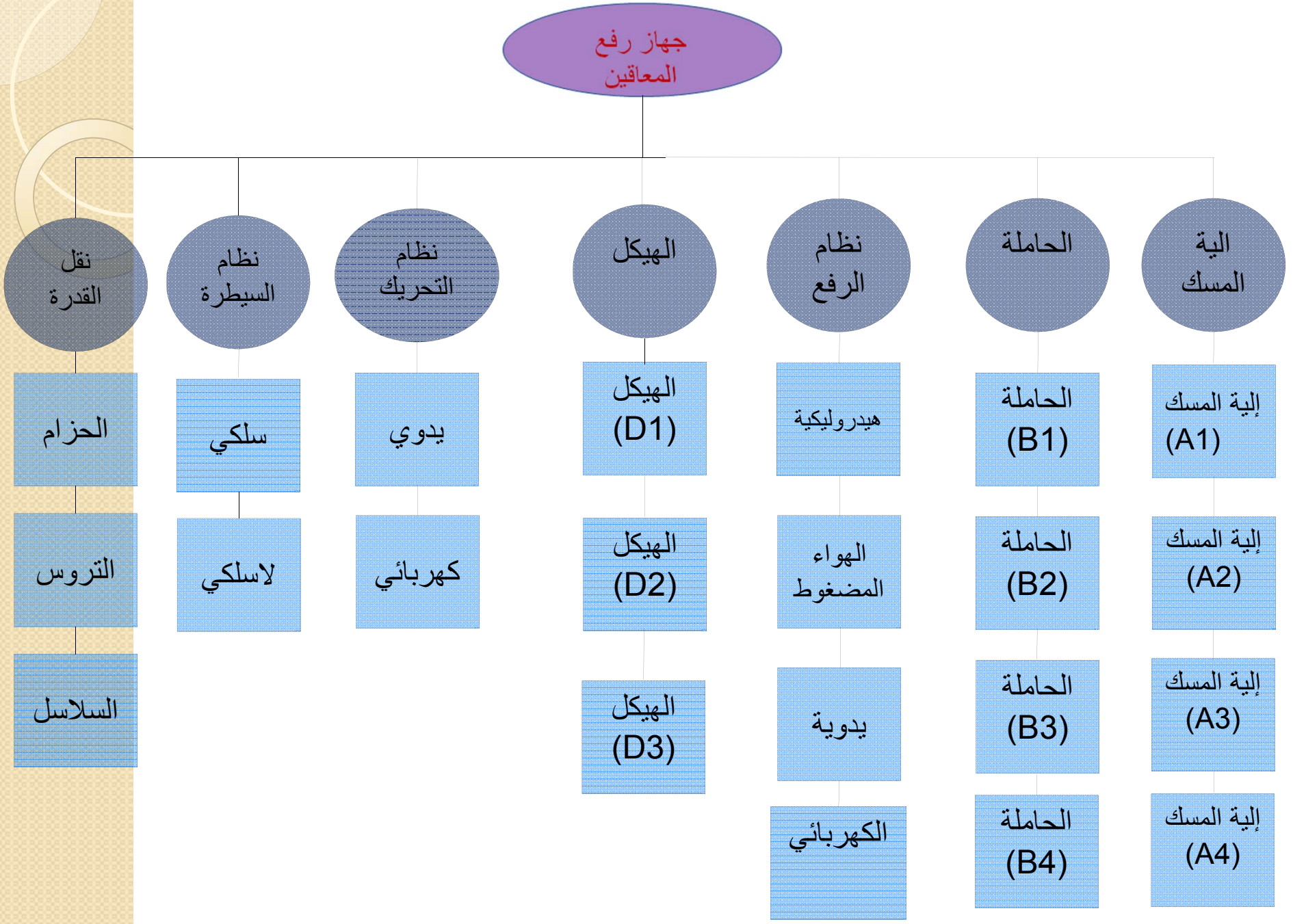


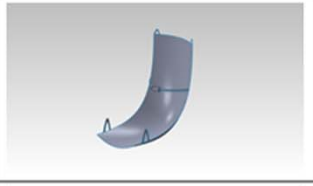
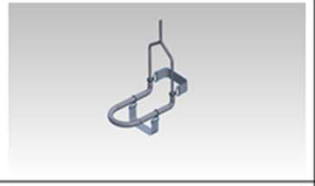
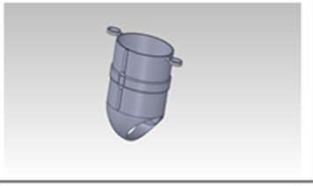
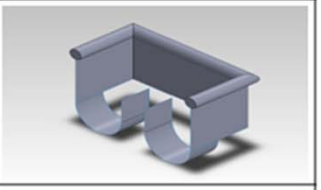
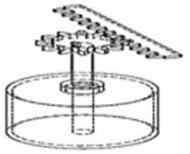
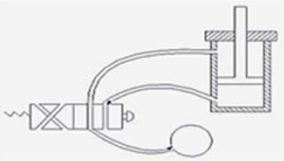
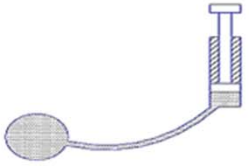
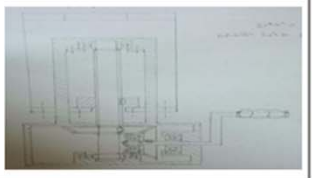
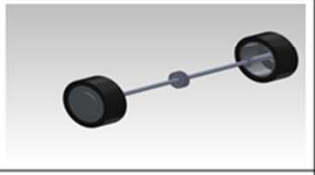
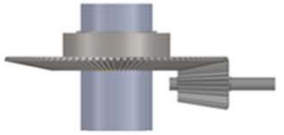

