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- René Thom first proposed catastrophe theory in the 1960s and 1970s
- a mathematical model which describes discontinuous leaps in dynamic systems

The Basics of Catastrophe Theory

- stability: stable, semi-stable, unstable
- features tend to be attracted to certain stable positions known as *attractors*
- For example, one parameter differentiating vowels is tongue-height, but certain points on the continuum between high and low constitute attractors with the possible tongue-heights defining a certain vowel being restricted to only three or four.

Typically, only "four types of behaviour are possible in a system of differential equations in the plane ... exceptions are infinitely rare" (Stewart 1989:103). These four types of behaviour revolve around four types of features.

Sink: a single, stable point. If you start the system at some point near to the sink, it will move towards it (often in a spiral). When it reaches the sink, it stays there.

Source. This is a single point, like the sink, but it is unstable. Any system that starts at or near a source tends to move away from it.
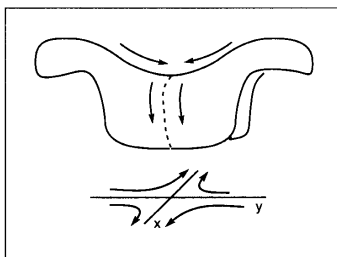

Figure 1: The saddle (from Alligood et al 1997:64)

Saddle (Figure 1). This combines some features of the source and the sink. It is stable in some directions and unstable in others. Two flow lines which meet at the saddlepoint are known as the separatices of the saddle.

Limit cycle: consist of a closed loop. If you start on a limit cycle, you go around forever in a periodic motion.

Lass (1997:299-300). One example is "the constant emergence and loss of front rounded vowels in the history of English. Neither Proto-Germanic nor Northwest Germanic had /y, ø/; but these emerged in prehistoric Old English as the result of *i*-umlaut of */u, o/ …, were lost during Old English by merger with /i/ and /e/, re-emerged in Middle English, were lost in the southern standard varieties in late Middle English, and are becoming increasingly common in modern dialects."

Control variables	State variables	
Number of control factors (codimension)	One behaviour axis (cuspoids, corank 1)	Two behaviour axes (corank 2)
1	Fold	---
2	Cusp	---
3	Swallowtail	hyperbolic umbilic, elliptic umbilic
4	Butterfly	parabolic umbilic

Table 1: The seven elementary catastrophes (after Woodcock & Davis 1978:43, with alternative terminology from Saunders 1980:31-32)
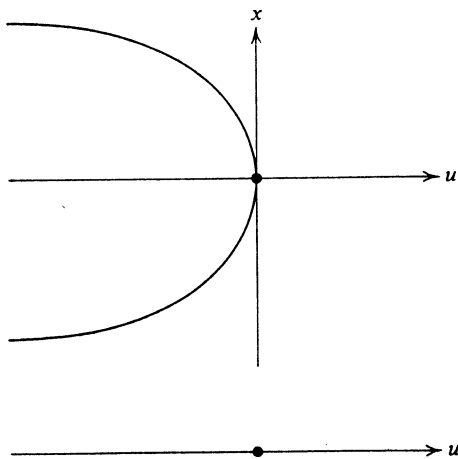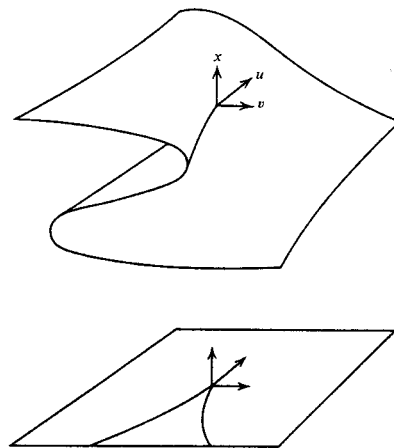

