

CATASTROPHE THEORY

Discovered by René Thom
around 1962-1969

Method of modelling.

CONTINUOUS
CAUSES \longrightarrow DISCONTINUOUS
EFFECTS.

Based on deep theorems in topology



EFFECT
 x

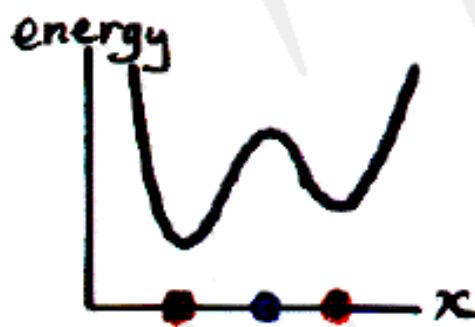
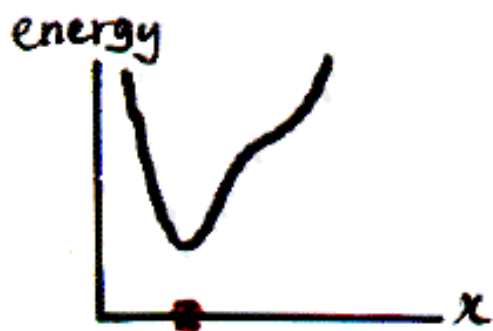
GRAPH OF
CAUSE AND
EFFECT.

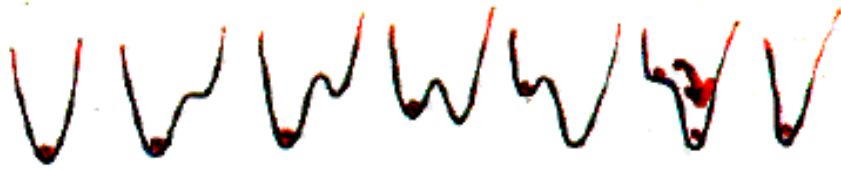


CAUSE

①

②

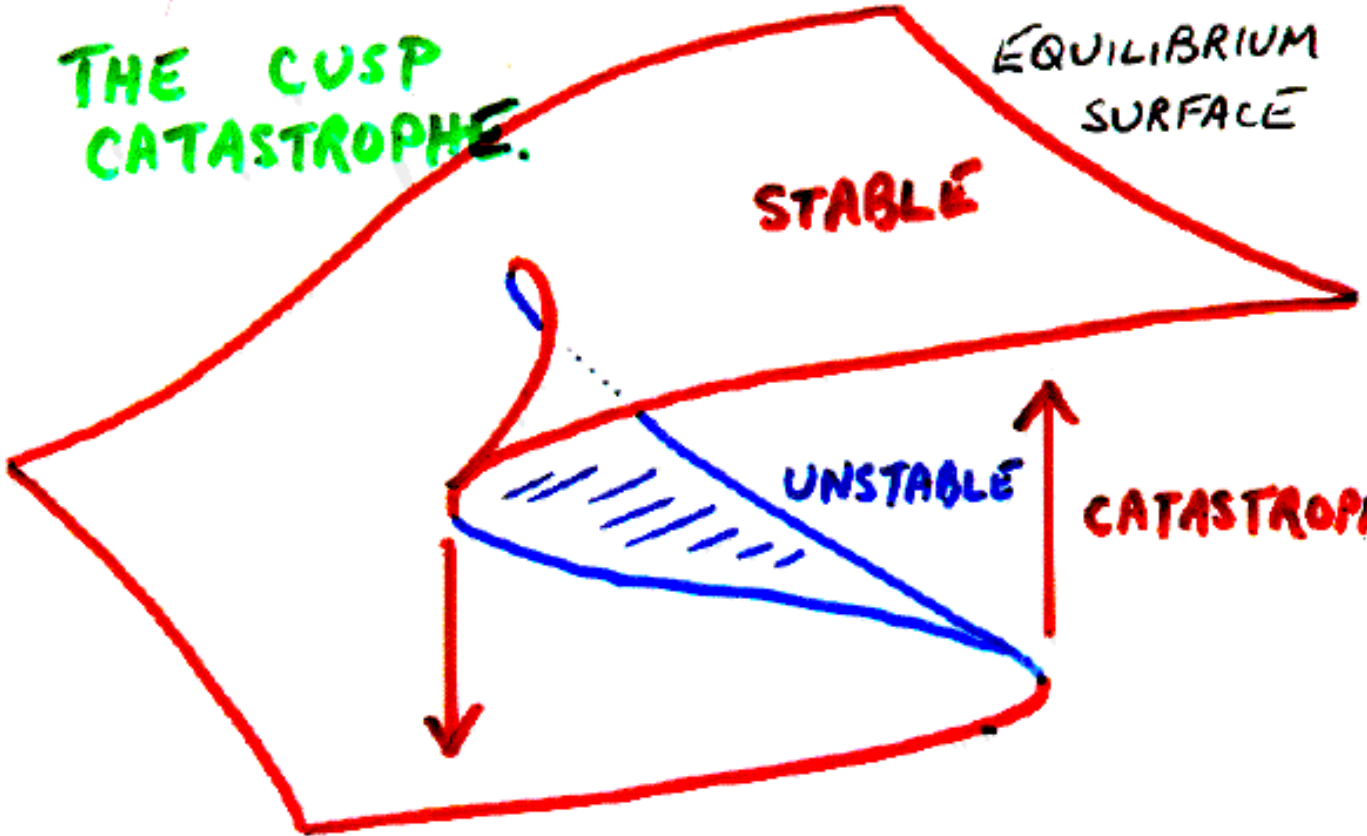




THE CUSP
CATASTROPHE.

