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Department of Mechanical, Materials & Manufacturing Engineering
Design and Manufacture
Morphology Chart Creation and Presentation

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Background

- The purpose of the PDR is to demonstrate that there is an **optimum concept** that has a **high probability** of meeting the requirements.
- To do that requires concept options to be created, a Morphology chart is a means of capturing ideas for **reference and communaction**
- Creating a Morphology chart requires identifying **the Functions** of the device, component, system or process (the first column of the matrix), and then as many **Means** as possible to satisfy each function, the rows of the matrix.
- If the device is completely new and there are none with the same or similar prime functions then it can be challenging to complete the chart without considerable iteration.
- However the task becomes easier if it is possible to consider an object with similar functions, as in the Generate Concept lecture where an Ink Jet Printer was derived from the Morphology of a pencil.

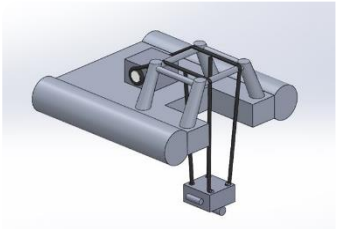
The Underwater Surveillance Device

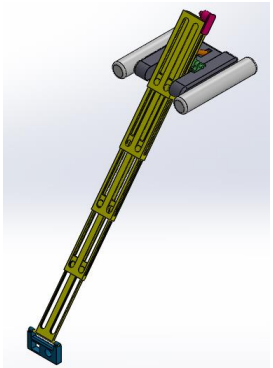
- There was no precedent for this device, it was completely new.
- The requirement for the team was:
  - To complete **a Generic Morphology Chart** to capture all their creative thinking.
  - To create **Concept Specific Charts** to illustrate how each of their concepts satisfied ALL the functions.
- They created many concepts, some were not viable, some were eliminated based on engineering judgement but five were considered worthy of detailed evaluation.
- In the project presentation the Generic Chart was full size, but the specific concept charts were reduced for clarity of illustration, the full-size versions would have been presented in the formal report.

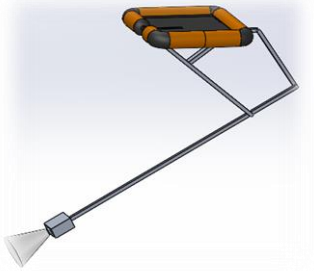
Capturing Ideas – the Generic Morphology Chart

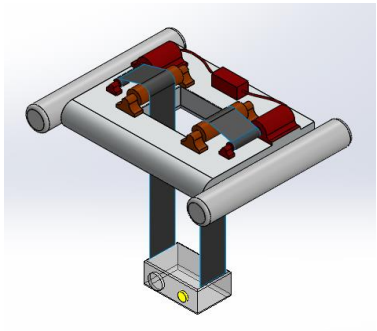
Functions	Options								
	A	B	C	D	E	F	G	H	I
To survey underwater (PF)	Camera	Sonar	Collector	Optical Wire	Periscope	Endoscope	None		
To provide power	Battery	Two-stroke engine	Four-stroke engine	Solar cell	Shore-based	Turbine	Hydraulic	None	
To support viewing device at 2m	Runner pole	Wires	Belt	Telescopic pole	Unit fixed periscope	Linkage	Pantograph	Ladder	None
To enable support to reach 2m	Powered lead screw	Winch	Pneumatic piston	Powered chain/belt	Inflatable bladder	Powered worm wheel	None		
To attach to the water manager	Bolts	Two-bar linkage	Elastomer j oint	Accordion	Welding	Slider	Train coupli ng	Four-bar linkage	None
To provide buoyancy	Single sealed hull	Catamaran sealed hull	Bladder	Drums	Waterproof foam	Low density material	None		
To rotate the surveyor	Water Manager	Servo motor	Propellers	Pressured jet	None				
To record footage	Saved remotely	Solid state memory	Cloud	Optical memory	None				
To improve surveying capability	Allow silt to settle	High resolution equipment	Light	Obstacle mover	Windscreen wipers	Air/water jets	None		
To control Device	Radio	Bluetooth	Wi-Fi	Mechanical	Voice	Wired remote	None		

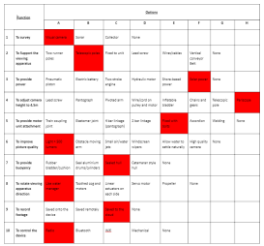
The Concept Specific Charts with Each Concept

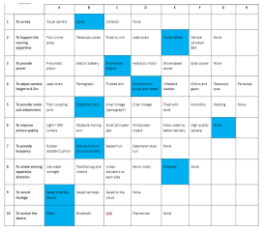












The Thrust Reverser Actuation System Lock

- There are many instances where powered machinery is locked to prevent it from operating if powered inadvertently, usually for safety and only unlocked on commend.
- The device must be unlocked before the machinery can be used:
  - Chain saws
  - Land Rover Transmission Brake
  - Mobility scooter
  - Automatic transmission electric brakes
- The Aircraft Thrust Reverser System Lock (TRASL) is another.
- **They all have the same Functions just different Means of satisfying them.**
- So by analysing the Chainsaw the Morphology of a TRASL can be created.
- This provides the means to create concept options

