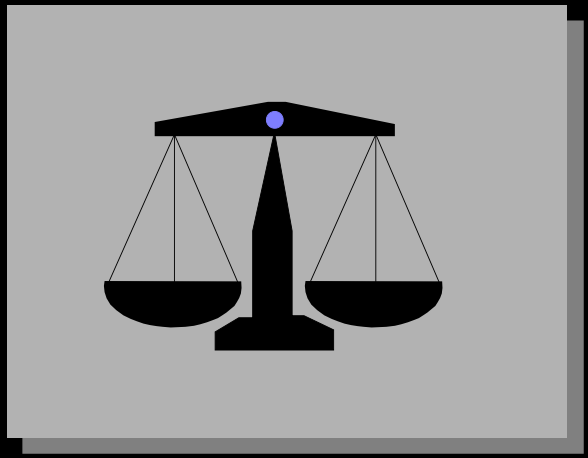
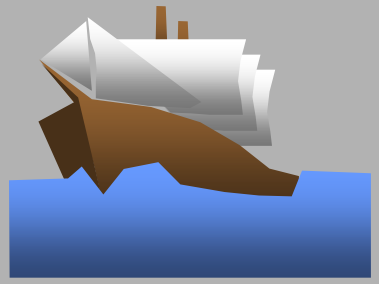
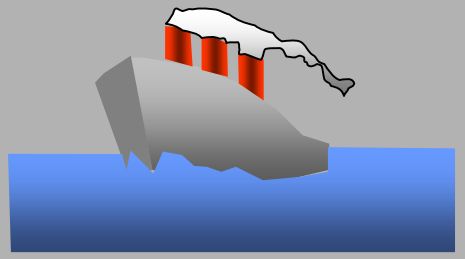
Objective Laws Of System Evolution

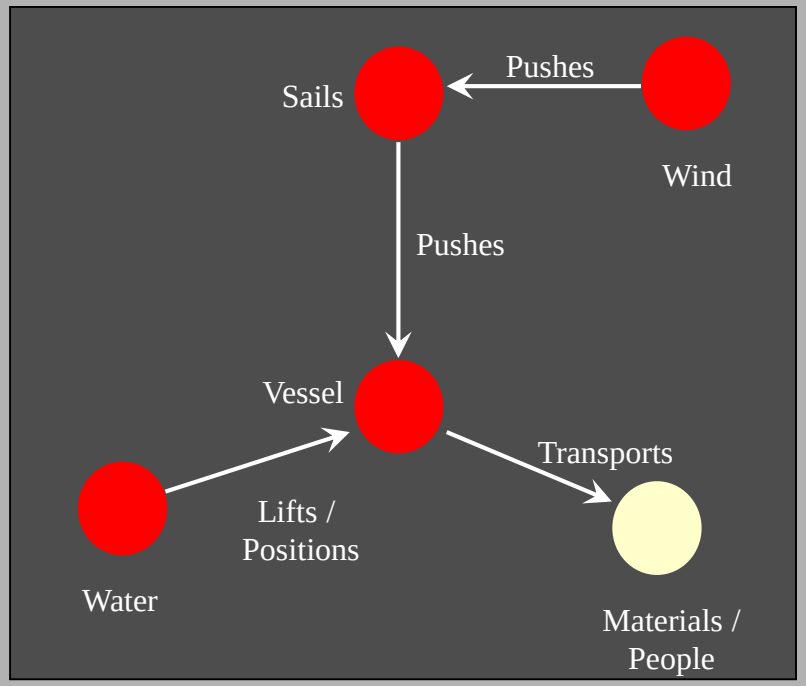


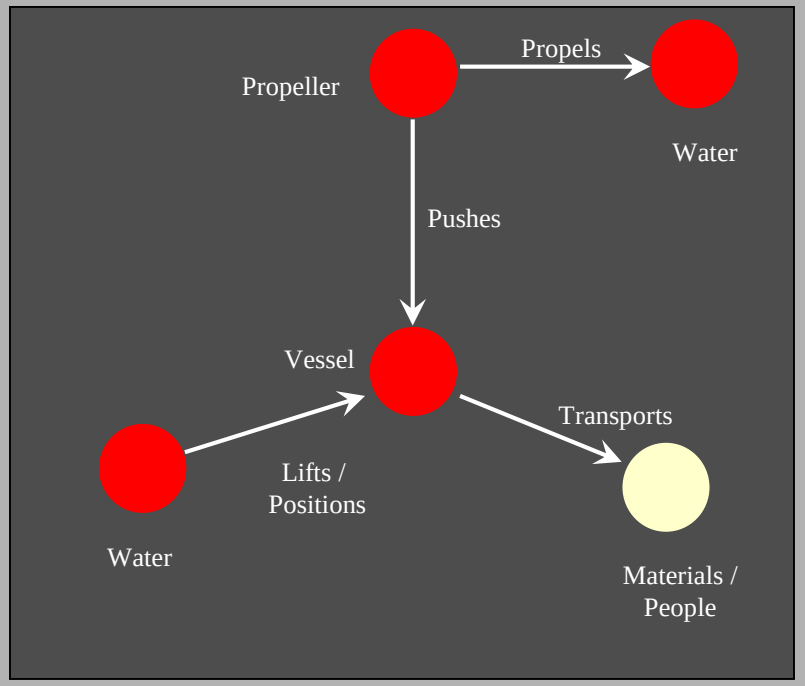
Systems Evolve in Predictable Ways

Systems Never Remain Static

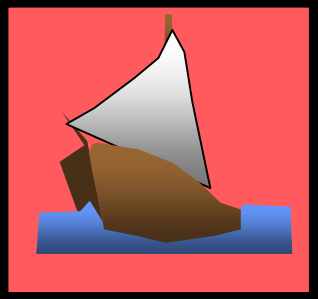
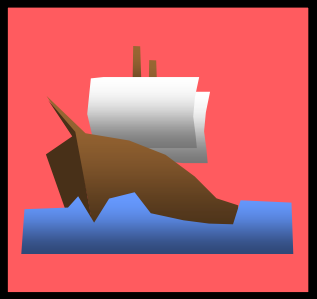
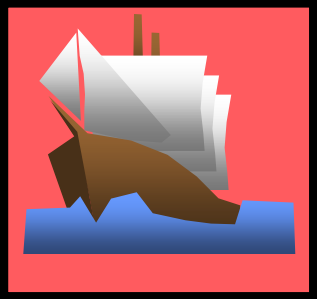
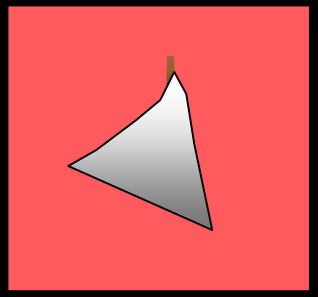
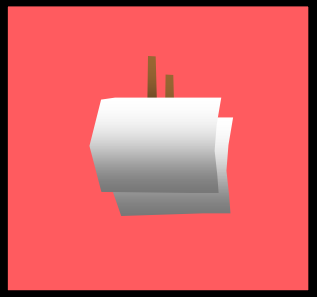
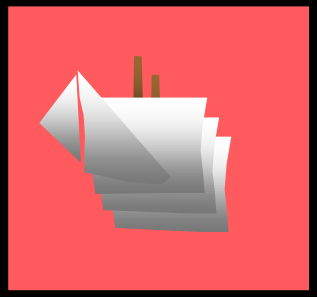
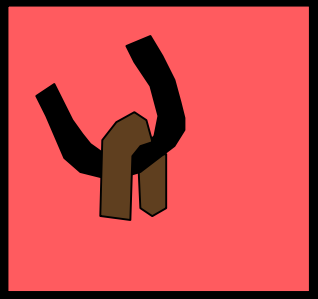
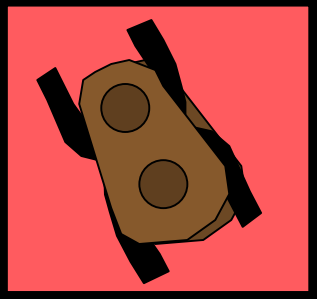
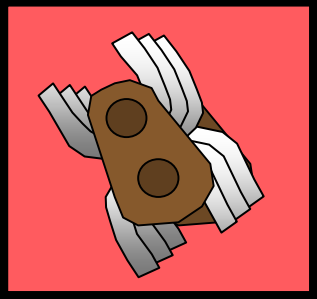