EQUILIBRIUM
SURFACE

STABLE



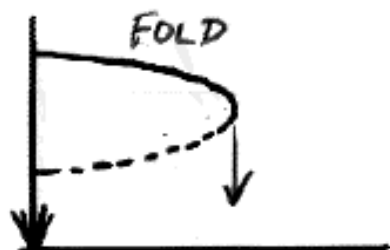
PARAMETER
SPACE

THEOREM (THOM 1968)

Two CAUSAL FACTORS
 MULTIDIMENSIONAL EFFECT
 MINIMISING PRINCIPLE

\Rightarrow

EQUILIBRIA FORM A
 SMOOTH SURFACE
 ONLY SINGULARITIES ARE
 FOLDS & CUSPS.



NUMBER OF CAUSAL FACTORS	1	2	3	4	5
NUMBER OF SINGULARITIES	1 FOLD	1 CUSP	3	2	4	...

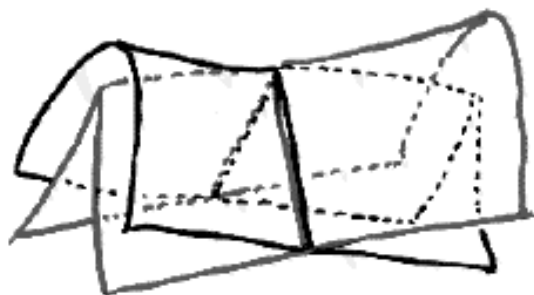
3 CAUSAL FACTORS



SWALLOWTAIL

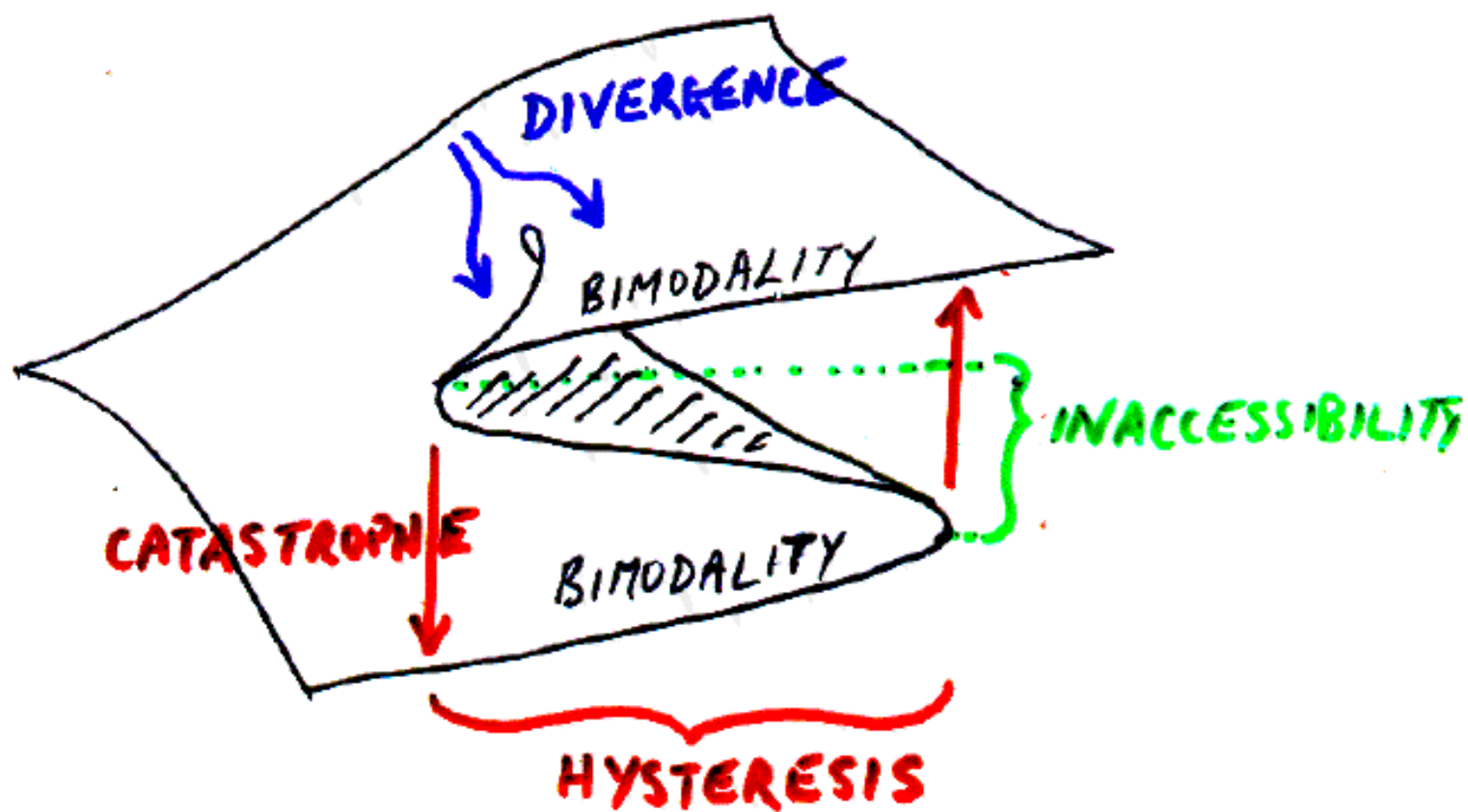


ELLIPTIC UMBILIC



HYPERBOLIC UMBILIC

FIVE QUALITATIVE PROPERTIES OF THE CUSP.

