

# VERIFICATION EVALUATION

**ENGN2225** Systems Engineering Design



# ICE BREAKER



# Ice Breaker

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➔ **Rechargeable Batteries**



➔ **Single-use Batteries**



**01**

Verification Theory

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**02**

Verification Theory Application:

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**03**

Evaluation Theory

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**04**

Evaluation Theory Application:

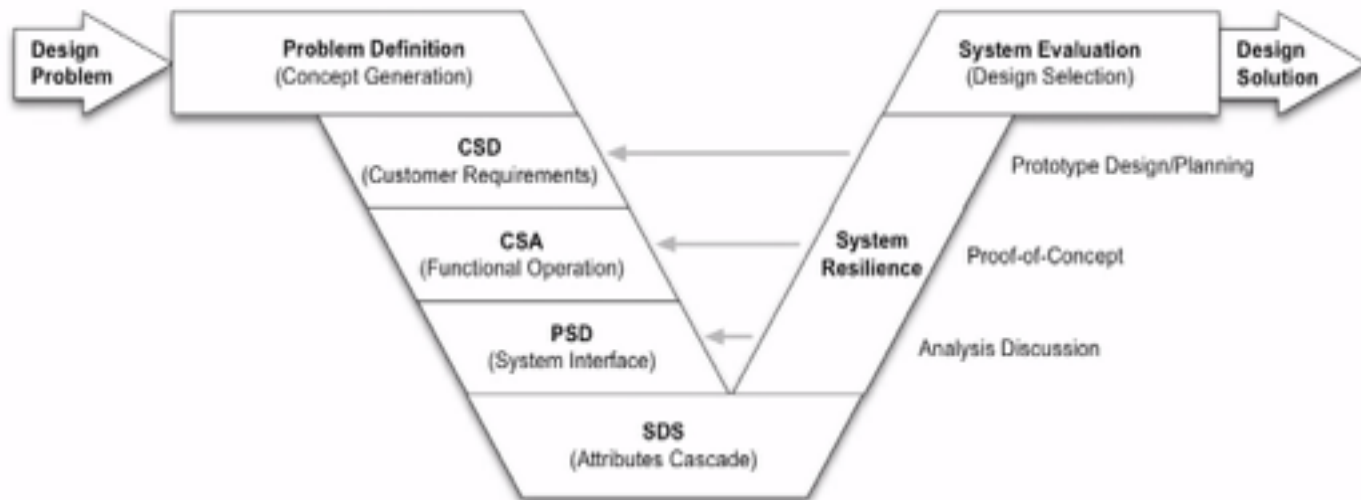
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# 01 Verification Theory

# Verification

## ➔ Resilience

➔ Resilience in your system can be achieved through testing and validation throughout the design process



# Verification

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## ➔ **Stages of testing:**

➔ Analytical Models – e.g. Replaceable: CAD model

➔ Proof of Concept – e.g. Strong Buckles: Test rig

➔ System Prototypes – e.g. Strong Straps: Prototype/working model

➔ Procedure – Details on method/what is being done/achieved.

# Verification

## → Testing Procedures

- • Which attribute? (Customer. Req)
- • Who does the testing? (Qualifications)
- • Procedure outline (Repeatable)
- • Pass/fail criteria (Benchmarking)

## → Standards

### Proof-of-Concept Testing A2.2.2 Easy to manoeuvre



### Proof-of-Concept Example Procedure

1. Power control unit and cutting motor (no blades)
2. Bring up to minimum speed
3. Measure speed and response time
4. Adjust to maximum speed
5. Measure speed and response time
6. Power off

### Proof-of-Concept Example

Attribute: A1.1.1 Adjustable speed

Test person: Technician

Pass/fail criteria: Adjust to customer required speed +/- 10%



## **02** Verification Application

# Verification – Activity

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## ➔ **What am I doing?:**

➔ Your group is given some Customer Requirements

➔ Quickly make a few Design Requirements and a very brief Attribute Cascade

➔ Formulate some Tests to test the attributes of your design

➔ Present your best Test to the whole group

# Verification – Activity

Rank	Hiking	Shopping	University	Travelling
1	Comfort	Design/ Aesthetics	Design/ Aesthetics	Capacity
2	Durability	Cost	Cost	Protection
3	Capacity	Capacity	Durability	Cost
4	Weight	Strength	Comfort	Design
5	Cost	Recyclable/ Reuse	Weight	Durability

## **03** Evaluation Theory

## Evaluation

**“A process for decision making”**



# many types of Evaluation Criteria

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➔ **Direct or weighted ranking**