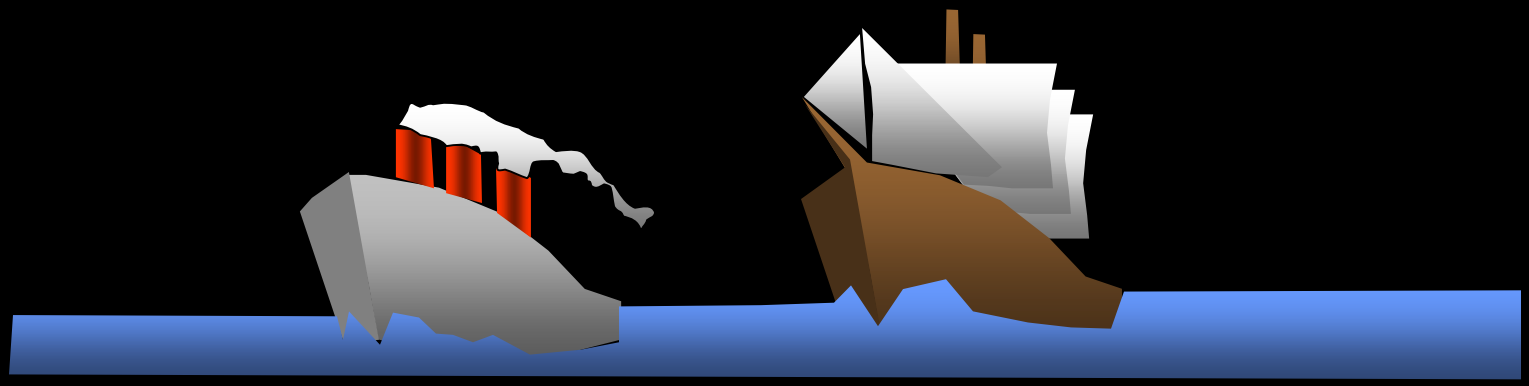




Systems Change at all levels

	Past	Present	Future
Super System			
System			
Sub System			

If two systems have the same function, but use different effects (physical phenomena) to deliver the main function we will call them different systems



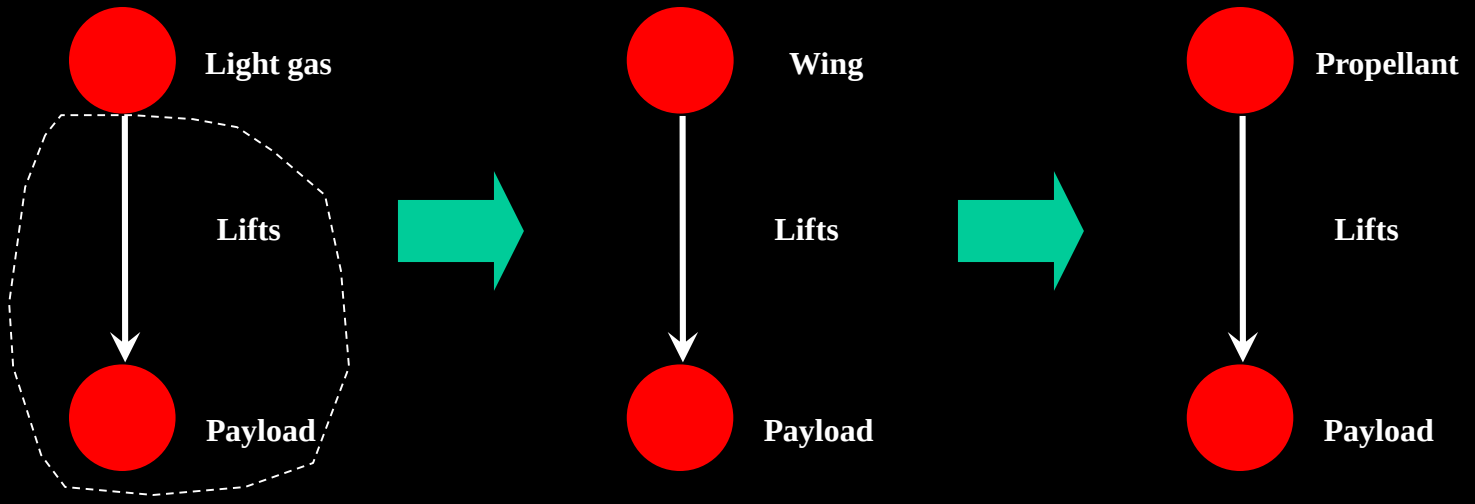
Different Propulsion Systems

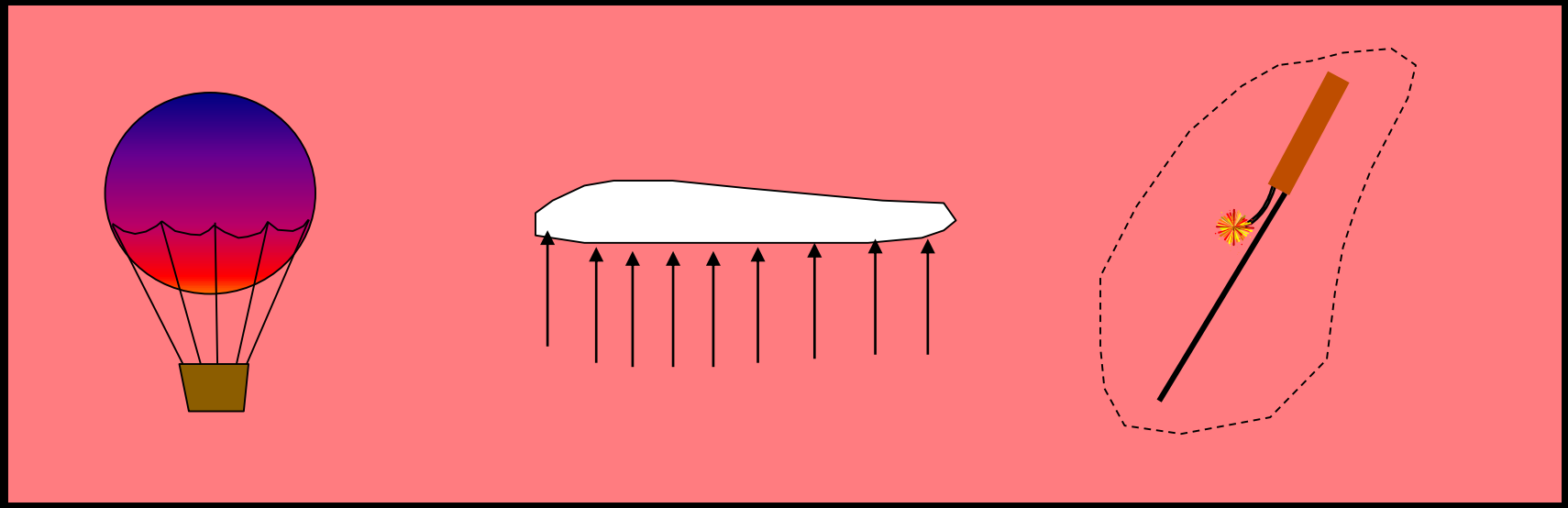
Same Function but Different Effects (Steam Powered and Wind Powered)

Same Propulsion System

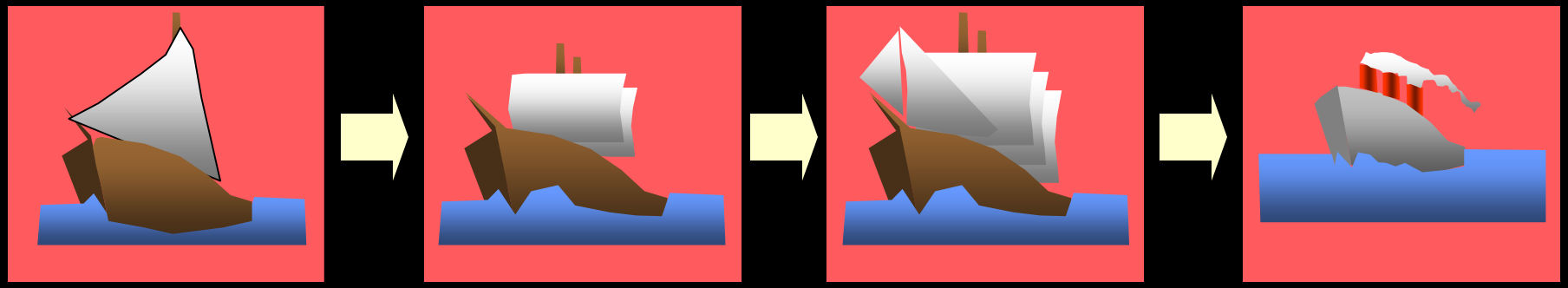
Same Function and Same Effect (Oars)

What Stages Occur Between Effects?