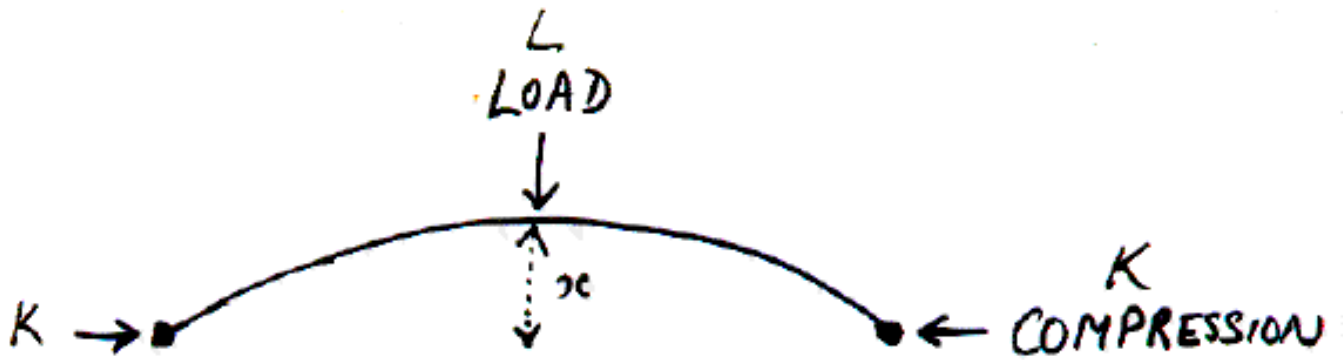


If you ever come across a scientific phenomenon displaying one of these qualities, check if any of the others are present, and, if so, see if there is a hidden cusp catastrophe underlying the phenomenon.

SOME APPLICATIONS OF CATASTROPHE THEORY

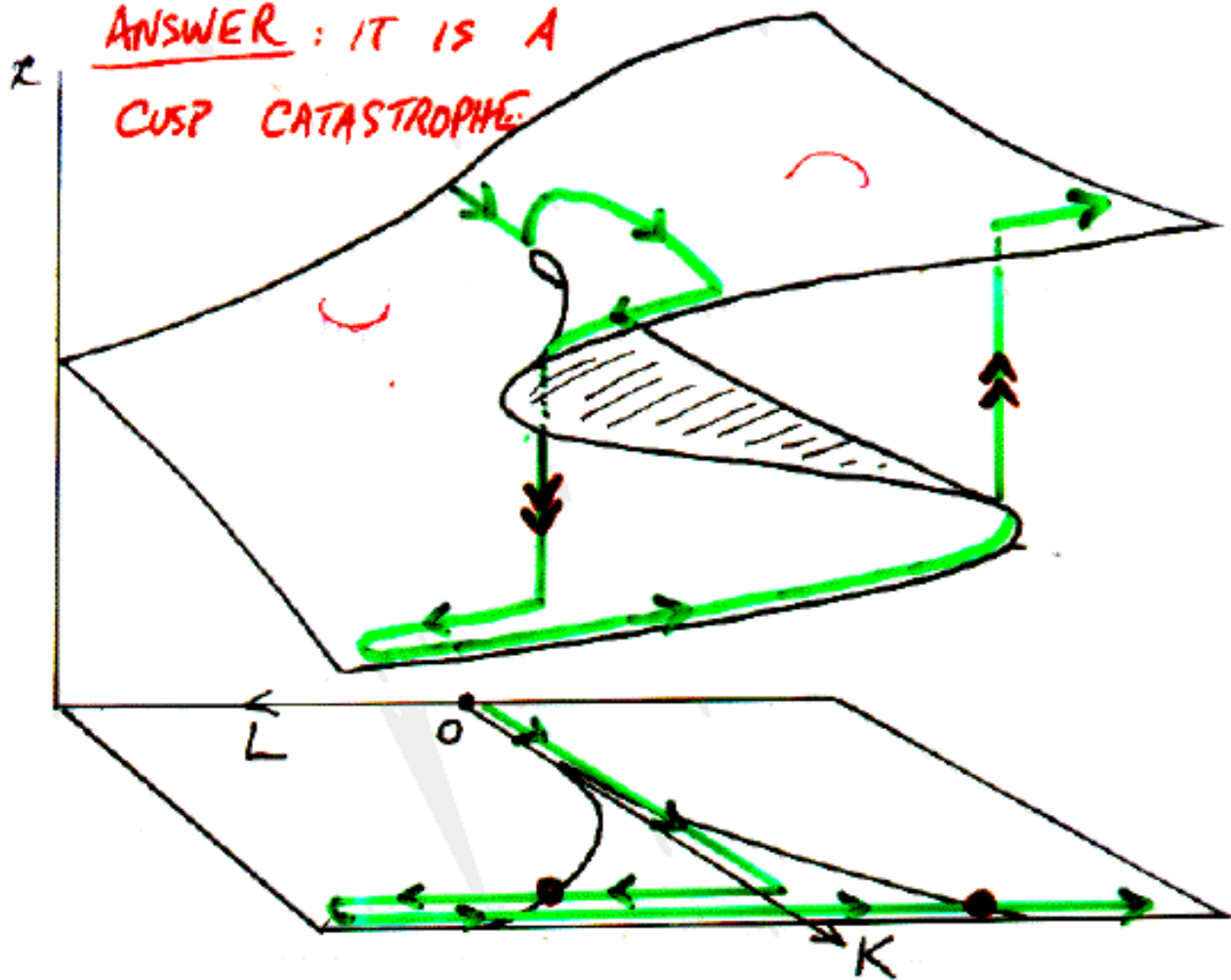
PHYSICAL SCIENCES	BIOLOGICAL SCIENCES	SOCIAL SCIENCES
<ul style="list-style-type: none">• bucklingcapsizingphase transitionshock waveslight caustics	<ul style="list-style-type: none">• evolutiondifferentiationmorphogenesisregulationheartbeatnerve impulsesleep/wake• fight/flight• territorial defence <p><u>MEDICINE</u></p> <ul style="list-style-type: none">anorexia/bulimiamanic/depressionstressshock• hyperthyroidism	<p><u>ECONOMICS</u></p> <ul style="list-style-type: none">• inflation explosioncurrency devaluationmarket crasheseconomic collapsegrowth spurt <p><u>SOCIOLOGY</u></p> <ul style="list-style-type: none">revolutionsprison riotshijackinghawks/dovesideologiesWage bargainingcompromisecommittee behaviour <p><u>PSYCHOLOGY</u></p> <ul style="list-style-type: none">Changes of perceptionswitches of moodinspiration/disillusionrational/emotionaldecision making