SGS
Jewel
佳宝牌
PACKING

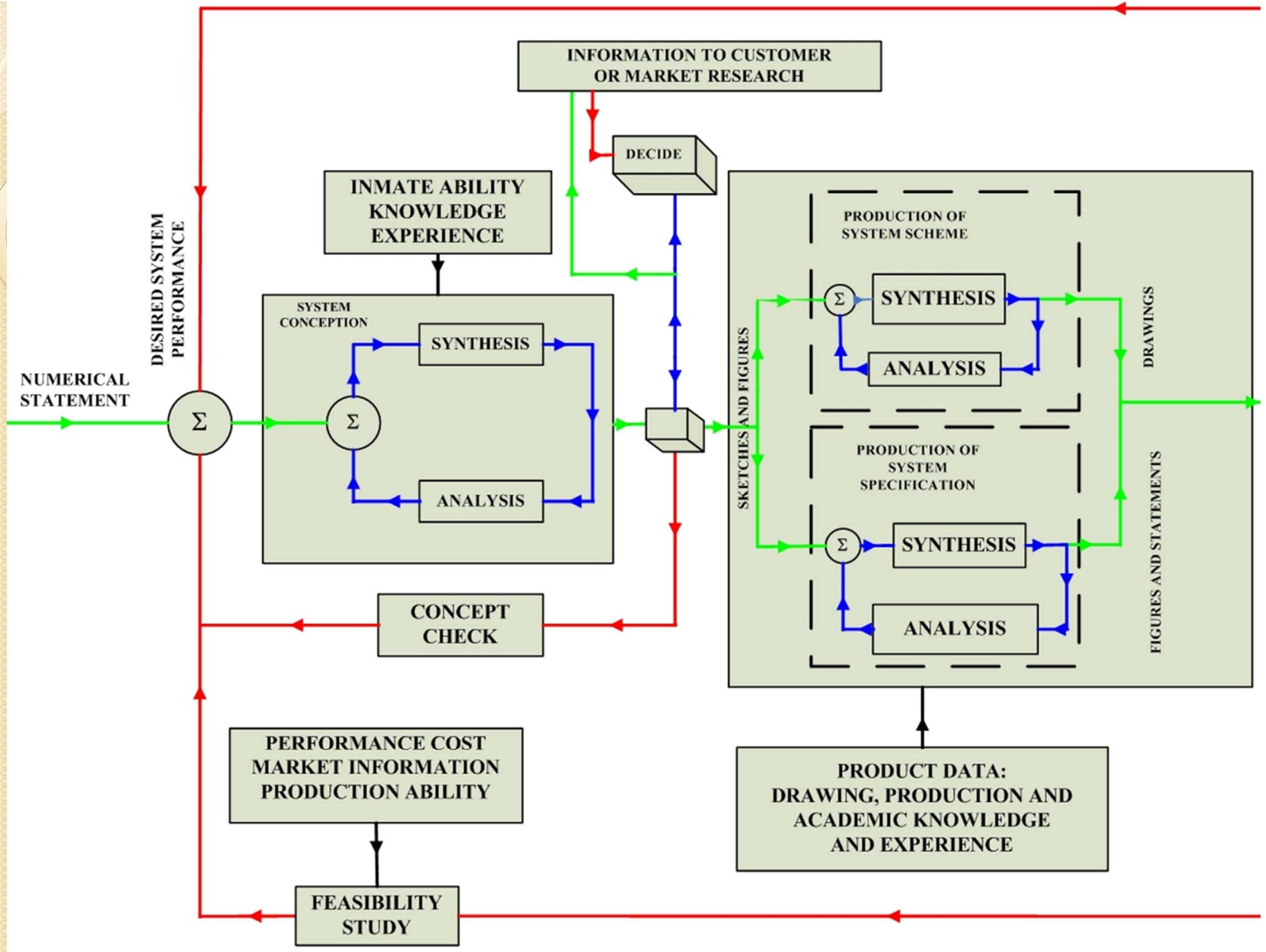

Audited Supplier
Supplier Assessment

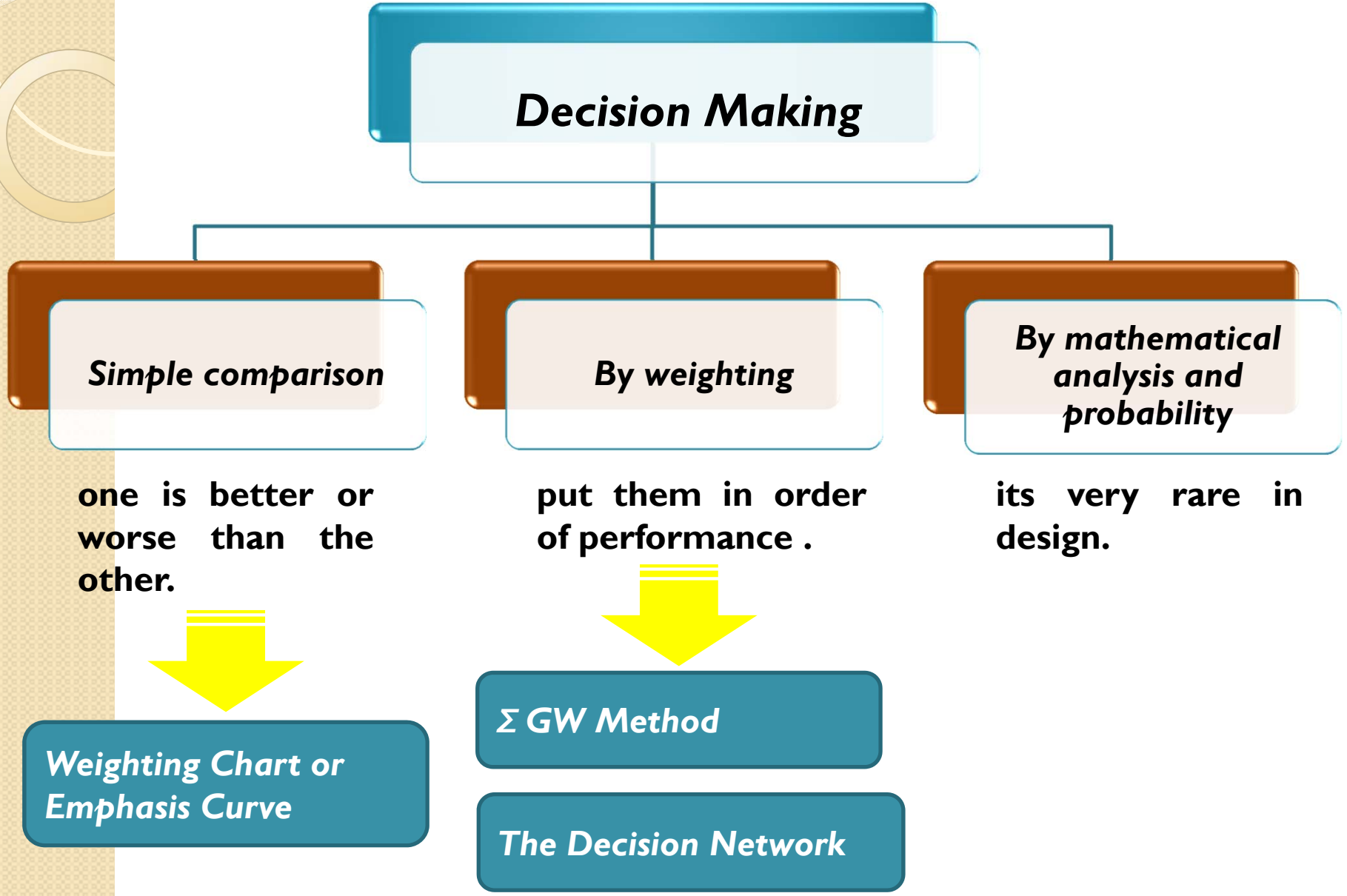
Example3.

Current solutions


جهاز رفع المعاقين
الية المسك
الحاملة
نظام الرفع
الهيكل
نظام التحريك
نظام السيطرة
نقل القدرة
إلية المسك (A1)
إلية المسك (A2)
إلية المسك (A3)
إلية المسك (A4)
الحاملة (B1)
الحاملة (B2)
الحاملة (B3)
الحاملة (B4)
هيدروليكية
الهواء المضغوط
يدوية
الكهربائي
الهيكل (D1)
الهيكل (D2)
الهيكل (D3)
يدوي
كهربائي
سلكي
لاسلكي
الحزام
التروس
السلاسل

Alternatives / Main features	Alternative 1	Alternative 2	Alternative 3	Alternative 4
ألية ألمسك				
الحامل				
ألية الرفع				
ألهيكل				
ألية ألتحريك				
التحكم				
نقل القدرة				


INFORMATION TO CUSTOMER OR MARKET RESEARCH
DECIDE
INMATE ABILITY KNOWLEDGE EXPERIENCE
DESIRED SYSTEM PERFORMANCE
NUMERICAL STATEMENT
SYSTEM CONCEPTION
SYNTHESIS
ANALYSIS
PRODUCTION OF SYSTEM SCHEME
SYNTHESIS
ANALYSIS
SKETCHES AND FIGURES
DRAWINGS
PRODUCTION OF SYSTEM SPECIFICATION
SYNTHESIS
ANALYSIS
FIGURES AND STATEMENTS
CONCEPT CHECK
PERFORMANCE COST MARKET INFORMATION PRODUCTION ABILITY
PRODUCT DATA: DRAWING, PRODUCTION AND ACADEMIC KNOWLEDGE AND EXPERIENCE
FEASIBILITY STUDY


Decision Making
Simple comparison
By weighting
By mathematical analysis and probability
one is better or worse than the other.
put them in order of performance .
its very rare in design.
Weighting Chart or Emphasis Curve
Σ GW Method
The Decision Network

Weighting Chart or Emphasis Curve

1. The features, (such as, weights, cost, power, wear), are given letters, A, B, C, D, etc, for easier compilation of a table.
2. These features are used for heading both the rows and the columns.
3. A diagonal is placed across the table, because (A) cannot be compound with (A), and so on of (B, C, and D).
4. Then (A) compared with (B, C, and D)
5. (B) is compared with (C and D)
6. (C) is compared with (D).
7. When the top half of the table completed, the number of times that letter (A), appears in the table marked at the right hand edge of the table against row (A), and this repeated for the others. (These values termed the performance values).
8. Now the weighting considered to take the best choice.
9. This method is simple and the designer decides the measure of importance by using whatever Aid he may find useful.
10. This method used when there is not detail information.