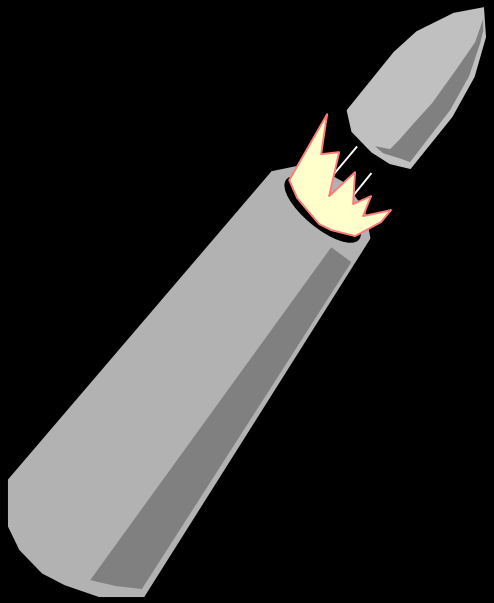


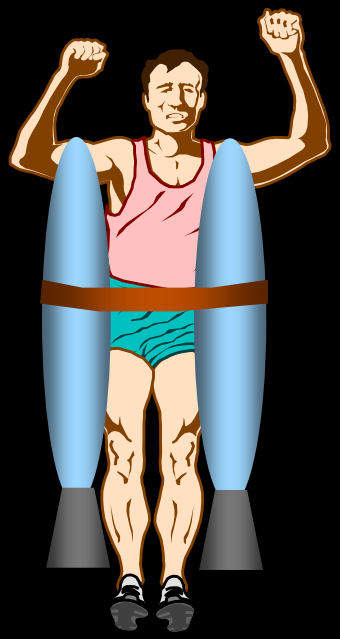
Law of Stages



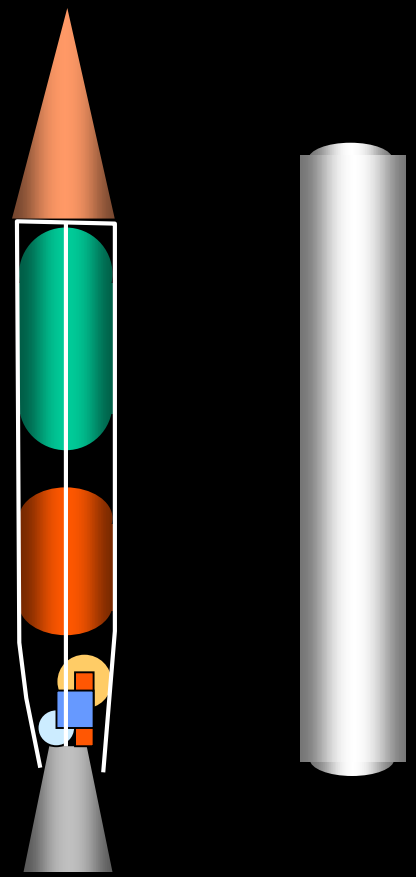
How systems grow up

Stage 1: Determining the Parts and Where They Go



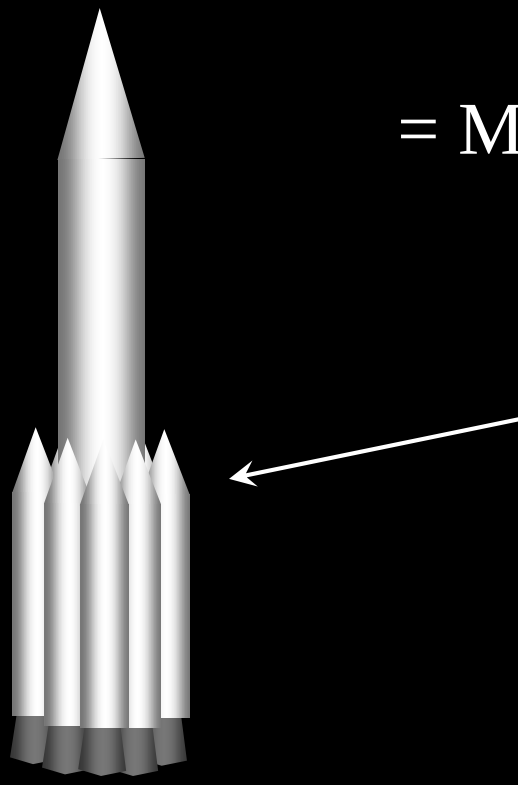


Stage 2: Removing the Bad Marks



Fuel Tanks become supporting structure

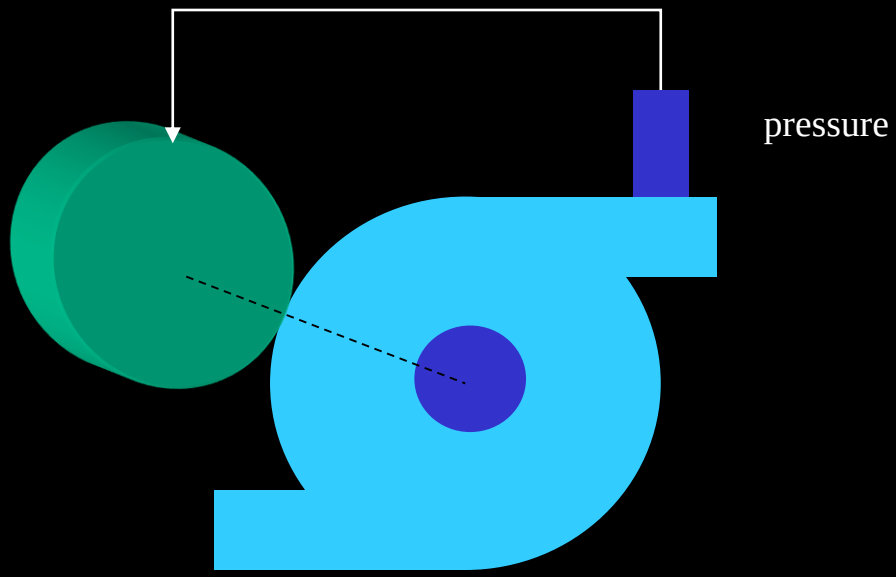
Stage 3: Dynamizing



= Make Adjustable

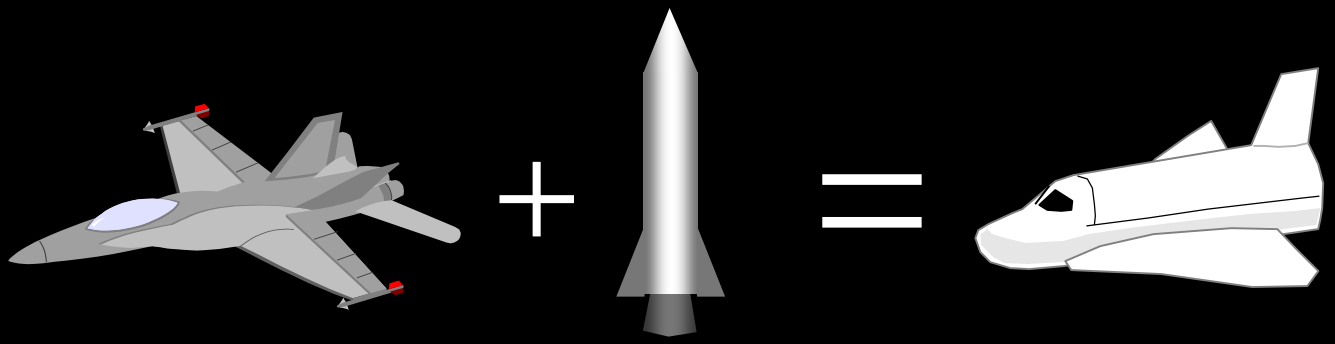
Boosters can be added or removed depending upon payload

Stage 4: Introducing Feedback

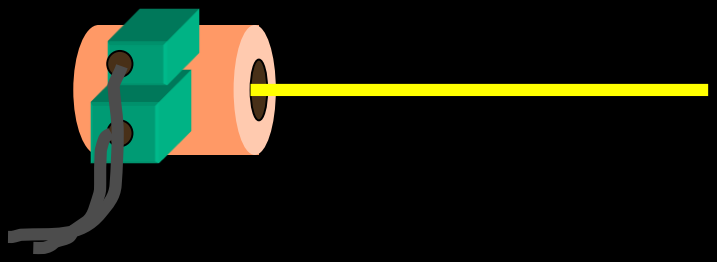


Stage 5: Transition To New Effect
The Effect is Still Present but...

Combine with Super-system



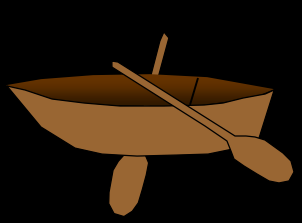
Macro to Micro (Make use of Bulk Properties)

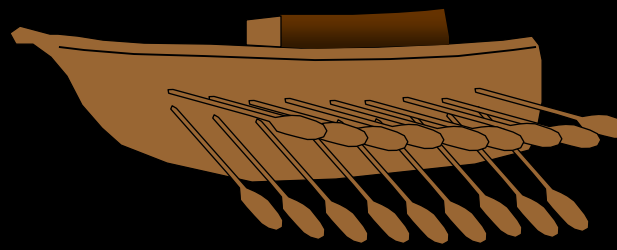


Ionic Drive Engine
uses bulk properties of Plasma

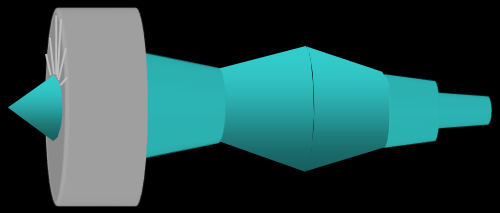
Time For a New Effect?