BEAM

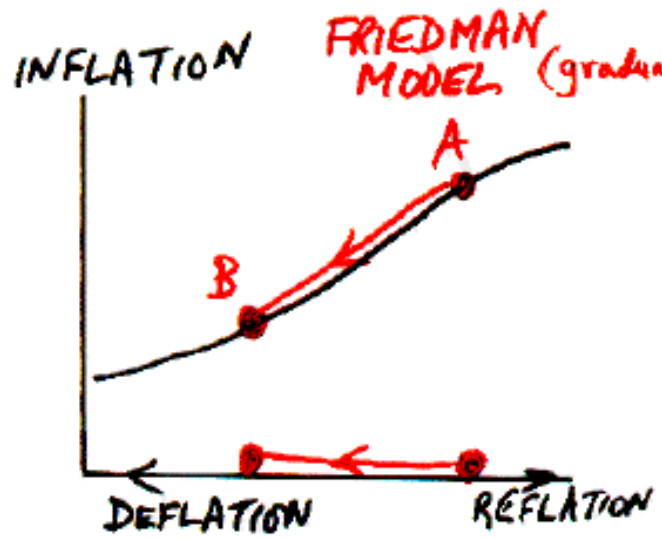
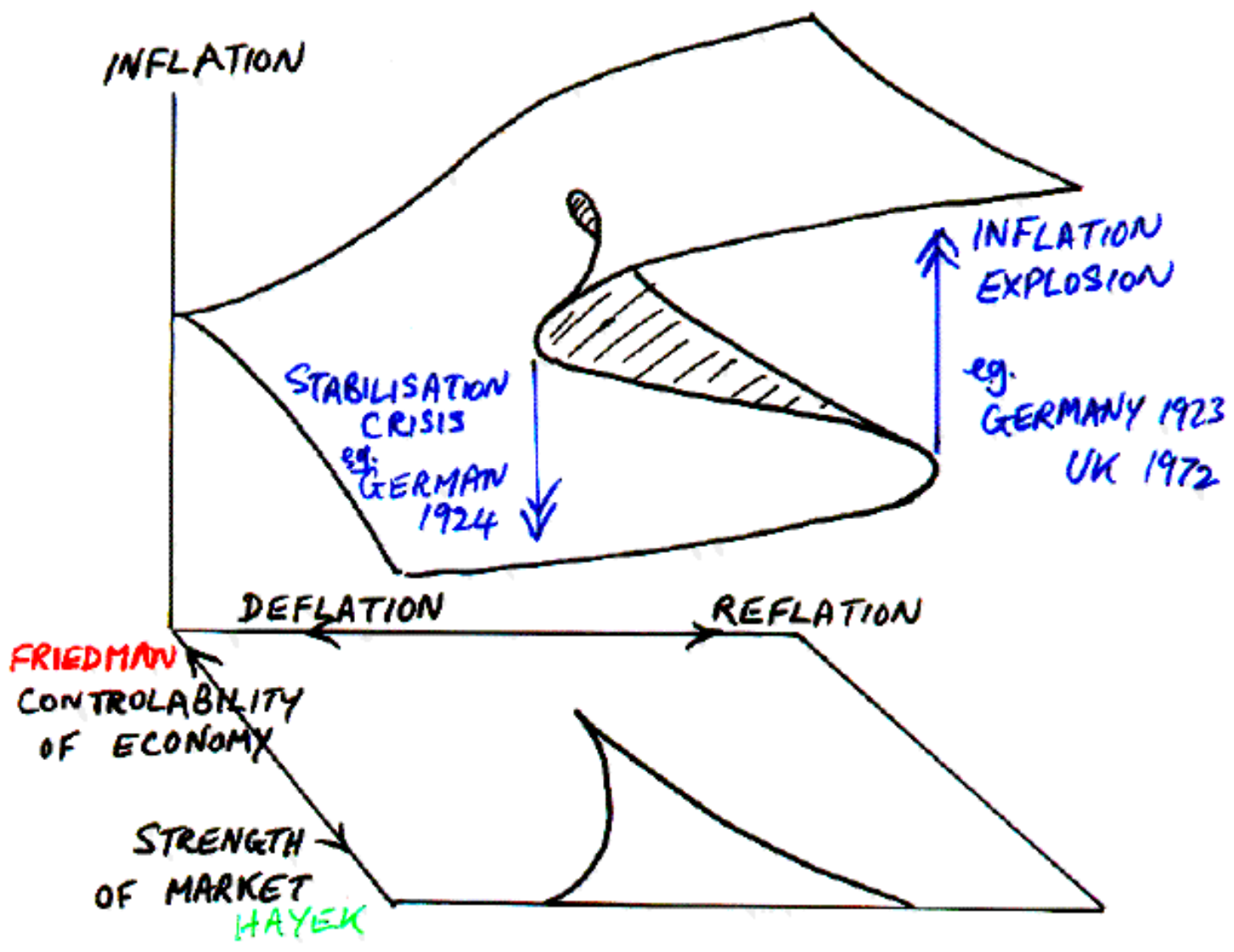


QUESTION , HOW DOES THE
DISPLACEMENT x DEPEND
UPON THE LOAD & COMPRESSION ?