➔ Systematic elimination

➔ Comparison across alternatives

➔ Comparison across a standard

➔ Mathematical techniques: Laplace, Maximin, Maximax, Hurwicz

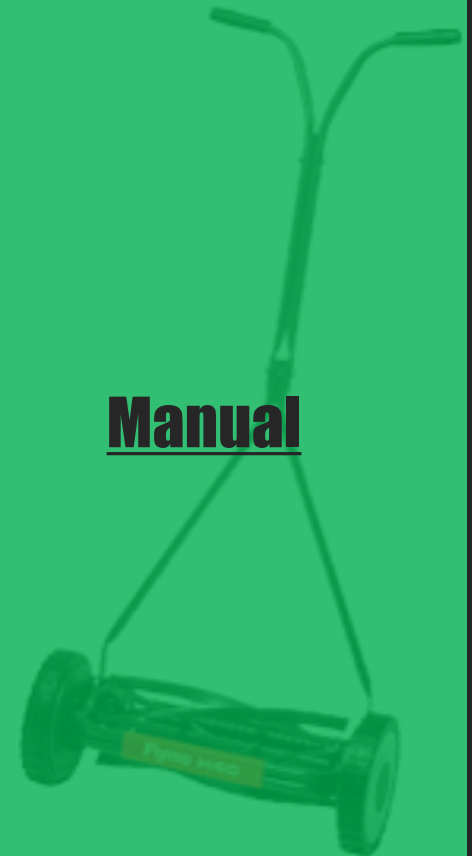
# Land-mower Example



Petrol



Electric

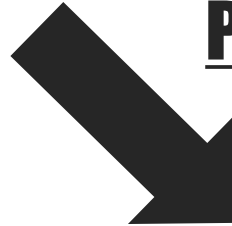


Manual

## Customer Requirements

- Durable
- Cheap
- Cuts Grass
- Easy to use
- Low maintenance
- Looks Good
- Reliable
- Spare parts
- Recyclable
- Low noise

## Pair-wise Analysis



	durable	cheap	cuts grass	easy to use	low maintenance	looks good	reliable	spare parts	recyclable	low noise	SCORE	RANK
durable		1	0	0	1	1	0	1	1	0	5	5
cheap	0		0	0	0	0	0	1	0	0	1	=9
cuts grass	1	1		1	1	1	1	1	1	1	9	1
easy to use	1	1	0		1	1	1	1	1	0	7	3
low maintenance	0	1	0	0		1	0	1	0	0	3	7
looks good	0	1	0	0	0		0	1	0	0	2	8
reliable	1	1	0	0	1	1		1	0	0	5	4
spare parts	0	0	0	0	0	0	0		1	0	1	=9
recyclable	0	1	0	0	1	1	1	0		0	4	6
low noise	1	1	0	1	1	1	1	1	1		8	2



# Evaluation Matrix

## SCALE

5 = Exceeds compliance

3 = Full compliance

1 = Partial compliance

0 = Non-compliance

	WEIGHTING		LAWNKEEPER PETROL		LAWNKEEPER ELECTRIC		FLYMO H40 MANUAL	
	RANK	WEIGHTING	RELATIVE COMPLIANCE	WEIGHTED VALUE	RELATIVE COMPLIANCE	WEIGHTED VALUE	RELATIVE COMPLIANCE	WEIGHTED VALUE
durable	5	1	3	3	3	3	3	3
cuts grass	1	5	5	25	5	25	3	15
easy to use	3	3	3	9	3	9	3	9
reliable	4	2	3	6	5	10	5	10
low noise	2	4	0	0	3	12	5	20
	TOTALS			43		59		57

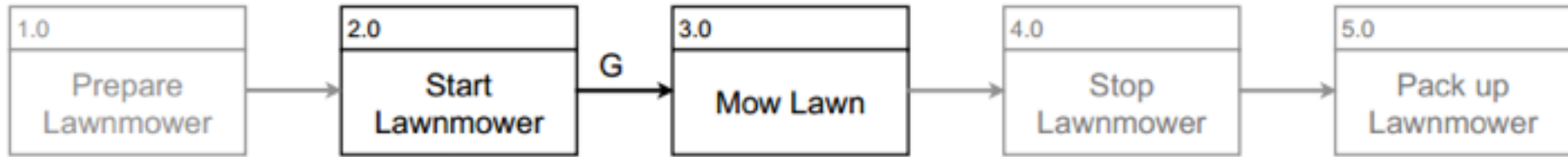
# Evaluation can occur at multiple stages