↓ Has the system become very specialized?

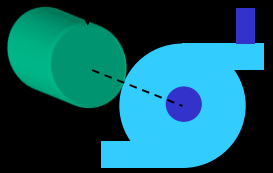




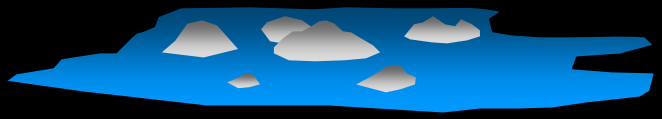
↓ Has the system reached the point of diminishing return?



↓ Is automatic feedback used to perform the main function?



↓ Must multiple conflicts be resolved for improvement?



New Effect Towards End of Maturity

Level of invention

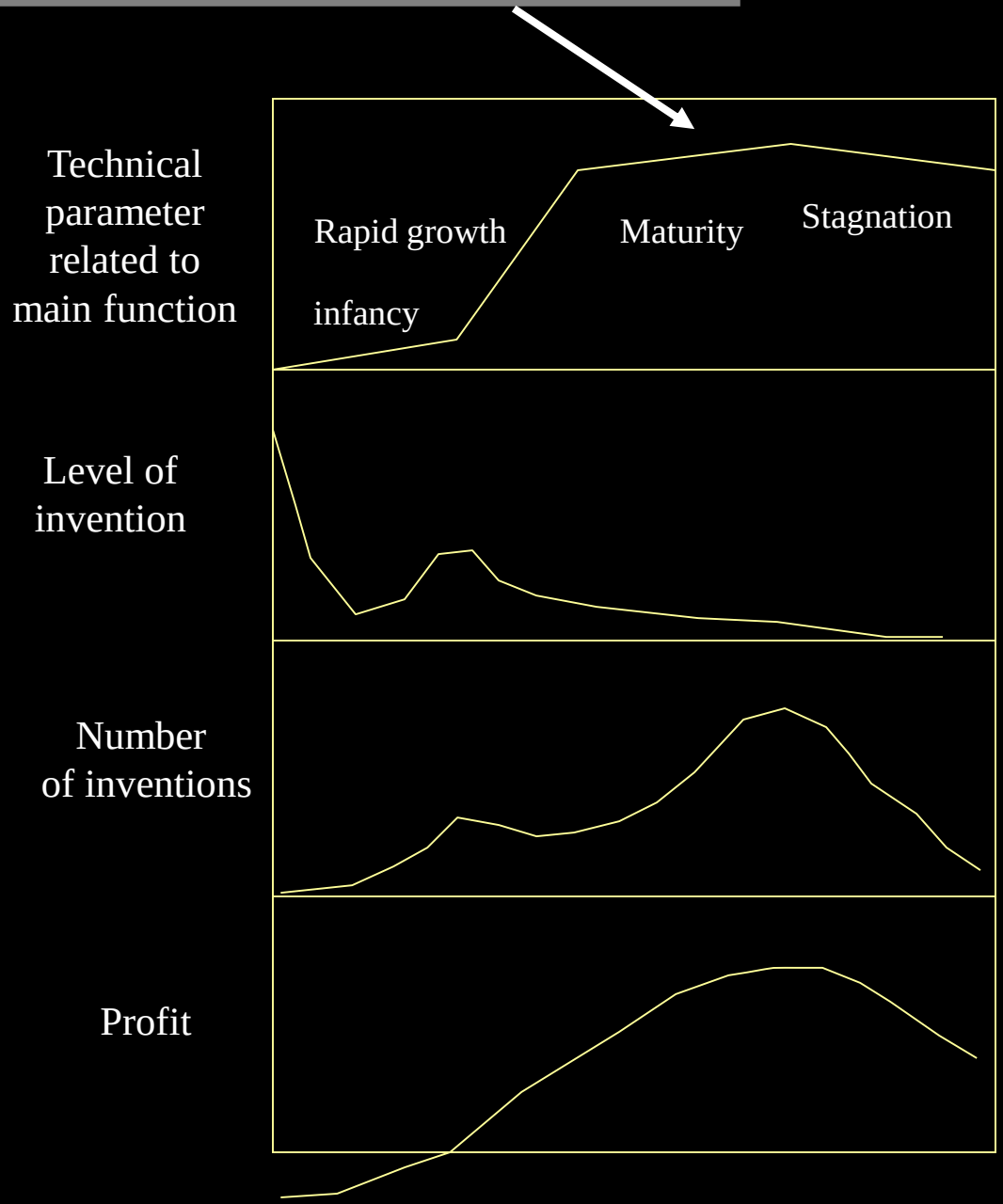
1. **No resolution of contradiction**

2. **Resolves contradiction with small change**

3. **Resolves contradiction with a major change. Uses technology from same field**

4. **Resolves contradiction. Complete change in Effect. Usually a technology from another field.**

5. **Fundamental Effect. Has ability to change the super-system to which it belongs.**



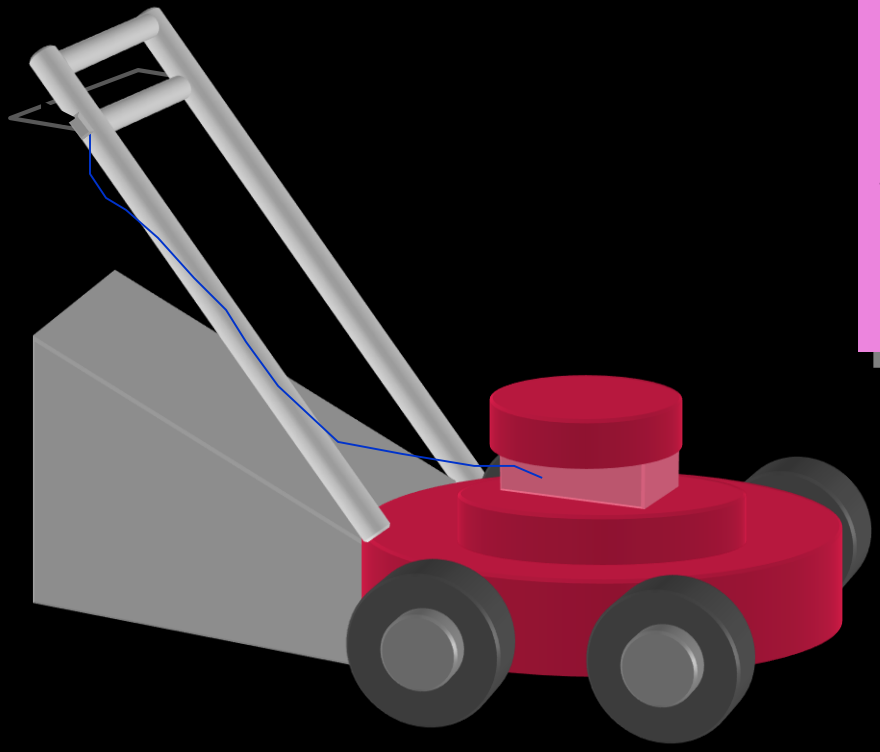
Law of Increasing Ideality

More **functions done *better***

$$\text{Ideality} = \frac{\text{Index of Useful Functions}}{\text{Index of Harmful Functions}}$$

Less Harmful Functions (Includes $ Time Weight and Harmful Interactions)

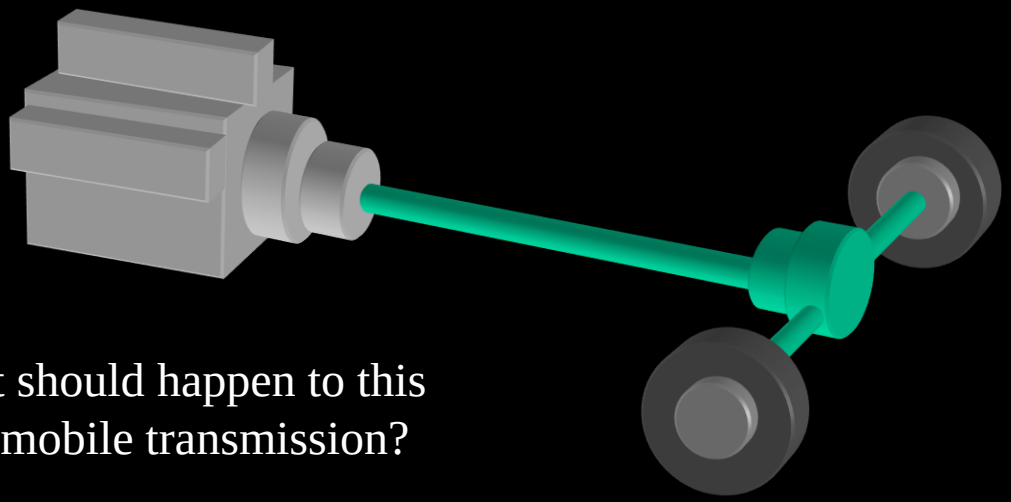
Ideality Exercise



Based upon the laws of ideality, what should happen to this lawn mower?