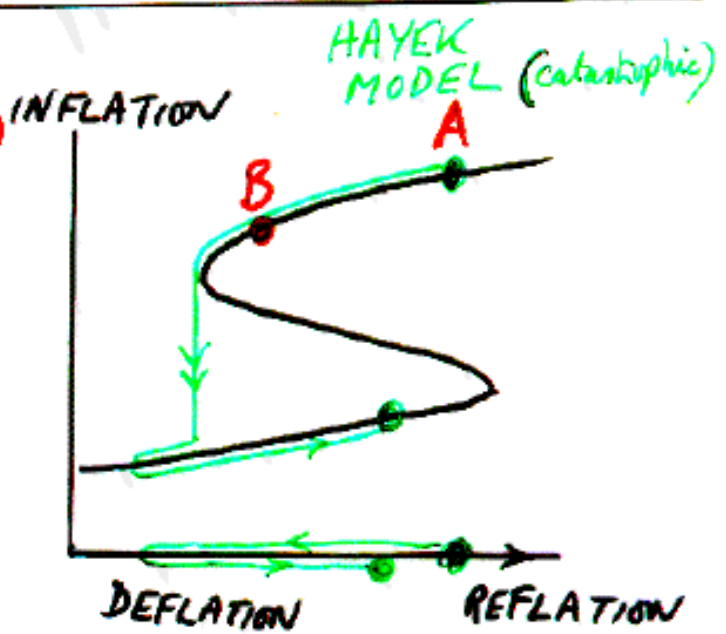
ANSWER : IT IS A
CUSP CATASTROPHE



COMPARISON OF POLICIES TO CONTROL INFLATION

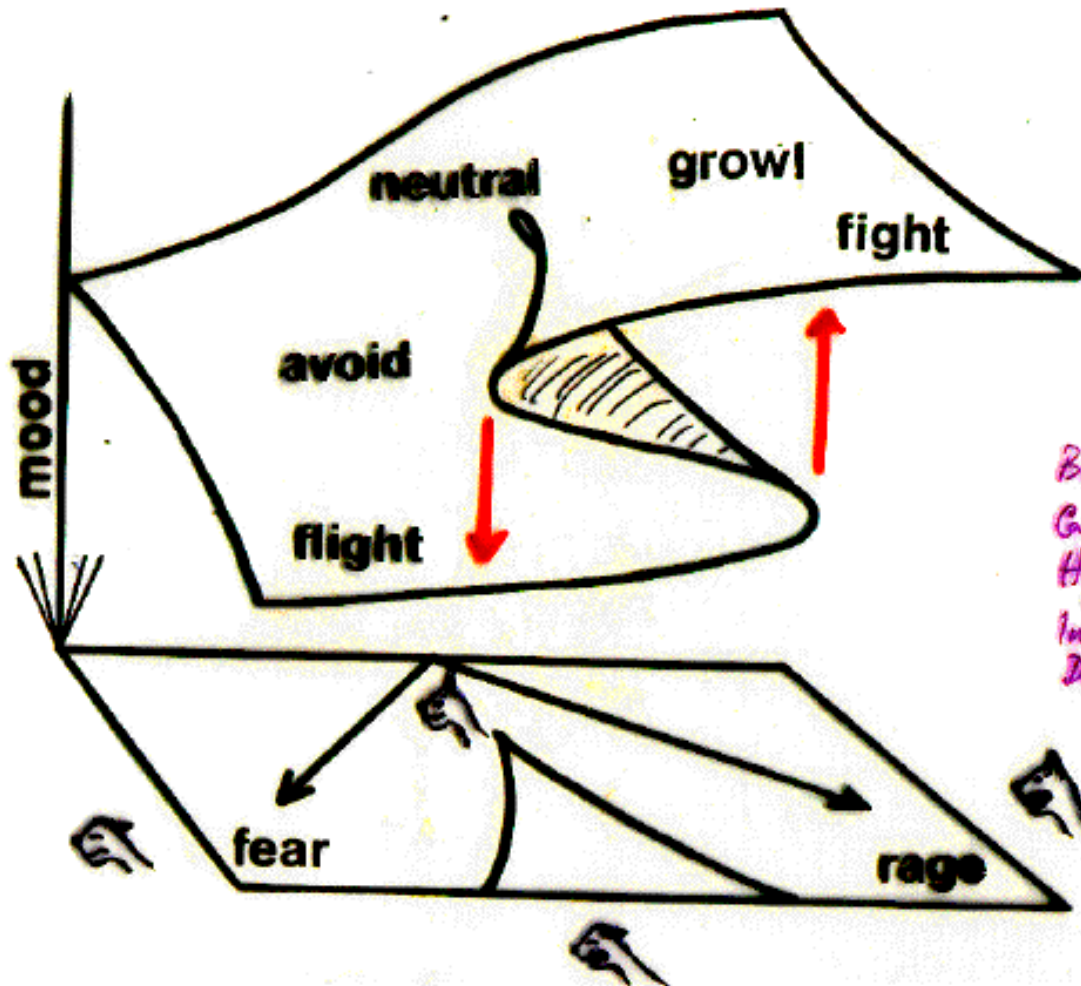


POLICY: DEFLATE & HOLD
(UK 1983-1988)