Alternatives / Alternatives	A	B	D	C
A		A	A	A
B			D	C
D				D
C				
Order of preference	1st	4th	2nd	3rd

Σ GW Method

1. **At the bottom of the table, we now have a measure of performance of the different designs when considered in relation to the chosen feature.**
2. **When the values at the bottom of the table differs by about 10%, then they should be considered to be equal at this stage, that's mean, the accurate of this method is about 90%.**
3. **The disadvantages of this method lie in difficulty in making the initial weighting decisions.**
4. **The other difficulty lies in the choice of features that will be considered in order to obtain a measure of performance.**

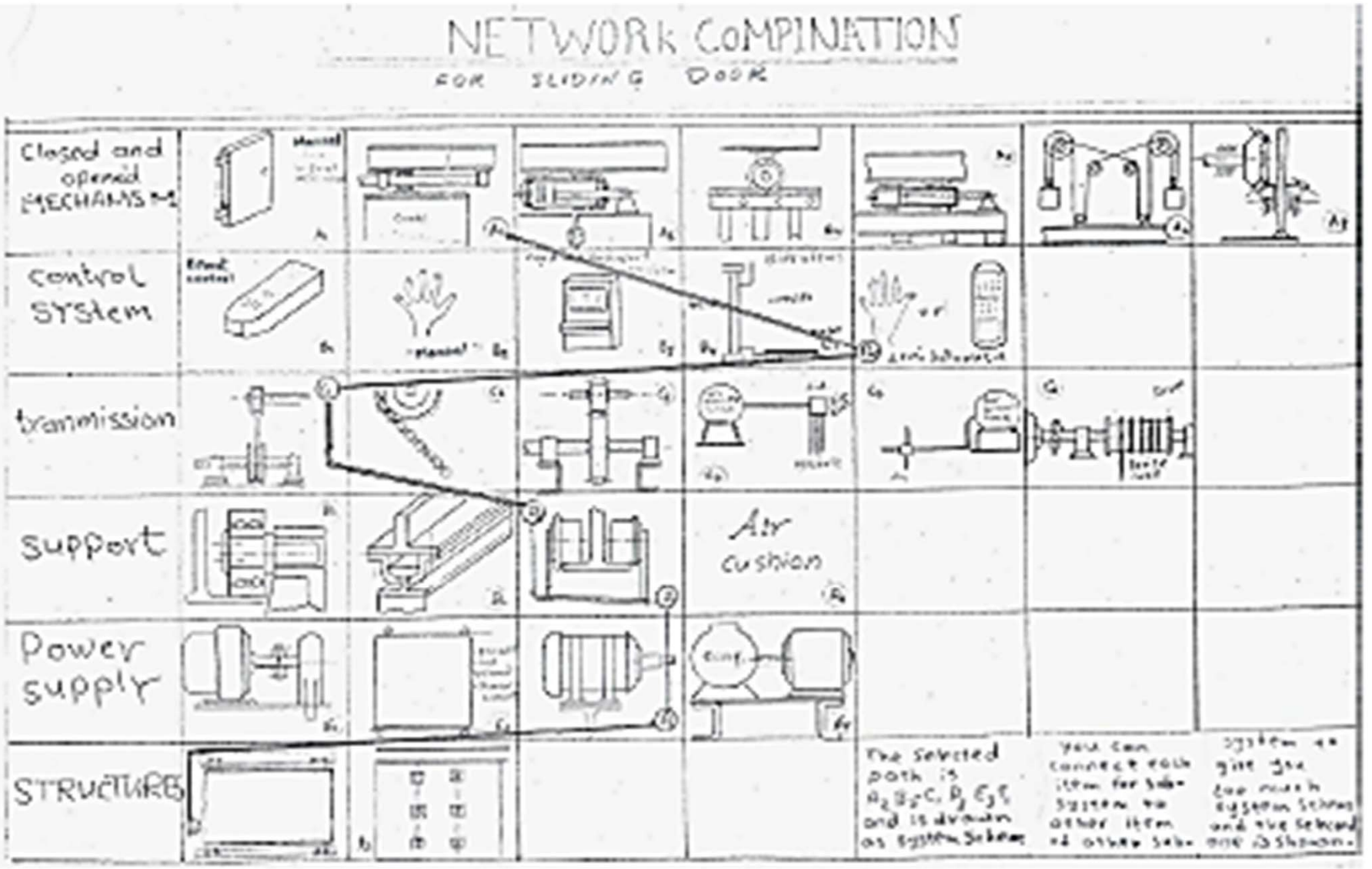
Alternatives / Main features	W	C1		C2		C3		C4	
		G	GW	G	GW	G	GW	G	GW
safety	20	14	280	16	320	17	340	11	220
weight	15	9	135	8	120	11	165	12	180
life	12	7	84	9	108	10	120	5	60
control	13	6	78	7	91	11	143	5	65
noise	15	5	75	6	90	12	180	13	195
Appearance	14	9	126	7	98	10	140	8	112
Total cost	10	5	50	6	60	8	80	9	90
size	11	4	44	5	55	7	77	8	88
performance	18	10	180	11	198	14	252	9	162
∑GW		1052		1140		1497		1172	
Order of preference		4_{th}		3_{rd}		1_{st}		2_{nd}	