Law of Shortening Energy Paths

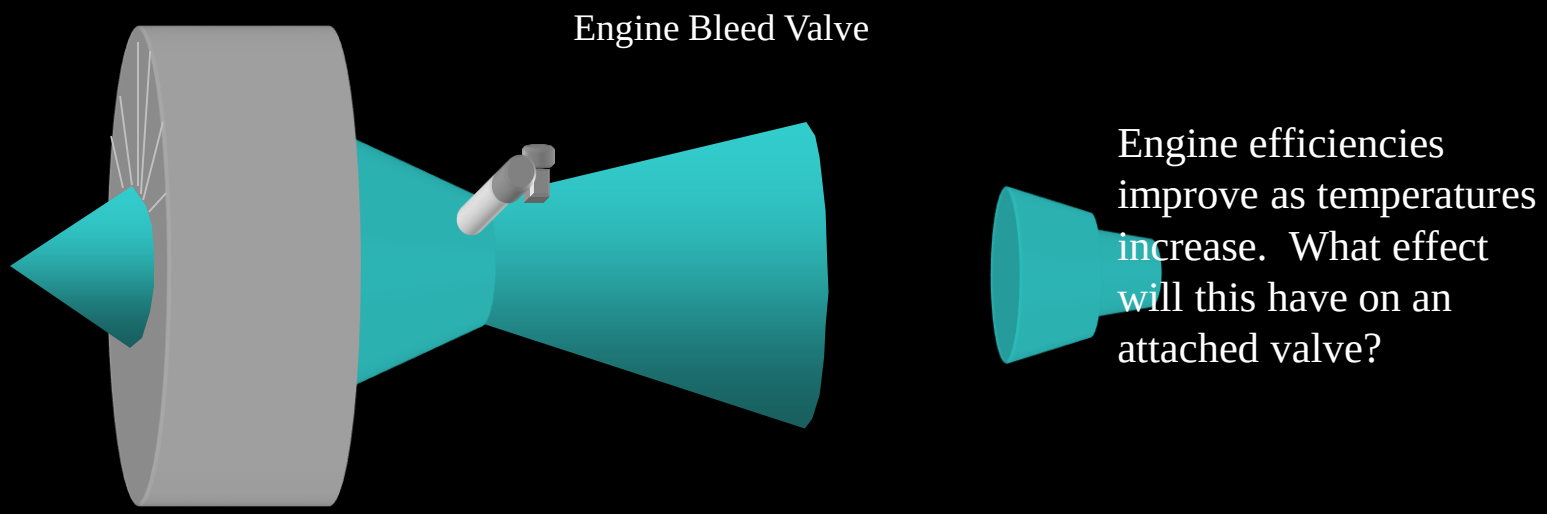
- Transmissions paths are shortened and eventually eliminated
- Energy transformations are reduced and finally eliminated.
- Muscle and control signals use the same field.



What should happen to this automobile transmission?

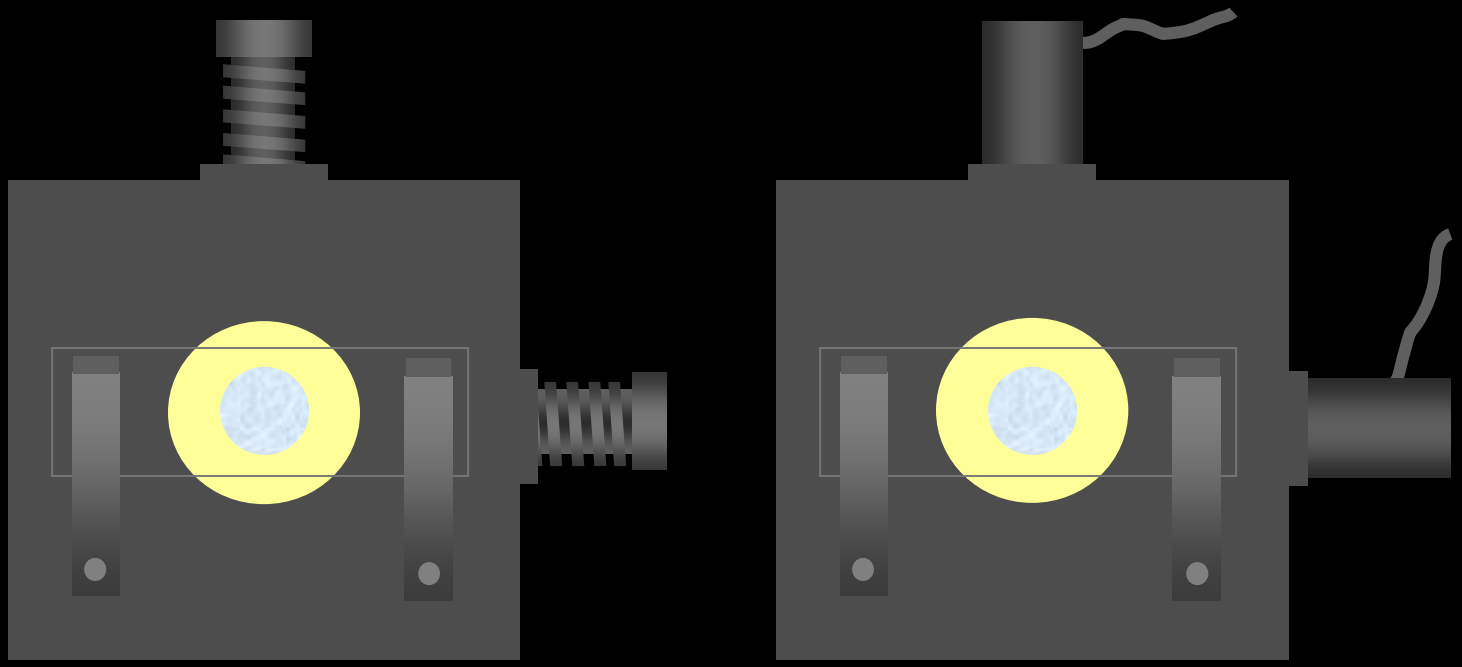
Law of Non-Uniform System Development

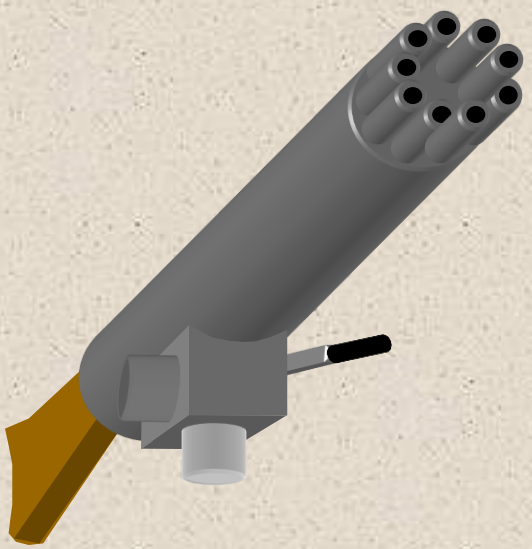
- System parts are improved in “fits and spurts”
- When one part is improved, other parts may be harmed.
- System improvement is slowed by increasing conflicts.
- When one part improves, other parts may appear worse by comparison.
- System Takes on Subsystem improvements and Effects

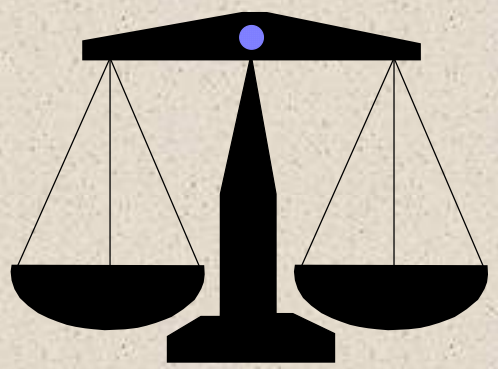


Law of Transition from Macro to micro

↓ Functions performed at the macro-level are eventually performed at the micro level where the **bulk properties** are controlled by a field.