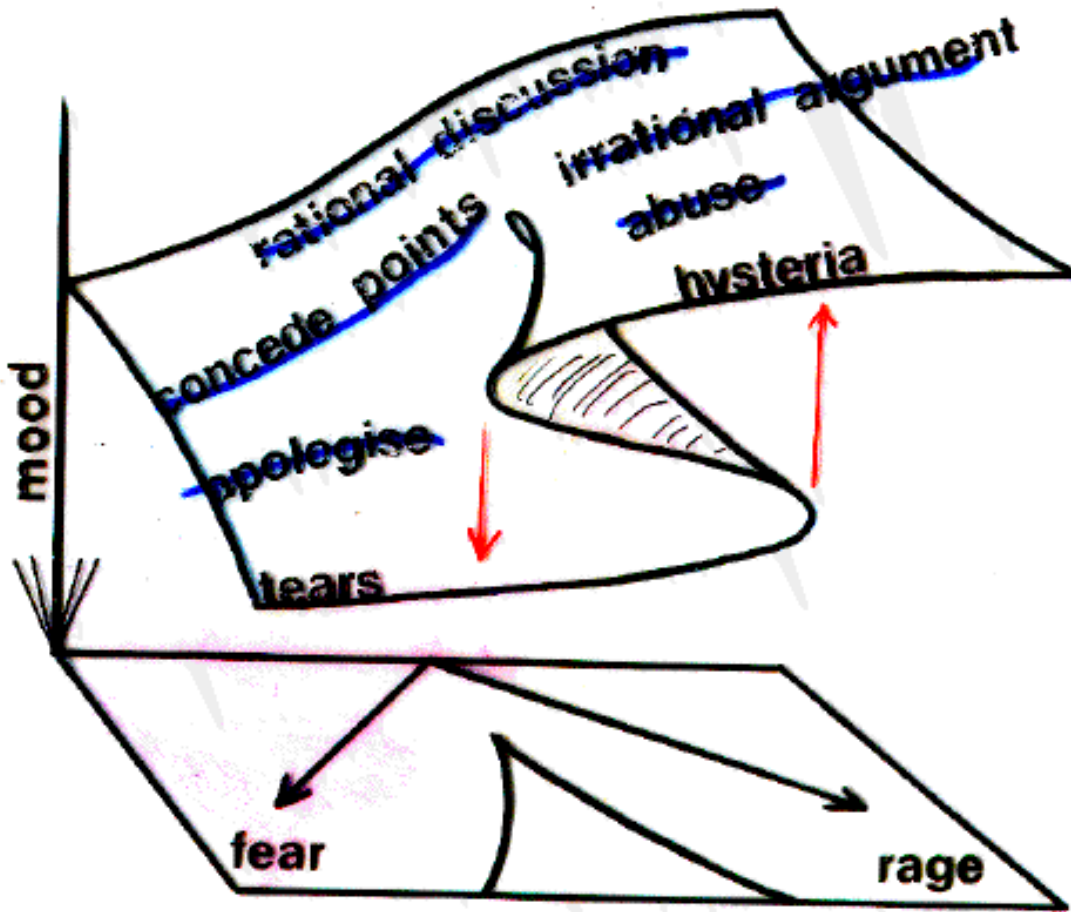
POLICY: DEFLATE HARD, U-TURN & REFLATE.
(GERMAN 1923-4)

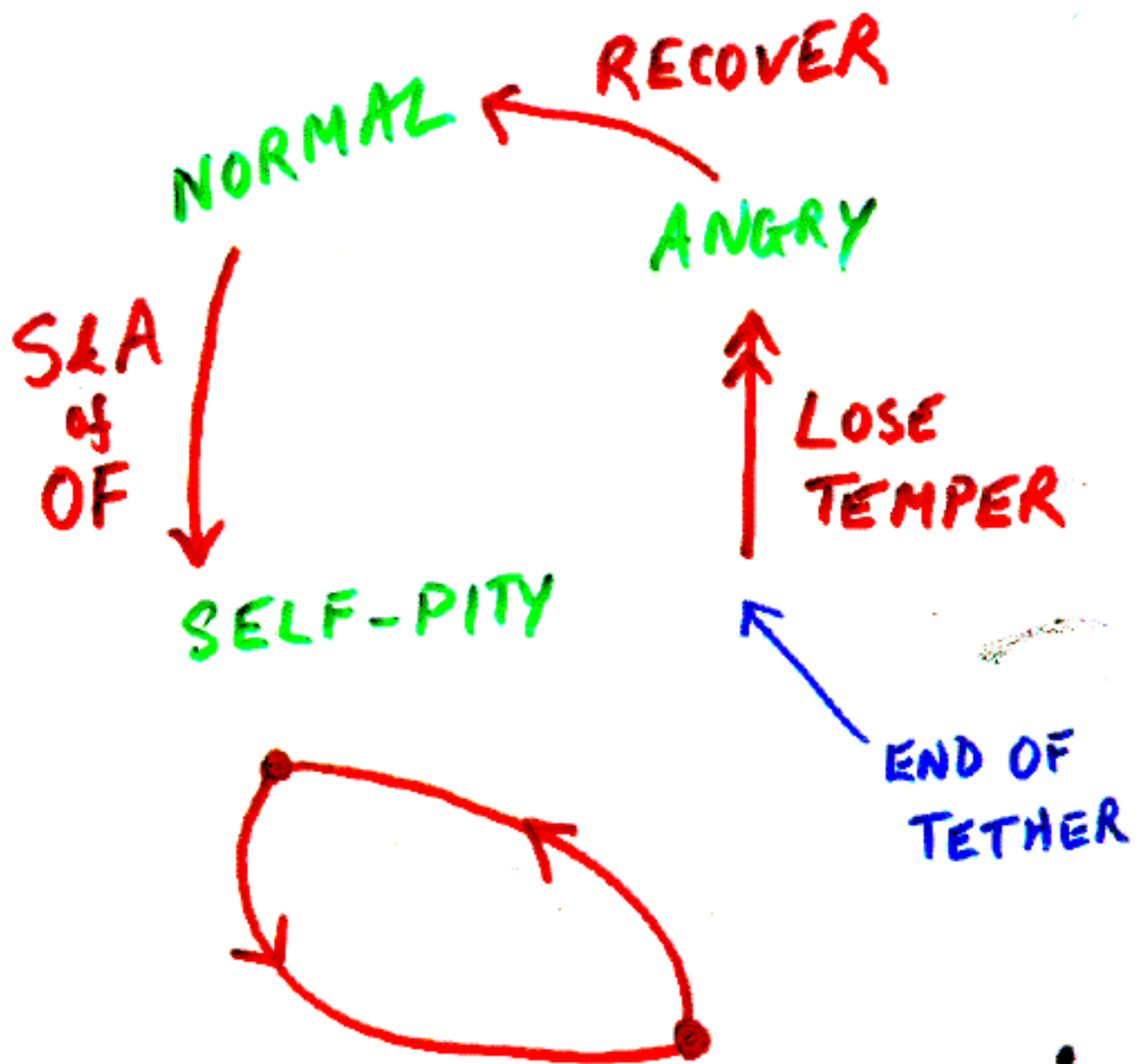
LORENZ: FEAR & RAGE ARE CONFLICTING FACTORS
INFLUENCING AGGRESSION.