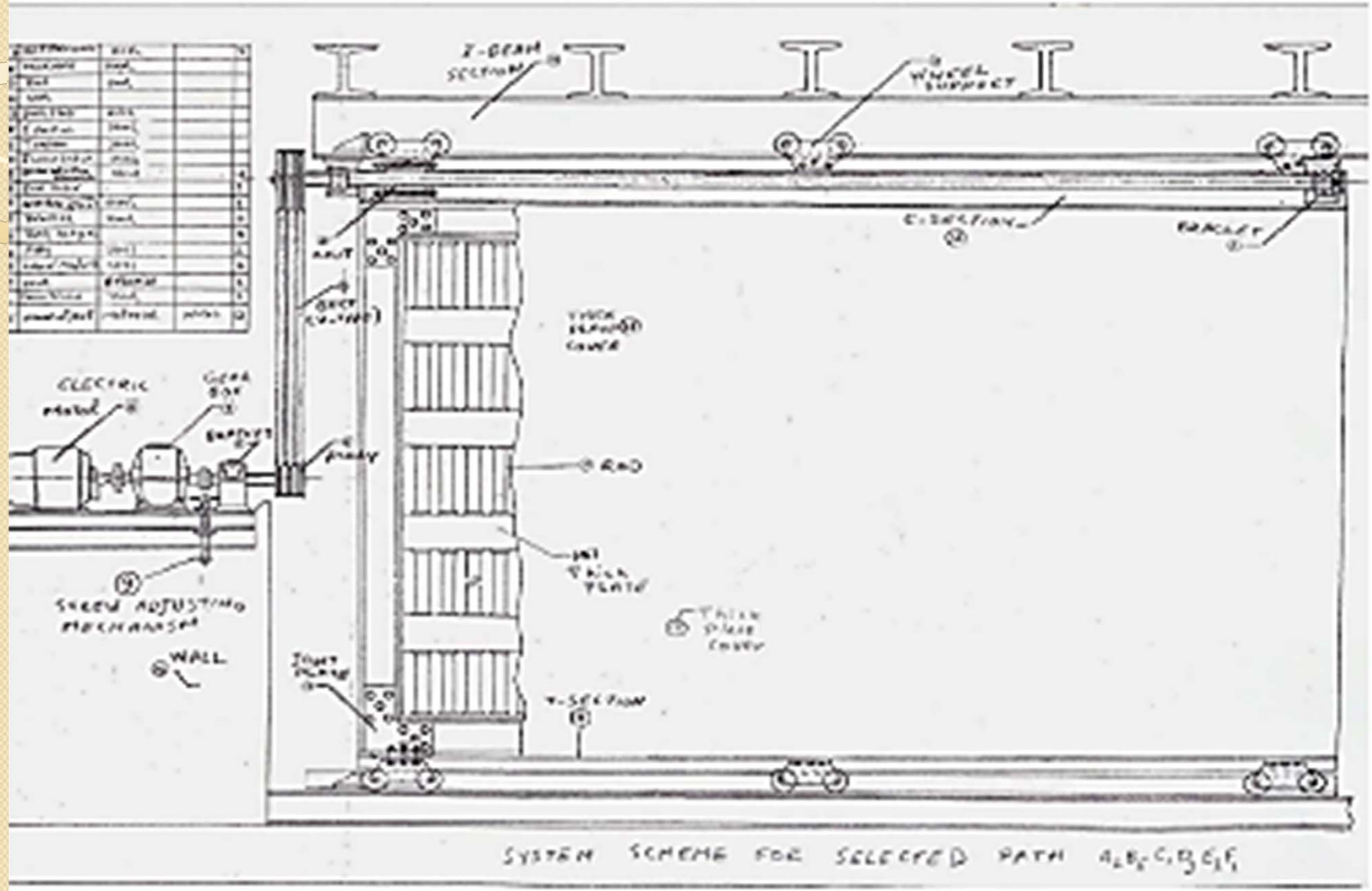
The Decision Network

1. This method involves a little from each of the methods above.
2. It is difficult to use, but it worth the effort.
3. The example below clarifies this method.
4. After doing the example, trace the parts from top to the bottom of the decision network.
5. Find the measure of performance.

NETWORK COMPINATION

FOR SLIDING DOOR

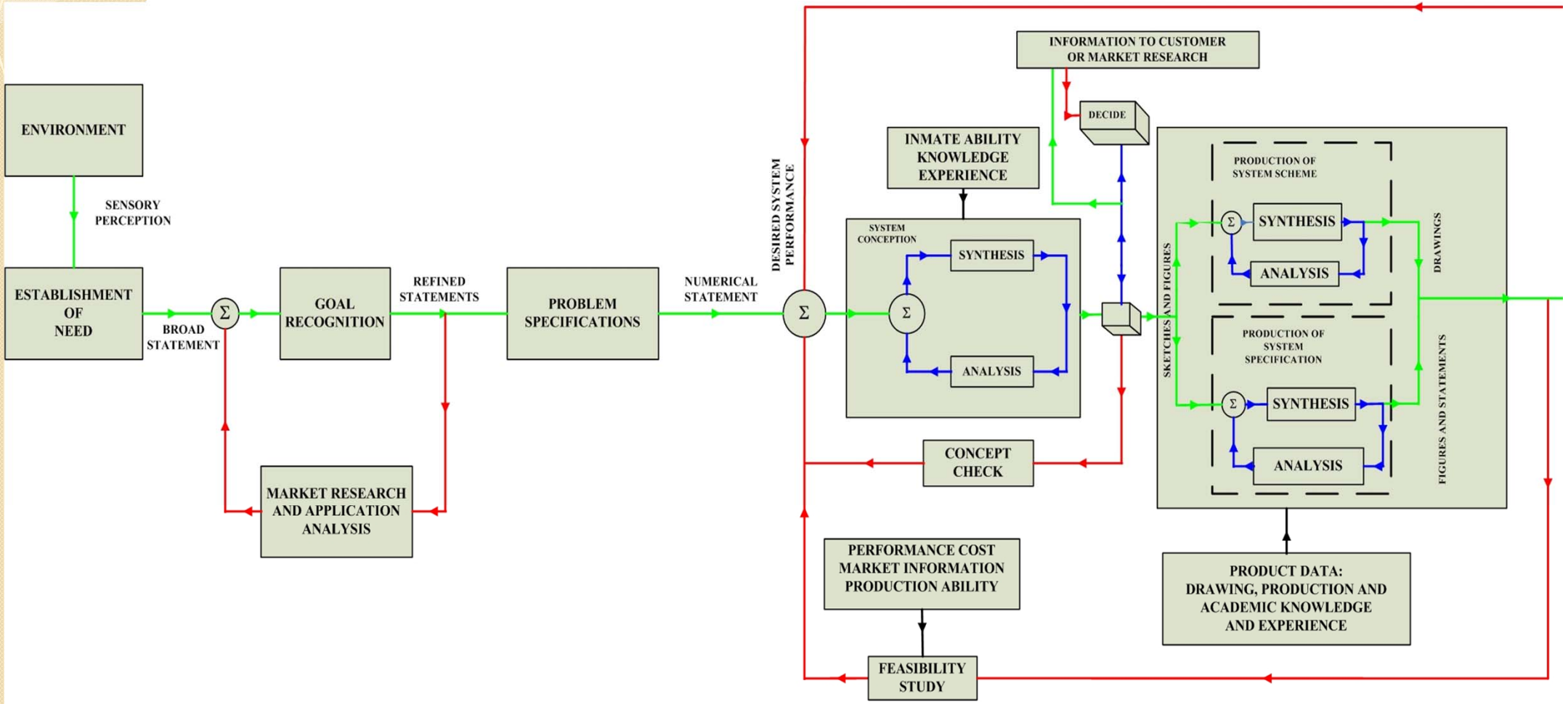



I-BEAM SECTION
WHEEL SUPPORT
C-SECTION
BRACKET
NUT
ROD
THIN PLATE
THIN PLATE CLAMP
T-SECTION
ELECTRIC MOTOR
GEAR BOX
COUPLER
SPEED ADJUSTING MECHANISM
WALL
JOINT PLATE
SYSTEM SCHEME FOR SELECTED PATH $A_1B_1C_1B_2E_1F_1$

Mechanical Engineering Design II

Eleventh & Twelfth Lectures

- **Production of system specification**
- **Production of system scheme**
- **Feasibility Study**


ENVIRONMENT
SENSORY PERCEPTION
ESTABLISHMENT OF NEED
BROAD STATEMENT
Σ
GOAL RECOGNITION
REFINED STATEMENTS
PROBLEM SPECIFICATIONS
NUMERICAL STATEMENT
MARKET RESEARCH AND APPLICATION ANALYSIS
DESIRED SYSTEM PERFORMANCE
INFORMATION TO CUSTOMER OR MARKET RESEARCH
DECIDE
INMATE ABILITY KNOWLEDGE EXPERIENCE
SYSTEM CONCEPTION
SYNTHESIS
ANALYSIS
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PERFORMANCE COST MARKET INFORMATION PRODUCTION ABILITY
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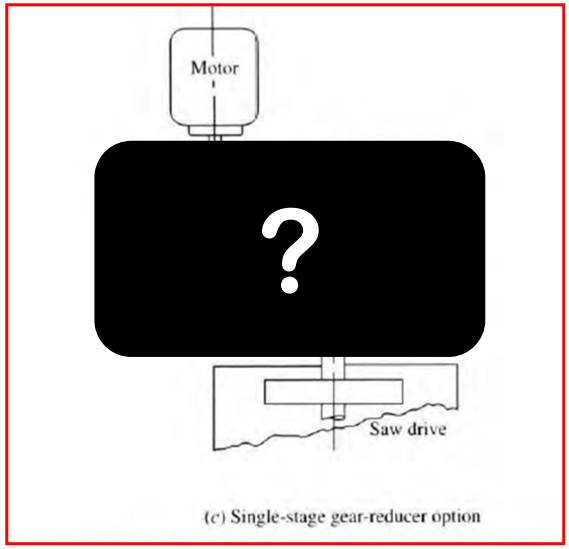
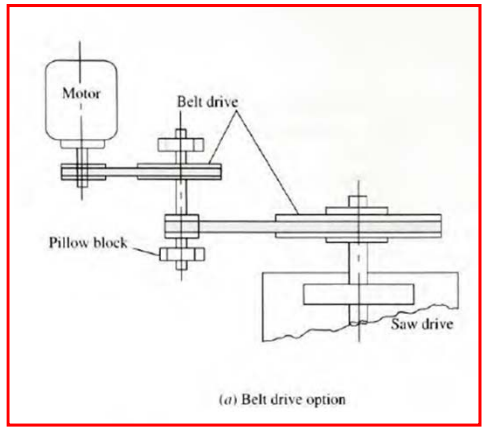
SKETCHES AND FIGURES
PRODUCTION OF SYSTEM SCHEME
SYNTHESIS
ANALYSIS
DRAWINGS
PRODUCTION OF SYSTEM SPECIFICATION
SYNTHESIS
ANALYSIS
FIGURES AND STATEMENTS
PRODUCT DATA: DRAWING, PRODUCTION AND ACADEMIC KNOWLEDGE AND EXPERIENCE