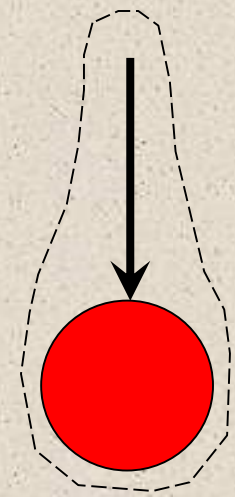




Lines of Evolution

Field

= Fundamental fields in physics which can be combined to form Effects



Move

Buoyancy

Liquid

Fields used in Buoyancy

Gravity

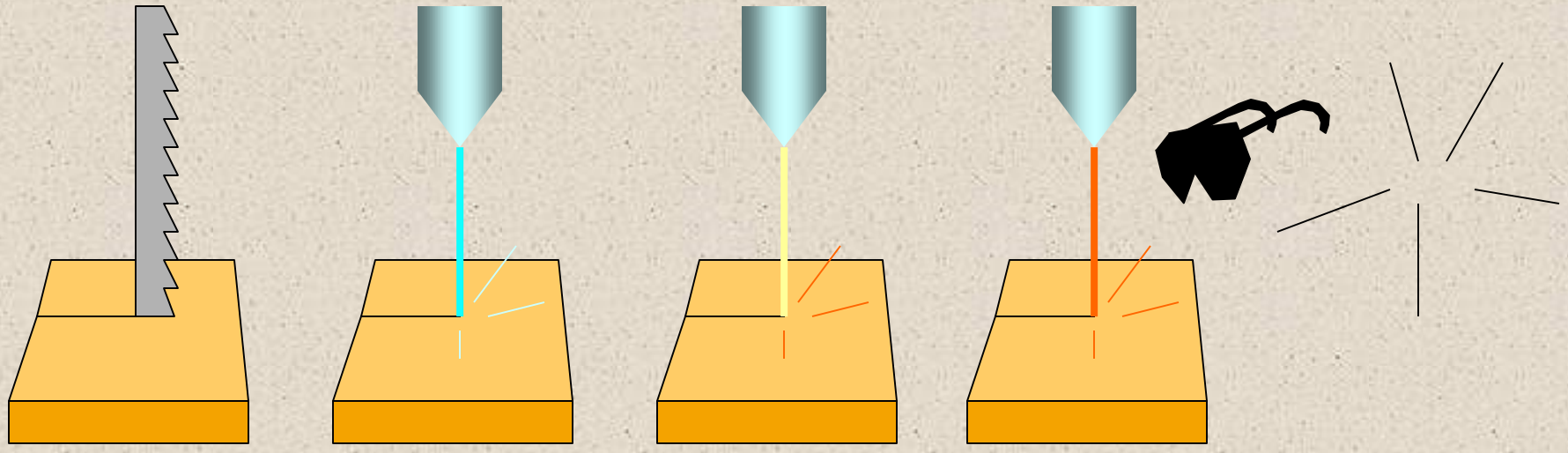
Pressure

TRIZ Fields

Elastic Force Internal and external	Gravity	Friction	Adhesive
Centrifugal Force	Inertia of Bodies (note direction)	Coriolis Force	
Bouyant force	Hydrostatic pressure	Jet Pressure	Surface Tension
Oder & Taste	Diffusion	Osmosis	Chemical Fields
Sound	Vibrations & Oscillations	Ultrasound	Waves
Electric Discharges (Corona)	Current	Eddie Currents (internal and skin)	Particle Beams
	Thermal Heating	Thermal Shocks	Nuclear Forces
	Electrostatic	Magnetic	
	Electromagnetic (Voltage)		Information

Radio Waves	Micro waves	Infrared	Light (Coherent & light Pressure)	Ultra- violet	X-Ray

Lines of Evolution
States and Fields

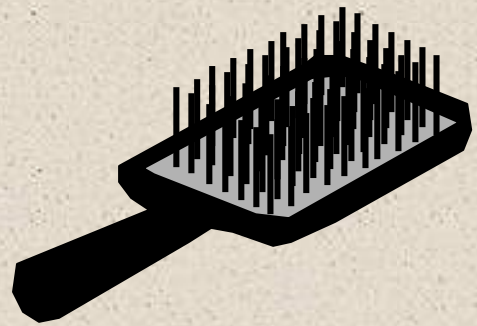


Solid **Liquid** **Gas** **Field** **Not Existing**

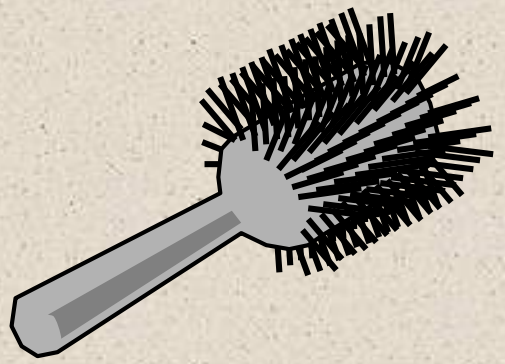
Lines of Evolution
Dimension

Point

1-Dim



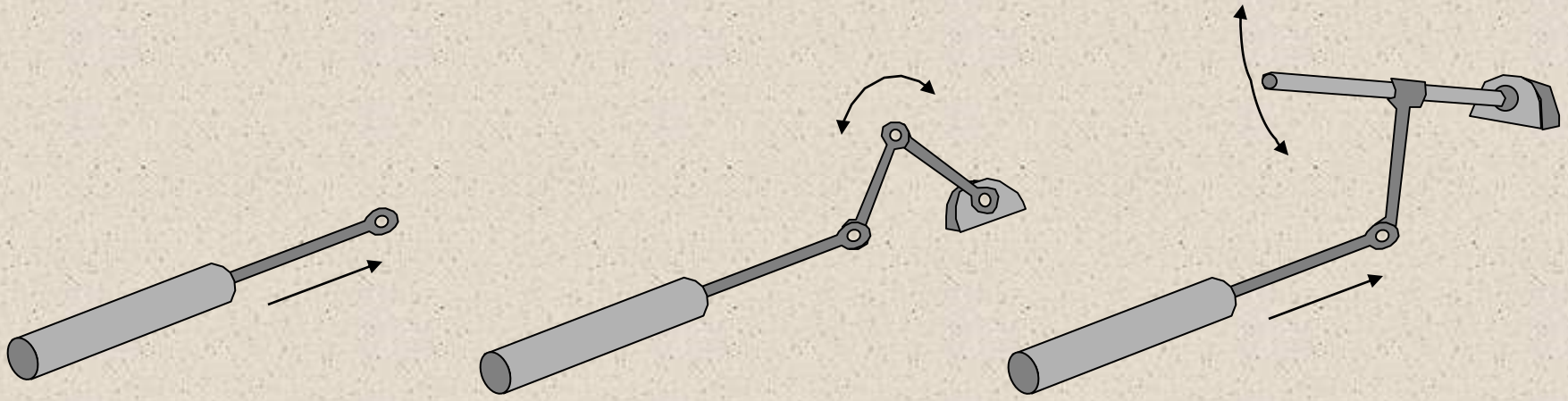
2-Dim



3-Dim

Lines of Evolution

Path



Linear

Curved in Plane

Curved out of Plane

Lines of Evolution
Dynamization

Fixed

Joint

Multiple Joints

Flexible

Lines of Evolution
Control

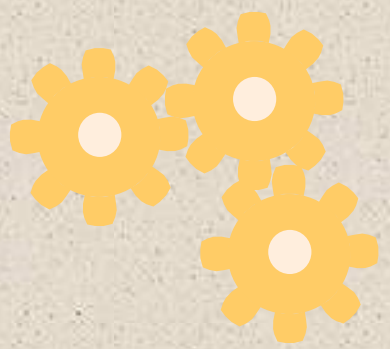
Fixed

Dynamized

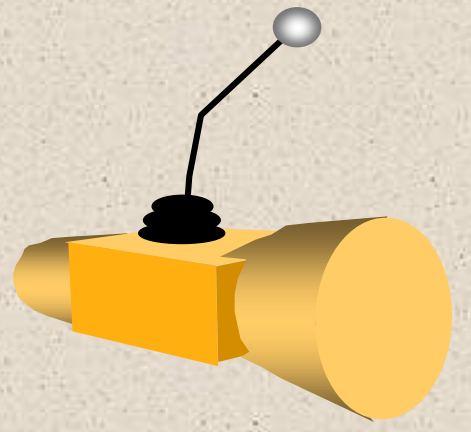
Increased Dynamization (Continuous, Multiple)

Feedback

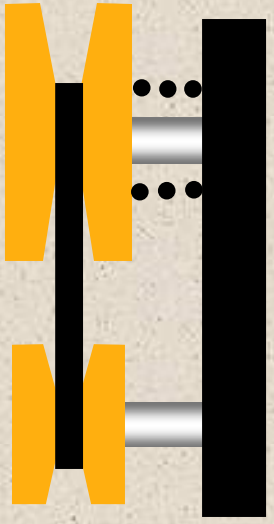
Lines of Evolution
Continuity of Variability