Customer Requirement	ID	Design Requirement
cuts grass	DR01-01	effective cutting mechanism
	DR01-02	catches grass appropriately
	DR01-03	safe for user and passers-by
reliable	DR02-01	minimise effort required to start
	DR02-02	minimise moving parts
easy to adjust	DR03-01	common adjustments made by hand
	DR03-02	adjustment time is fast
	DR03-03	adjustments are safe
low noise	DR04-01	minimise noise levels in operation

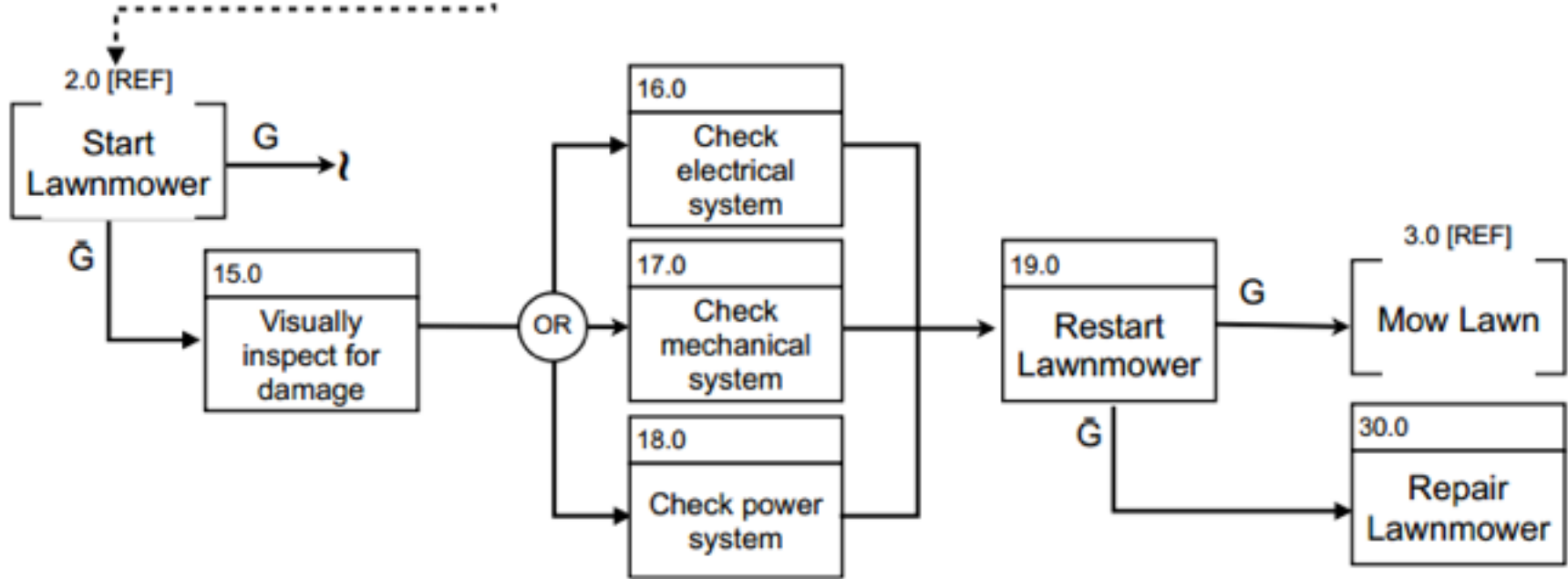
Primary Attribute	Secondary Attribute	Tertiary Attribute
A1.0 effective cutting mechanism	A1.1 fast spinning	A1.1.1 adjustable speed
		A1.1.2 adequate maximum speed
		A1.1.3 responsive speed
	A1.2 sharp blade	A1.2.1 self-sharpening
		A1.2.2 replaceable
A2.0 catches grass appropriately	A2.1 large catching area	A2.1.1 grass-to-catcher access
		A2.1.2 catcher cross-section size
	A2.2 removable catcher	A2.2.1 quick release
		A2.2.2 easy to manoeuvre

# Evaluation can occur at multiple stages

## FUNCTIONAL FLOW - TOP LEVEL



## MAINTENANCE FLOW - FIRST LEVEL





## Don't blindly choose the 'highest' option

- ❯ Does the product meet the benchmarks?
- ❯ Are the customer requirements complete?

## **04** Evaluation Application







# Conclusion



# Reference

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[http://eng.anu.edu.au/courses/ENGN2225/course-files/online\\_classroom/OC-Wk09\\_Evaluation.pdf](http://eng.anu.edu.au/courses/ENGN2225/course-files/online_classroom/OC-Wk09_Evaluation.pdf)

## Images

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