Power Transmission Problem

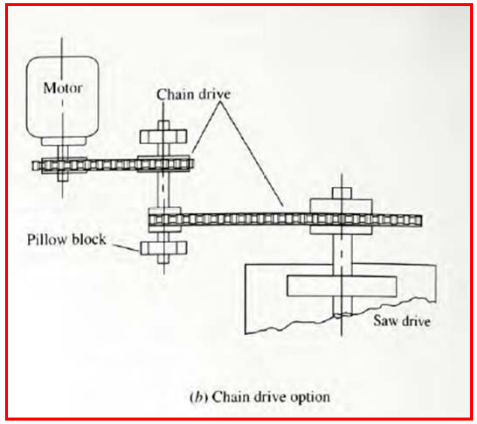


(c) Single-stage gear-reducer option

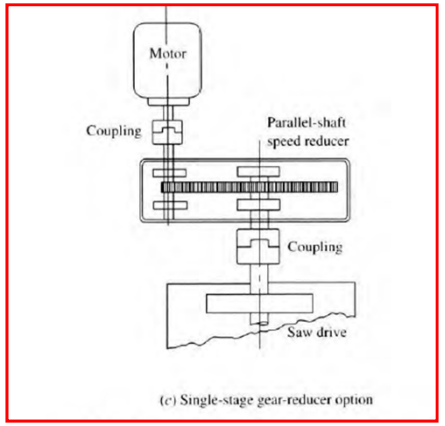
Alternative solutions



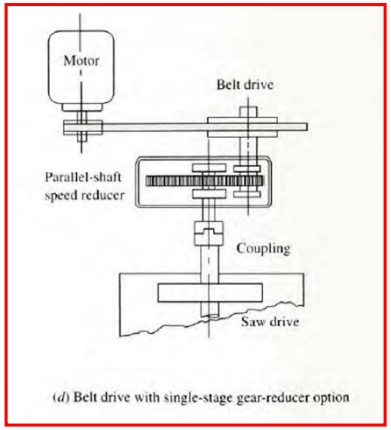
(a) Belt drive option



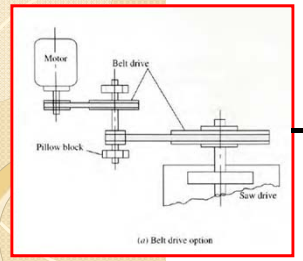
(b) Chain drive option



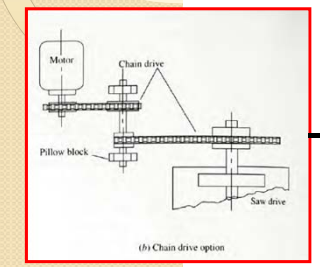
(c) Single-stage gear-reducer option



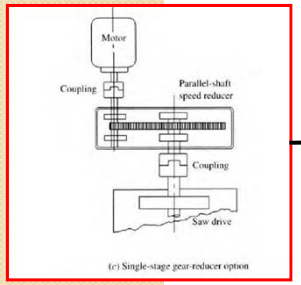
(d) Belt drive with single-stage gear-reducer option