*Bimodality
Catastrophe
Hysteresis
Inaccessibility
Divergence.*

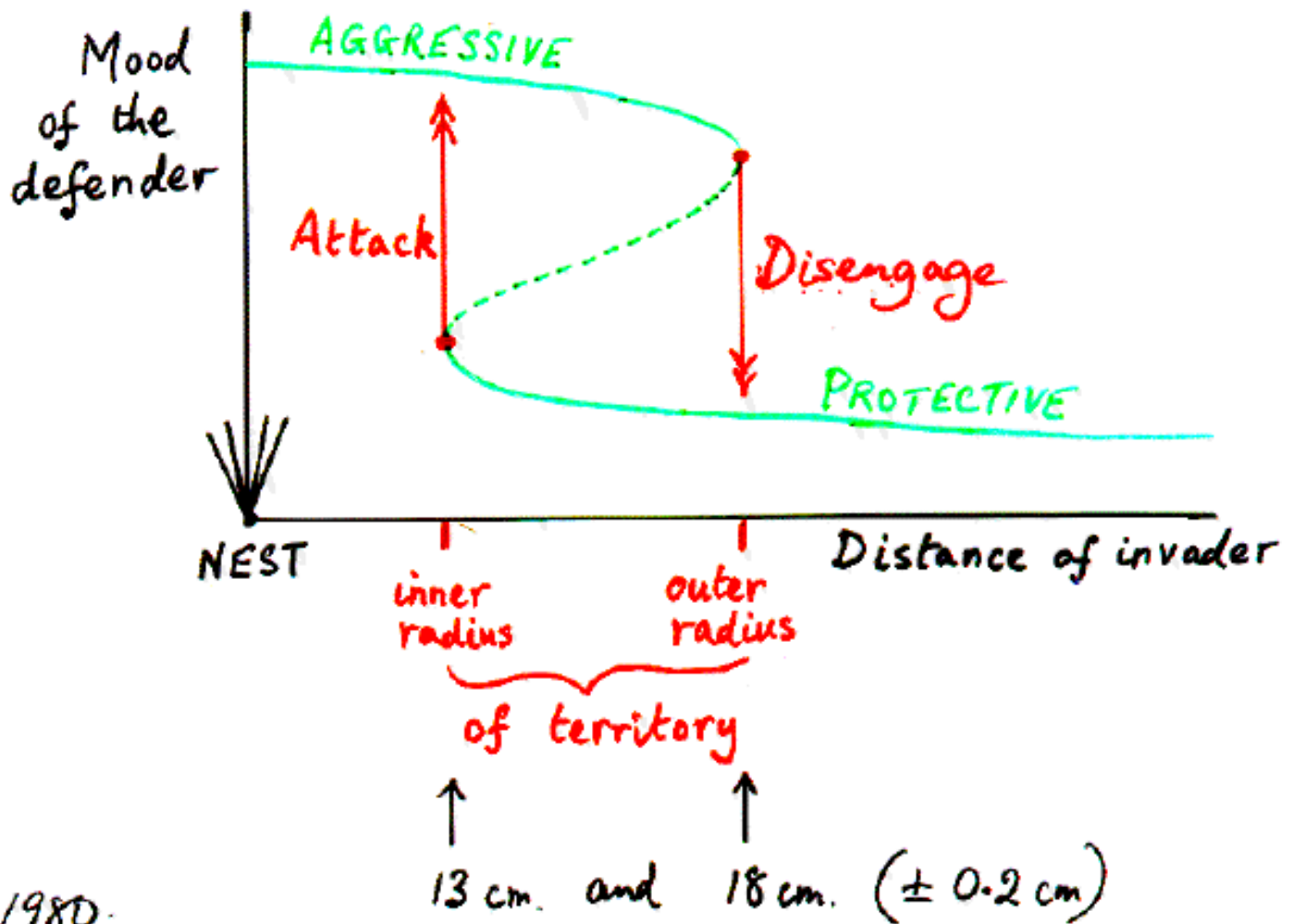
LORENZ: FEAR & RAGE ARE CONFLICTING FACTORS
INFLUENCING AGGRESSION.





TERRITORIAL FISH

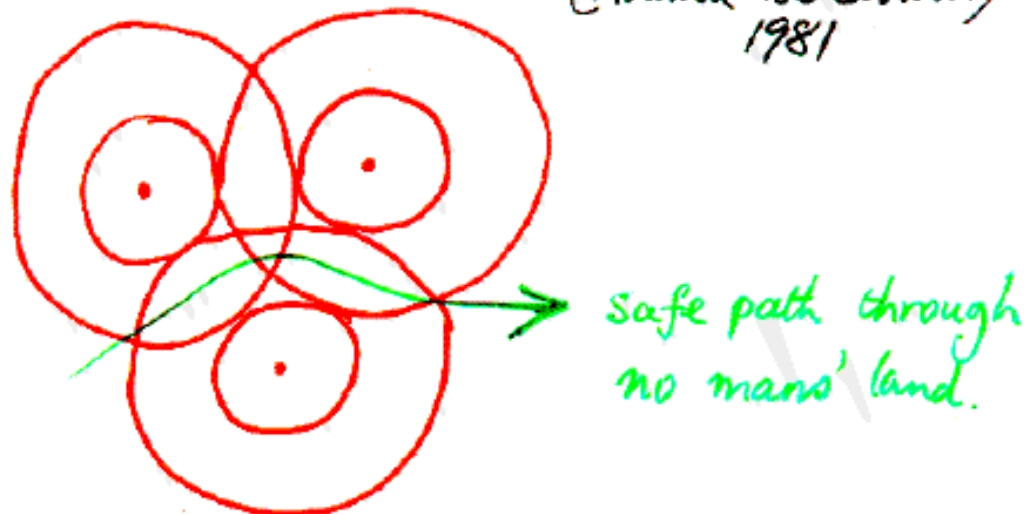
1976: Zeeman (Scientific American)