The Chainsaw Morphology

- One function is ‘To counter the applied torque’.
- The chainsaw lock achieves that by the Band brake.
- To aid generating other Means it could be generically termed ‘Circumferential friction’.
- By changing one word other means can be identified:
  - Radial friction
  - Axial friction
  - Axial positive
  - Radial positive
  - Circumferential Positive

The Basic Generic Morphology Chart

- The first line of the Generic Chart can then be completed

Locking Device							
	Functions/Means						
1	**To counter the applied torque**	Circumferential friction	Radial friction	Axial friction	Axial positive	Radial positive	Circumferential positive
2	**To…...**						
3	**To…...**						
4	**To…...**						

Deriving the Practical Means

- However for each of those generic Means there are numerous specific ones, and there could be more:
  - Circumferential Friction
    - *Band brake*
  - Radial friction
    - *Drum brake*
  - Axial friction
    - *Plate clutch*
    - *Cone clutch*
    - *Calliper brake*
  - Axial positive
    - *Hirth coupling*
    - *Dog Clutch*
  - Circumferential Positive
    - *Toothed belt*
  - Radial positive
    - *Locking gear*

Compiling the Chart

- In the Morphology Chart with six primary identified means with various sub options for each, the rows start to become very long.
- This becomes a difficult presentation problem to capture the essentials and still be readable.
- A suggestion would be to use Excel Spreadsheet to capture all the thinking, which has flexibility for new ideas as they are generated.

Locking Device										
	Functions/Means									
1	**To counter the applied torque**	Circumferential Friction	Radial Friction	Axial Friction			Axial positive		Radial positive	Circumferential positive
		Band brake	Drum brake	Plate Clutch	Cone Clutch	Caliper brake	Dog clutch	Hirth coupling	Meshed gears	Toothed belt
2	**To……**									
3	**To……**									
4	**To……**									

Compiling the Chart

- The next stage is to populate the rest of the chart
- The obvious one is ‘To engage the lock’, in the case of the chainsaw that is the function of the coil spring.
- By referring to that generically as ‘Mechanical’ it stimulates other specific means and other generic ones.

Locking Device										
	Functions/Means									
1	**To counter the applied torque**	Circumferential Friction	Radial Friction	Axial Friction			Axial positive		Radial positive	Circumferential positive
		Band brake	Drum brake	Plate Clutch	Cone Clutch	Caliper brake	Dog clutch	Hirth coupling	Meshed gears	Toothed belt
2	**To engage the lock**	Mechanical			Electrcal	Hydraulic	Pneumatic			
		Coil spring	Disc spring	Leaf spring						
3	**To….**									
4	**To…..**									

Compiling the Generic Chart

- The corollary of ‘To engage the lock’ would be ‘To disengage the lock’
- So by a means of logical steps and studying the features of the Chainsaw a complete Morphology chart can be completed.
- This can be presented in the PDR by copying and pasting into Word or PowerPoint

Locking Device										
	Functions/Means									
1	**To counter the applied torque**	Circumferential Friction	Radial Friction	Axial Friction			Axial positive		Radial positive	Circumferential positive
		Band brake	Drum brake	Plate Clutch	Cone Clutch	Caliper brake	Dog clutch	Hirth coupling	Meshed gears	Toothed belt
2	**To engage the lock**	Mechanical			Electrcal	Hydraulic	Pneumatic			
		Coil spring	Disc spring	Leaf spring						
3	**To disengage the lock**	Mechanical			Not complete!!					
		Lever cam								
4										

Presenting Specific Concepts

- It is necessary to identify the means of achieving the functions for a specific concept, as was the case of the Underwater Surveillance Device.
- Using the Chainsaw as an example, the means can be highlighted to define its Morphology.

Locking Device										
	Functions/Means									
1	**To counter the applied torque**	Circumferential Friction	Radial Friction	Axial Friction			Axial positive		Radial positive	Circumferential positive
		Band brake	Drum brake	Plate Clutch	Cone Clutch	Caliper brake	Dog clutch	Hirth coupling	Meshed gears	Toothed belt
2	**To engage the lock**	Mechanical			Electrcal	Hydraulic	Pneumatic			
		Coil spring	Disc spring	Leaf spring						
3	**To disengage the lock**	Mechanical								
		Lever cam								
4										

Presenting Specific Concepts with a Large Chart

- If the Generic Chart becomes too large to copy and paste legibly **(unlikely in the case of the TRASL)**
  - The full spread sheet should be submitted along with the report with a hyper link.
  - The Generic Morphology Chart presented in the ‘Basic’ form
  - An extract of the chart can be created for specific concepts, omitting detail of redundant features:

Locking Device							
	Functions/Means						
1	**To counter the applied torque**	Circumferential Friction	Radial Friction	Axial Friction	Axial positive	Radial positive	Circumferential positive
		Band brake	Drum brake				
2	**To engage the lock**	Mechanical			Electrcal	Hydraulic	Pneumatic
		Coil spring	Disc spring	Leaf spring			
3	**To disengage the lock**	Mechanical					
		Lever cam					
4							

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