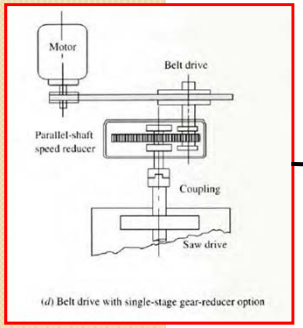
Analysis



Analysis

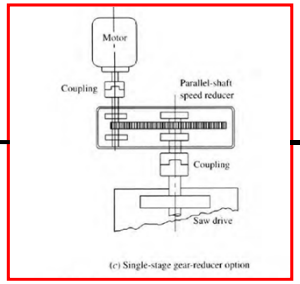


Analysis

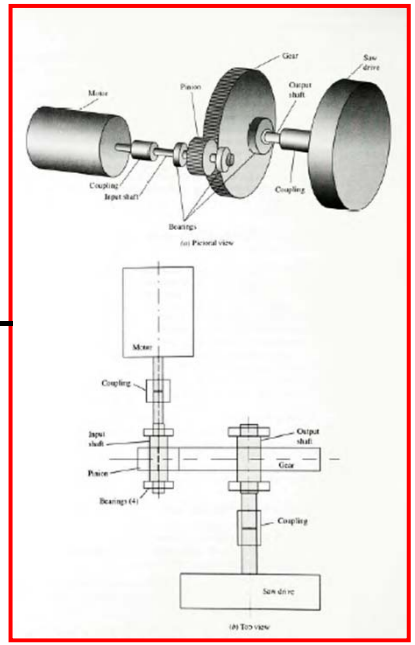


Analysis

Decision making according to criteria

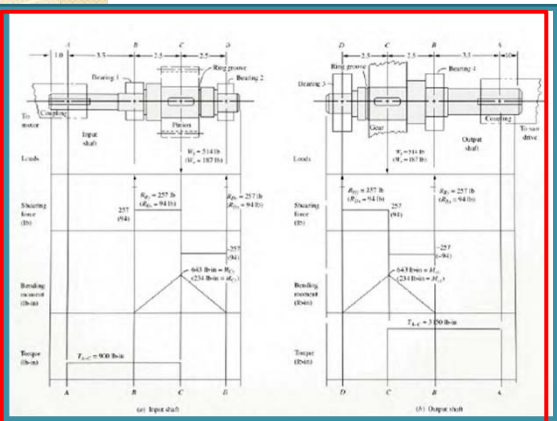


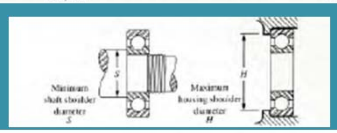
Best solution

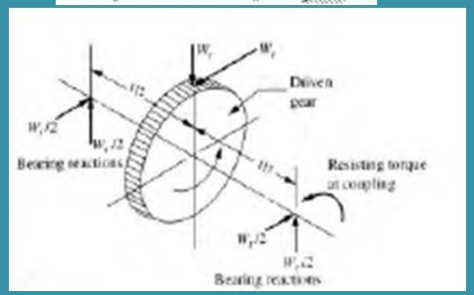


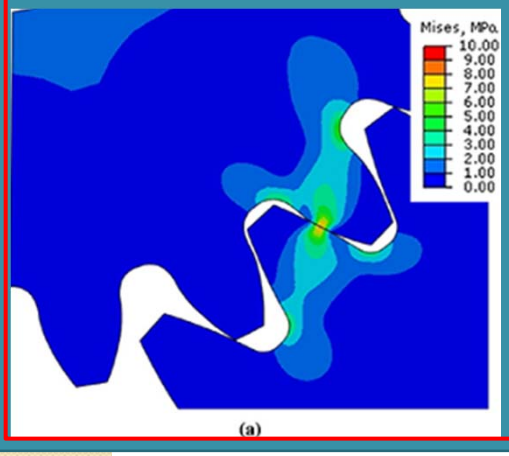
General Layout

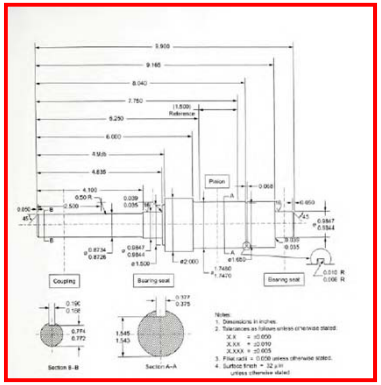
Production of system specification

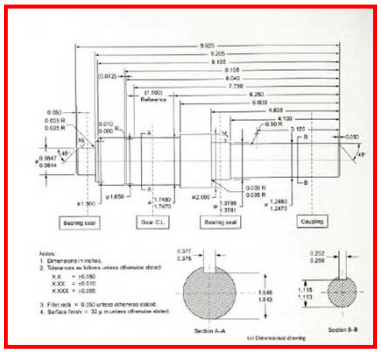




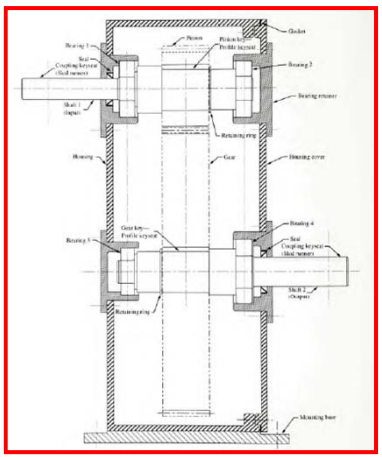






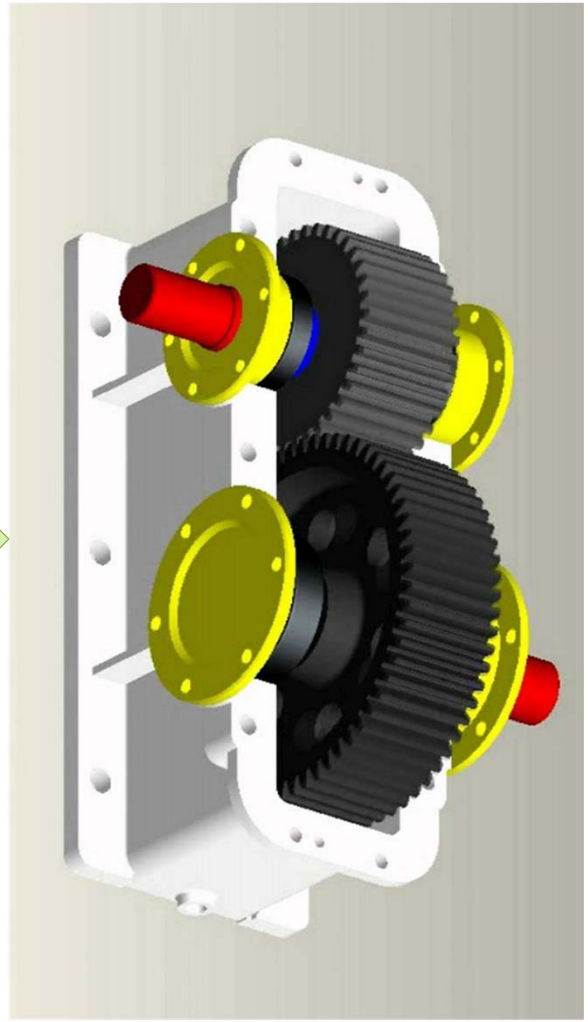


Detail Drawing

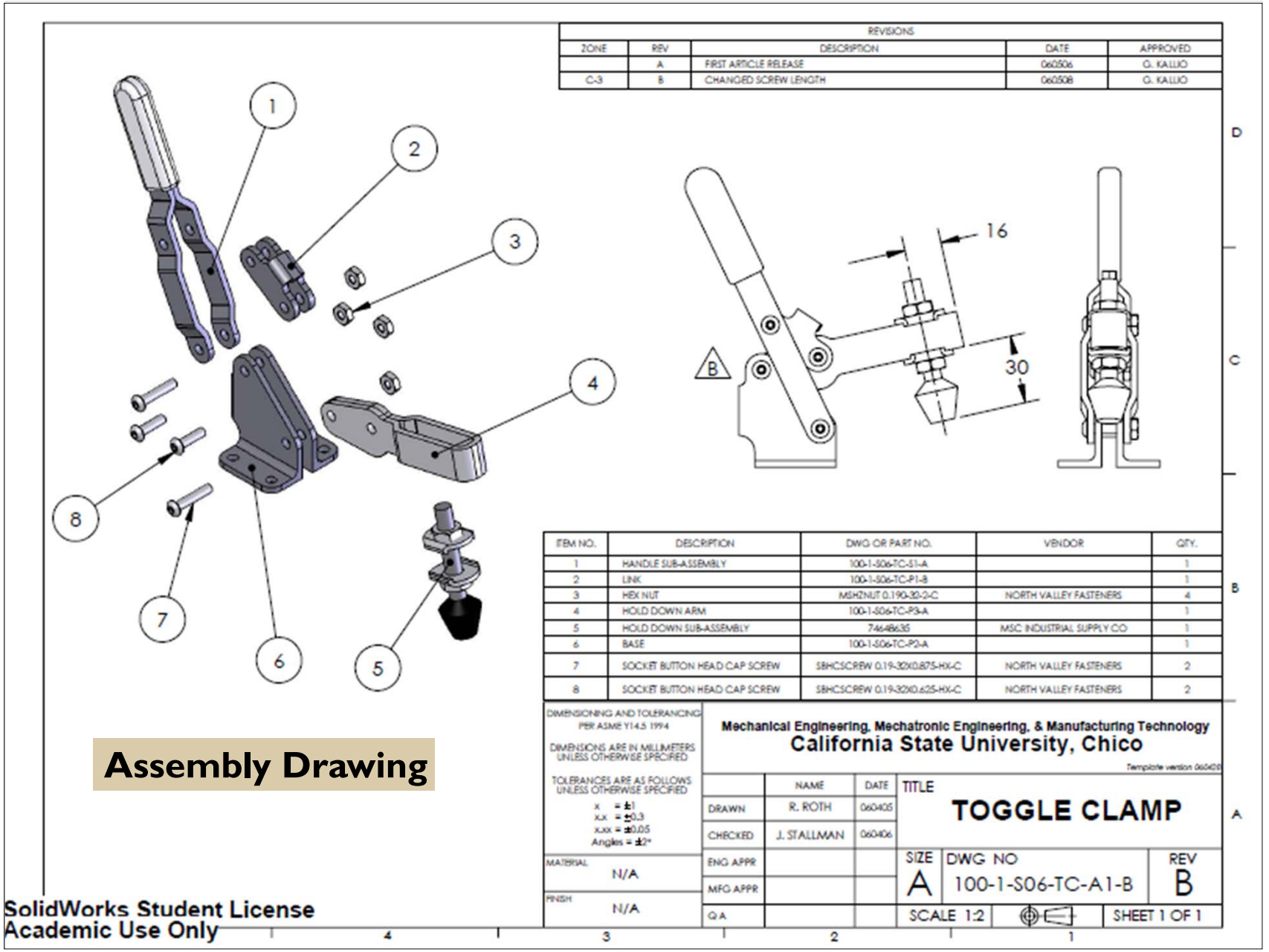


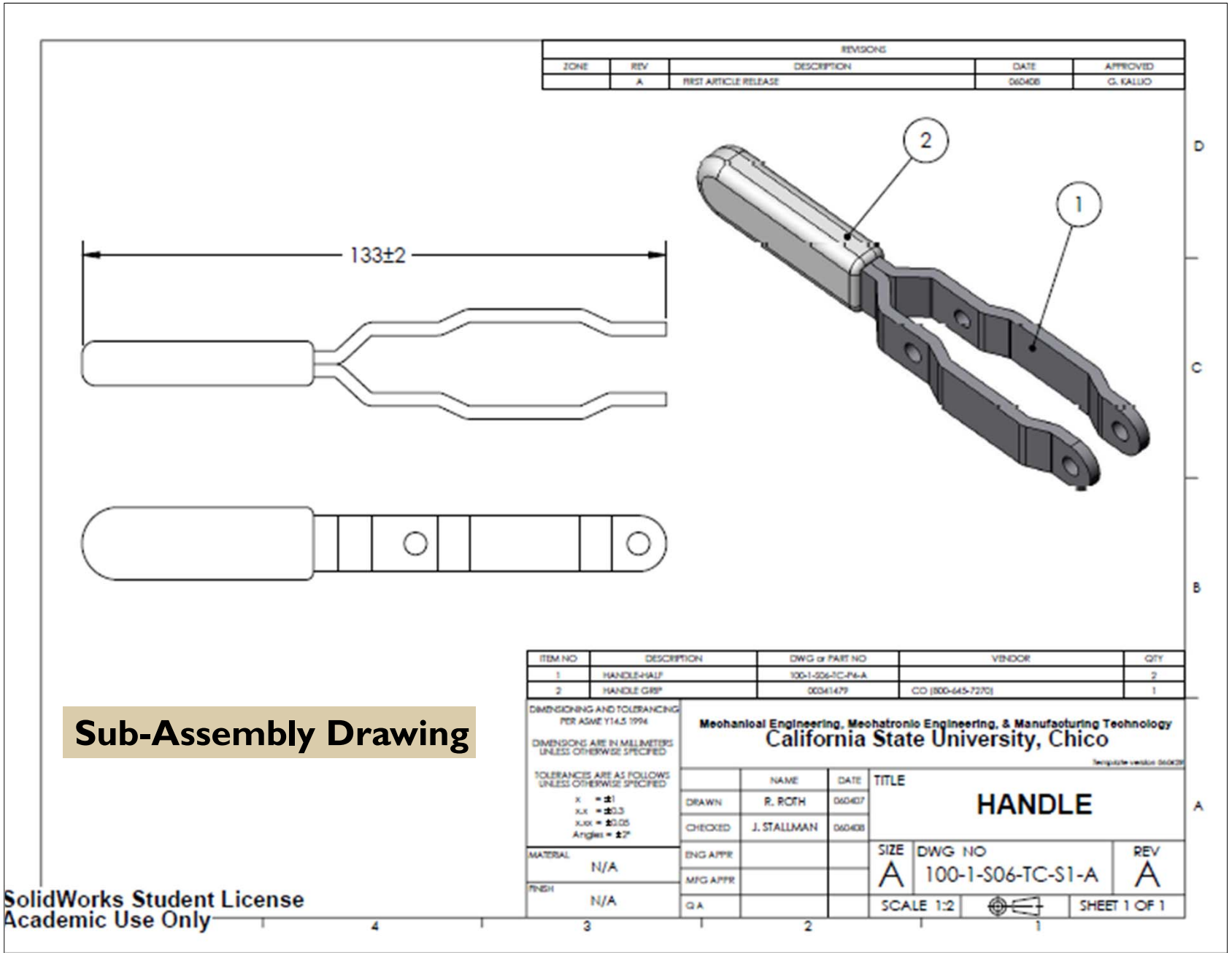
Assembly Drawing

Production of system scheme

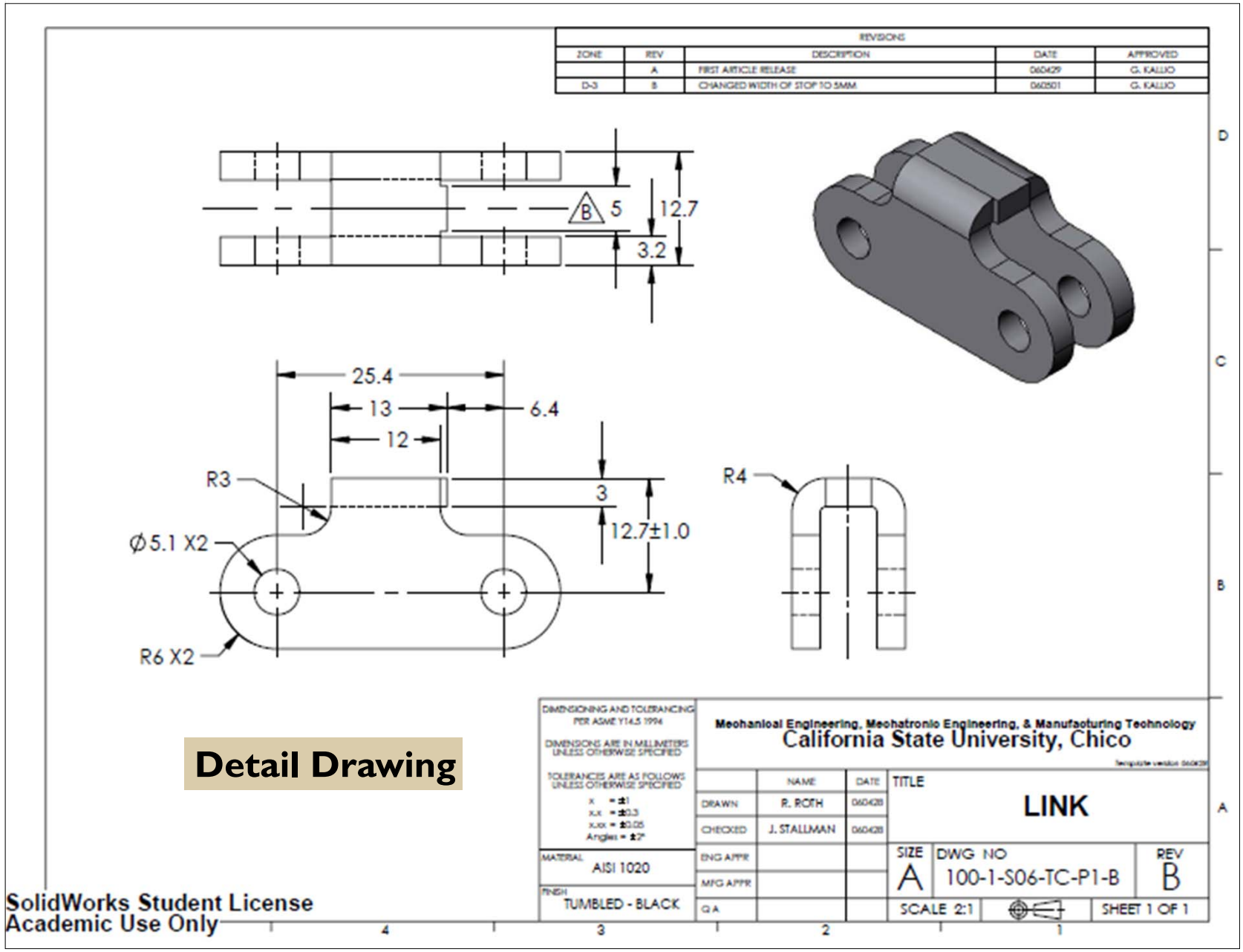


Final design


REVISIONS
ZONE | REV | DESCRIPTION | DATE | APPROVED
 | A | FIRST ARTICLE RELEASE | 060506 | G. KALLIO
C-3 | B | CHANGED SCREW LENGTH | 060508 | G. KALLIO
1
2
3
4
5
6
7
8
16
30
B
ITEM NO. | DESCRIPTION | DWG OR PART NO. | VENDOR | QTY.
1 | HANDLE SUB-ASSEMBLY | 100-1-S06-TC-S1-A | | 1
2 | LINK | 100-1-S06-TC-P1-B | | 1
3 | HEX NUT | MSHZNUT 0.190-32-Z-C | NORTH VALLEY FASTENERS | 4
4 | HOLD DOWN ARM | 100-1-S06-TC-P3-A | | 1
5 | HOLD DOWN SUB-ASSEMBLY | 74648635 | MSC INDUSTRIAL SUPPLY CO | 1
6 | BASE | 100-1-S06-TC-P2-A | | 1
7 | SOCKET BUTTON HEAD CAP SCREW | SBHCSCREW 0.19-32X0.875-HX-C | NORTH VALLEY FASTENERS | 2
8 | SOCKET BUTTON HEAD CAP SCREW | SBHCSCREW 0.19-32X0.625-HX-C | NORTH VALLEY FASTENERS | 2
Assembly Drawing
DIMENSIONING AND TOLERANCING PER ASME Y14.5 1994
DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED
TOLERANCES ARE AS FOLLOWS UNLESS OTHERWISE SPECIFIED
x = ±1
x.x = ±0.3
x.xx = ±0.05
Angles = ±2°
MATERIAL N/A
FINISH N/A
Mechanical Engineering, Mechatronic Engineering, & Manufacturing Technology
California State University, Chico
Template version 060405
NAME | DATE
DRAWN R. ROTH 060405
CHECKED J. STALLMAN 060406
ENG APPR
MFG APPR
Q A
TITLE
TOGGLE CLAMP
SIZE A
DWG NO 100-1-S06-TC-A1-B
REV B
SCALE 1:2
SHEET 1 OF 1
SolidWorks Student License
Academic Use Only
D
C
B
A
4
3
2
1



Sub-Assembly Drawing


REVISIONS
ZONE | REV | DESCRIPTION | DATE | APPROVED
A | FIRST ARTICLE RELEASE | 060429 | G. KALLIO
D-3 | B | CHANGED WIDTH OF STOP TO 5MM | 060501 | G. KALLIO
B
5
12.7
3.2
25.4
13
6.4
12
R3
3
12.7±1.0
Ø5.1 X2
R6 X2
R4
Detail Drawing
DIMENSIONING AND TOLERANCING PER ASME Y14.5 1994
DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED
TOLERANCES ARE AS FOLLOWS UNLESS OTHERWISE SPECIFIED
x = ±1
x.x = ±0.3
x.xx = ±0.05
Angles = ±2°
MATERIAL AISI 1020
FINISH TUMBLED - BLACK
Mechanical Engineering, Mechatronic Engineering, & Manufacturing Technology
California State University, Chico
NAME | DATE
DRAWN R. ROTH 060428
CHECKED J. STALLMAN 060428
ENG APPR
MFG APPR
QA
TITLE
LINK
SIZE A
DWG NO 100-1-S06-TC-P1-B
REV B
SCALE 2:1
SHEET 1 OF 1
SolidWorks Student License
Academic Use Only
D
C
B
A
4
3
2
1

The Feasibility Study

(Design Acceptance or Design Practicality)

- **The words “the feasibility study” are used to describe the analysis of the design which attempts to take into account all relevant facts. The outcome of the feasibility study is a major factor in the decision to continue with the design.**