Invariable

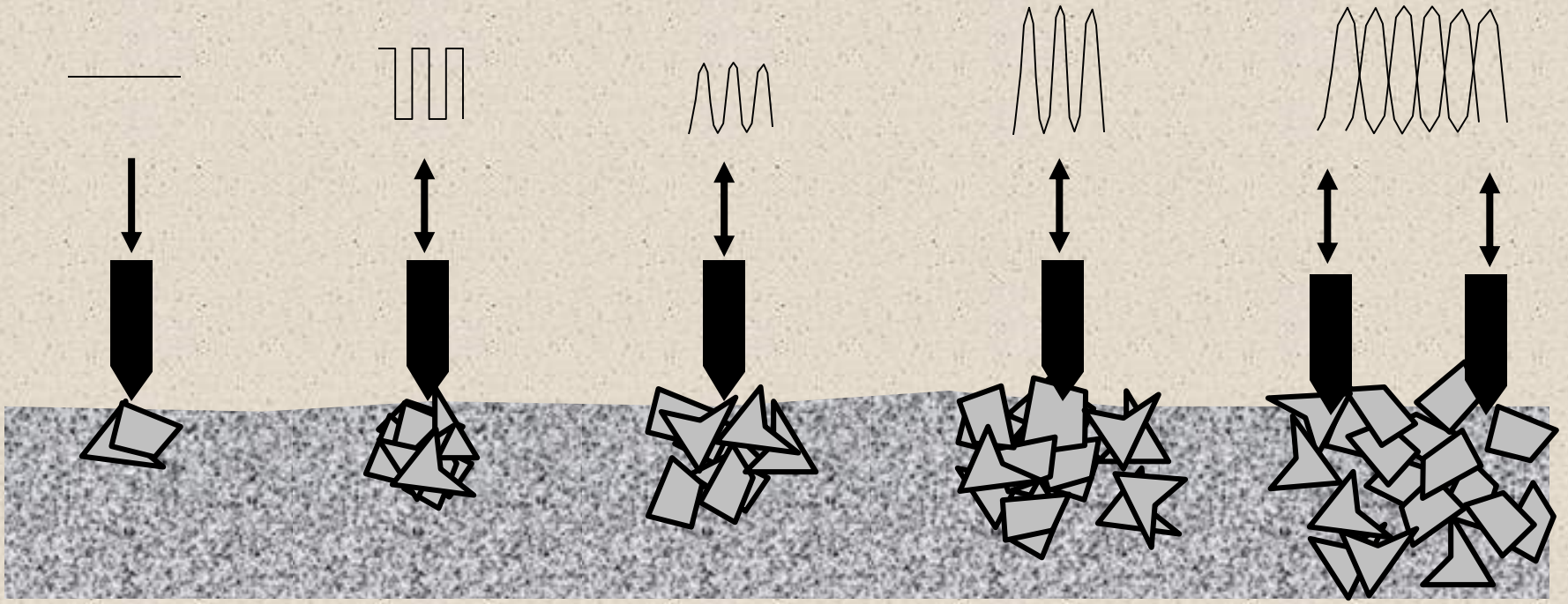


Stepwise Variable



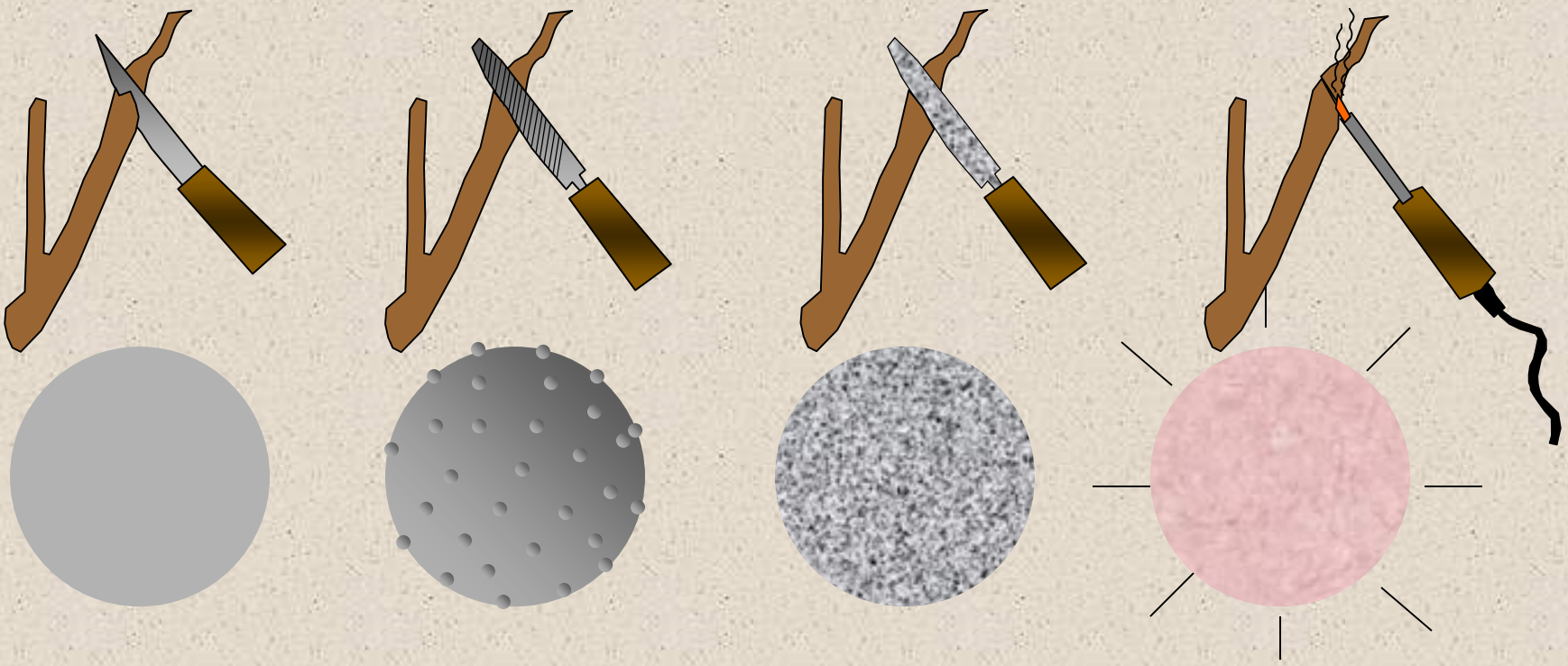
Continuously Variable

Lines of Evolution
Oscillations



Continuous **Pulsed** **Oscillating** **Resonating** **Standing Wave**

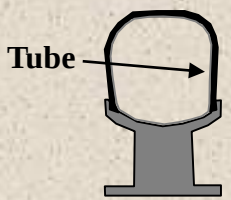
Lines of Evolution
Surface Structure

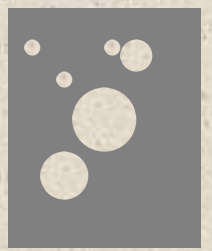


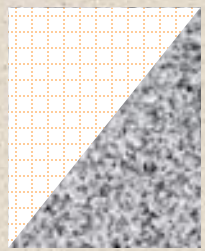
Smooth **Protrusions** **Roughness** **Activated Surface**

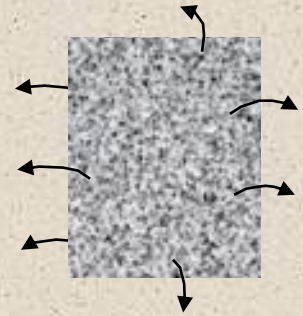
Lines of Evolution

Voids





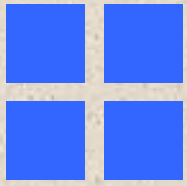




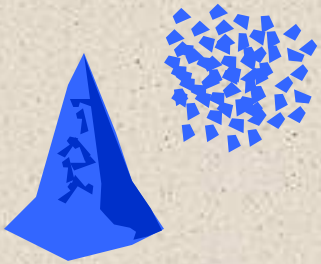
Monolith **Cavity** **Voids** **Capillary Structures** **Dynamized Pores**