1980:

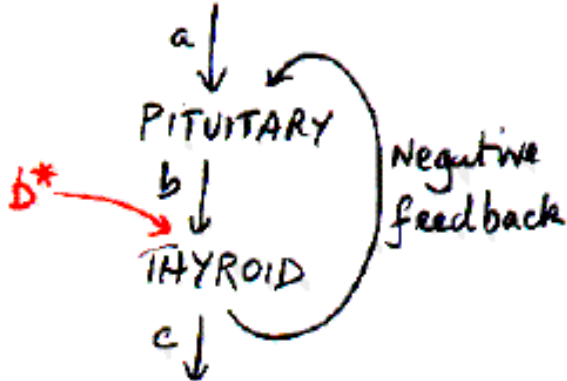
P.W. COLGAN measured the territories of pumpkinseed sunfish in Lake Opinicon, Canada.

(Animal Behaviour)
1981

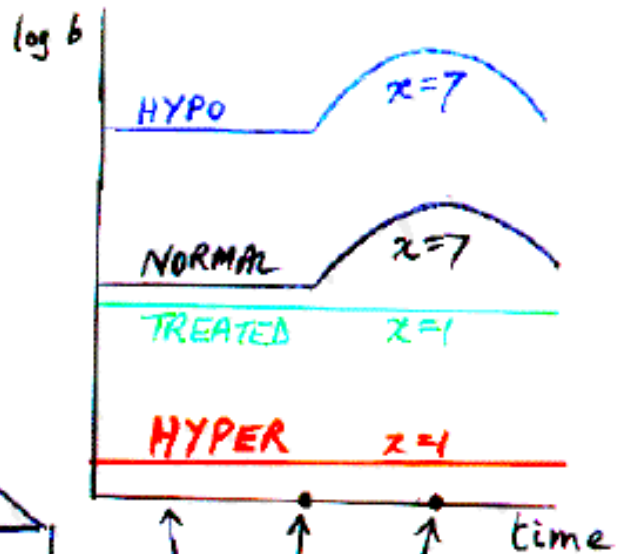
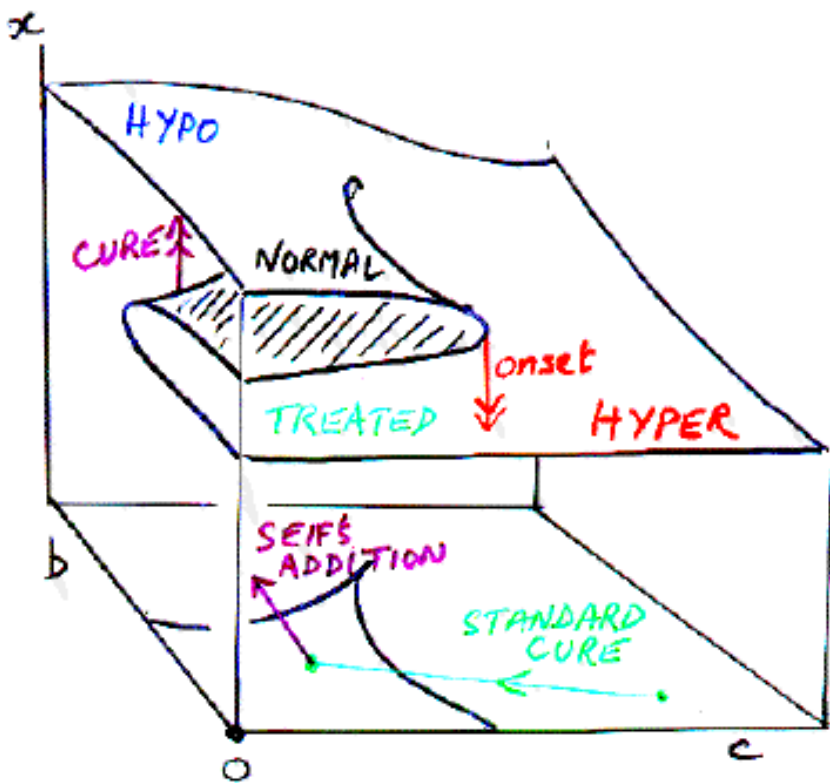
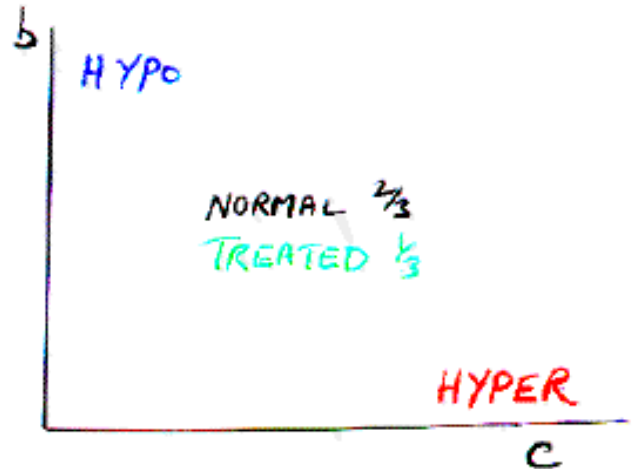


HYPER THYROIDISM : F.J SEIF

COLD → HYPOTHALAMUS



WARM AGAIN ← METABOLISM



- ① measure b
- ② inject a
- ③ 20 minutes later measure b again
- ④ calculate $x = \frac{b_{20}}{b_0}$

1. Conceptual grasp
2. Successful cure
3. Fitted data
4. Micro-model
5. Framework for ongoing research.

- Normal
- ▲ hypo
- hyper
- treated