- **It is not suggested that feasibility checking cannot begin until the system scheme and system specification are produced however, since this is the first point in the design process where the indicate the final form of the system, it is the most logical point at which to check that the system can be made economically and will perform reasonably well in the desired manner. (Any study carried out at an earlier stage could be termed a Plausibility Study).**

During the feasibility study, the following points should be checked:

1. **Is the system compatible with the basic physical laws? (Mainly conservation laws).**
2. **Is the system compatible as whole with its environment? In those cases where compatibility is relevant, are all parts of the system compatible with each other, and with adjacent parts of the environment?**
3. **Is the system economically feasible from the manufacturer's points of view?**
4. **Is the system feasible as regards its market?**
5. **Are all the properties of the system acceptable with the terms of the original design specification? Consider the follow-up of properties not mentioned in the design specification.**
6. **Is this particular design no better than previous existing designs? Compare and contrast. Consider the cost of covering features which are additional to those on existing equipment.**
7. **will the time taken to manufacture – test – develop and transport be reasonable? Critical path analysis can be used to highlight difficult regions.**
8. **Does the design demand new manufacturing techniques within the manufacturer's organization, or does the design demand completely new manufacturing techniques to make it economically feasible?**
9. **Is the system considered to be reliable enough for successful operation, or should special provisions be made to improve reliability.**
10. **Can the system be readily maintained, or is the design such that the minimum of maintenance is required?**
11. **Is the system legally saleable? Have any patent rights been violated?**

Mechanical Engineering Design II

Thirteenth Lecture

Design-Reliability and Failure

Design-Reliability and Failure

Failure of a design when in service costs money for replacement, and often the failure itself causes other financial looses. On the other hand, to design so that the chance of failure is very remote also costs money.

It can therefore be seen that the designer should consider failure of the design. The optimum design should be a compromise, that is, it is optimum only for the particular criteria relevant to that design.

It is known that a considerable amount of mechanical design is associated with very small quantities, and in a number of cases only one system is manufactured. In most designs the only items of equipment in frequent use are nuts and bolts. For this reason statistical methods which are often used to analyze failure and improve reliability are only of use in specialized mechanical engineering design, such as mass-produced car design.

The mechanical engineer has devised a number of methods to overcome the problem of lack of numbers, some of which will be mentioned here. These methods are also used by other designers, often in addition to statistical methods.

1. To make systems more reliable, use accurate methods of design analysis coupled with realistic assessment of loads.