Lines of Evolution
Segmentation

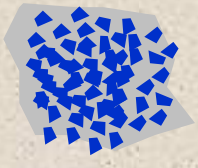
Monolith



Parts



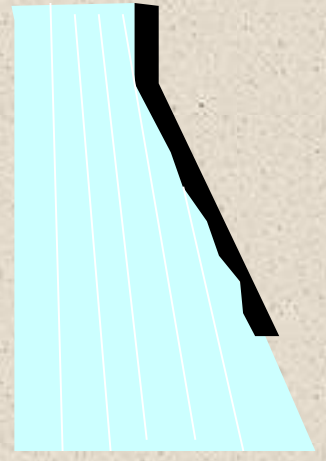
Powders
Mist



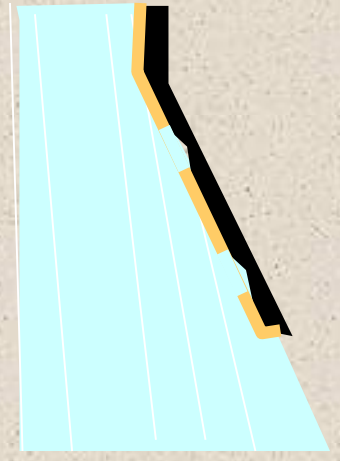
Mixed
Media

Lines of Evolution
Mediators

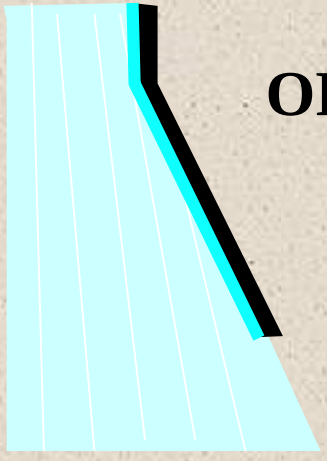
Rocket Nozzle



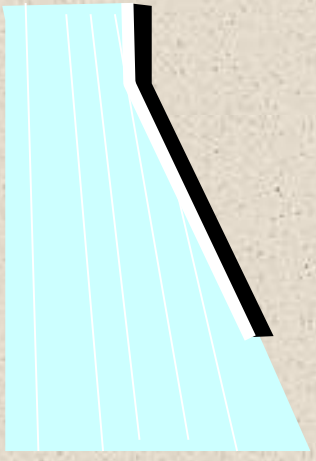
No Separation



Separator



OR



Separator made from Existing Objects

Separator Made From Voids

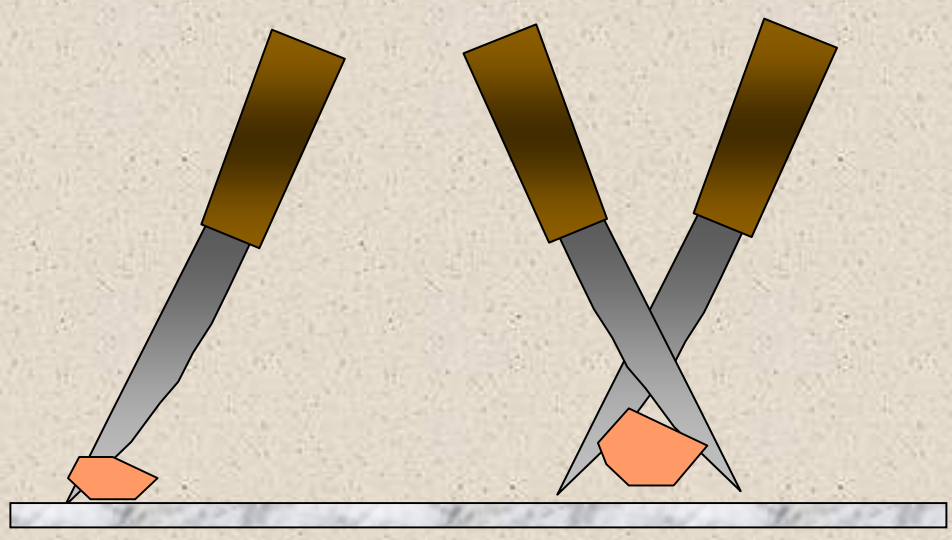
Lines of Evolution

Double
Multiply
Group

(Same)
(Biased)
(Different)
(Opposite)

Combine
Interact

Consolidate



?

Mono-System

Bi-System

Interacting

Mono-System (Fully Consolidated)

Lines of Evolution

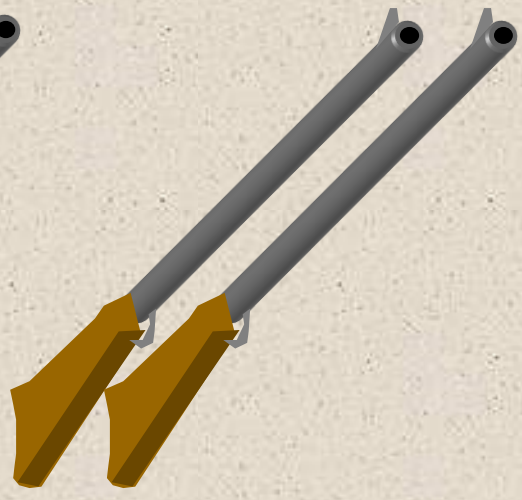
Double
Multiply
Group

(Same)
(Biased)
(Different)
(Opposite)

Combine
Interact

Consolidate

Mono-system



Homogeneous
Bi-system

Combined and
Partially
Consolidated

Mono-System
(Fully
Consolidated)

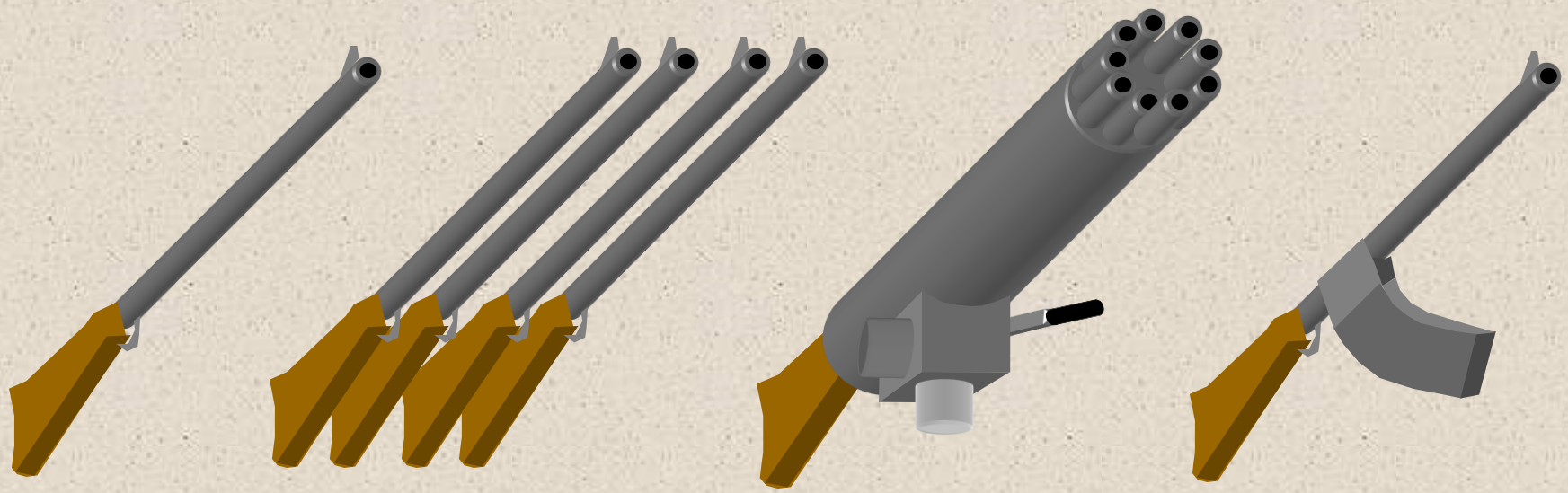
Lines of Evolution

Double
Multiply
Group

(Same)
(Biased)
(Different)
(Opposite)

Combine
Interact

Consolidate



Mono-system

Homogeneous
Poly-system

Combined and
Partially
Consolidated

Mono-System
(Fully
Consolidated)

Lines of Evolution

Double
Multiply
Group

(Same)
(Biased)
(Different)
(Opposite)

Combine
Interact

Consolidate

Bi-System
(Biased)

Combined and
Partially
Consolidated

?

Mono-System
(Fully
Consolidated)

Lines of Evolution

Double
Multiply
Group

(Same)
(Biased)
(Different)
(Opposite)

Combine
Interact

Consolidate

Bi-System
(Different)

Combined and
Partially
Consolidated

?

Mono-System
(Fully
Consolidated)

Lines of Evolution

Double
Multiply
Group

(Same)
(Biased)
(Different)
(Opposite)

Combine
Interact

Consolidate

Bi-System

Combined and Partially Consolidated

?

Mono-System (Fully Consolidated)

Lines of Evolution

Double
Multiply
Group

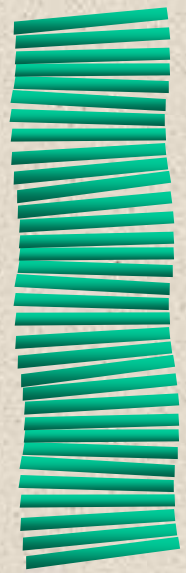
(Same)
(Biased)
(Different)
(Opposite)

Combine
Interact

Consolidate

Mono-System

Multiplied and Interacting



Mono-System (Fully Consolidated)