e.g. (a) Use adequate checking procedures.

(b) Use more accurate thick cylinder theory rather than the simpler and quicker theory in relevant cases.

(c) Use fatigue theory rather than arbitrary factors when considering cyclic loads.

(d) Assess loads realistically by dynamic analysis and careful thought rather than by arbitrary load factors.

2. If difficulty is encountered in putting note.1 into practice, then use generous reserve factors to take account of ignorance. Make use of rerating, (i.e. working at much reduced stress levels).

3. Remember that evolutionary design is in general more reliable than revolutionary design.

4. Make the design as simple as possible. The less parts there are in a piece of equipment, then the less chances of failure there are.

5. Use standard parts and materials of known and proven reliability.
6. Use British Standards. Also, use any other engineering standards and Codes of Practice which are known to improve reliability.
7. Build in redundancy (here interpreted in the same way as redundancy in beam analysis) and analyze as though the redundancy were missing. This is very similar to note.2 above, but it can be dangerous to use this method without considerable experience.
8. Design so that if one very important part should fail and give a catastrophic result, then another part or system takes over temporarily. It is better if the second system operates on a different principle to the first. Repair is executed as soon as possible.
9. Design to take overloads on the system by designing so that they cause visible distortion, but not catastrophic failure. Repair is executed as soon as possible.
10. If further functioning would be likely to cause damage to the system or its surroundings, incorporate devices or design features into the system so that failure causes the system to stop functioning. Take care that the sudden cessation of functioning does not itself cause troubles. Repair is executed as soon as possible.
11. Use composite structures so that failure of any one part, or a few parts, does not cause complete failure. Repair is executed as soon as possible.
12. Include devices that relieve the overload, but allow normal use to continue.

13. **Incorporate devices or design features so that incorrect assembly and use is preferably impossible. If incorrect assembly is possible, then there should be features which prevent normal operation.**
14. **Incorporate warning devices so that malfunctioning is obvious. Make warning devices so that the malfunctioning of the warning device itself is obvious.**
15. **Prepare adequate test specifications to ensure desired reliability.**
16. **Although it is included under the heading of note.6, ensure that electrochemical corrosion possibilities are adequately studied.**
17. **Consider special features relating to human safety if failure should occur.**
18. **Supply adequate information to all persons directly or remotely concerned with the equipment.**
19. **Set up adequate lines of communications and records to record and collate all information relating to failures.**

Certain of the notes above also relate to (failsafe design), that is the design of equipment that will revert to a safe condition if a failure should occur.