Figure 2: Fold catastrophe
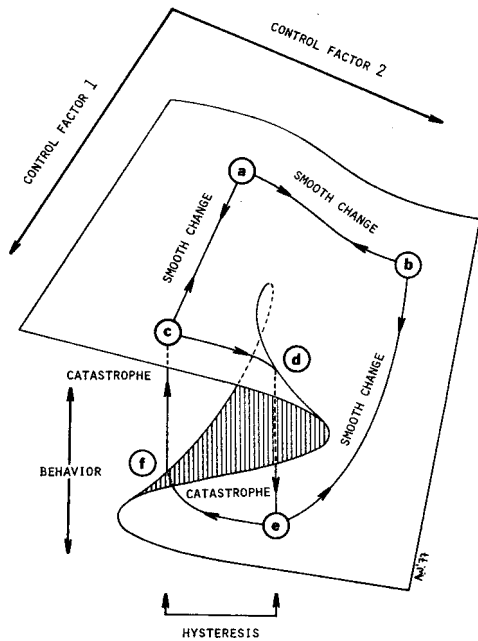

Firgure 3: Cusp catastrophe
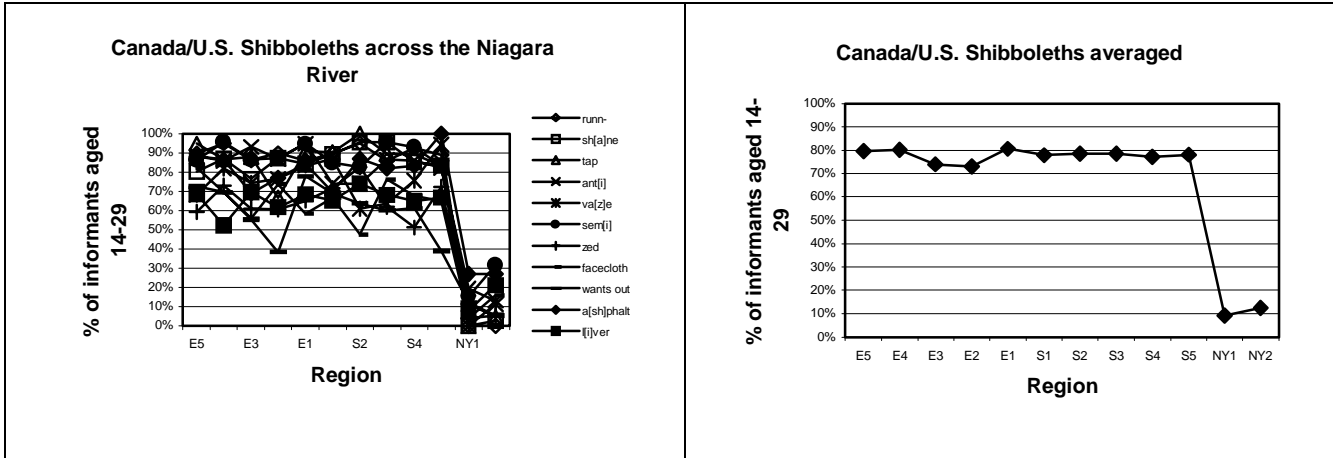
Figure 4: Paths on the cusp (Woodcock & Davis 48)

Figure 5: The Golden Horseshoe

Age	Canada	U.S.
14-19	64	33
20-29	297	31
30-39	166	2
40-49	151	2
50-59	106	5
60-69	37	5
70-79	36	2
over 80	78	
Grand Total	935	80

Table 1: Age distribution

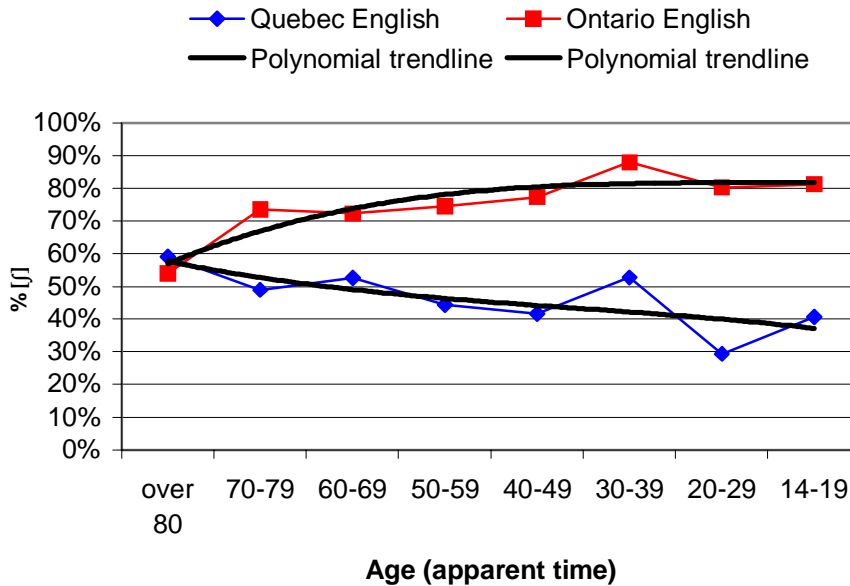**Table 2: Canadian/U.S. Shibboleths at the Niagara Border**

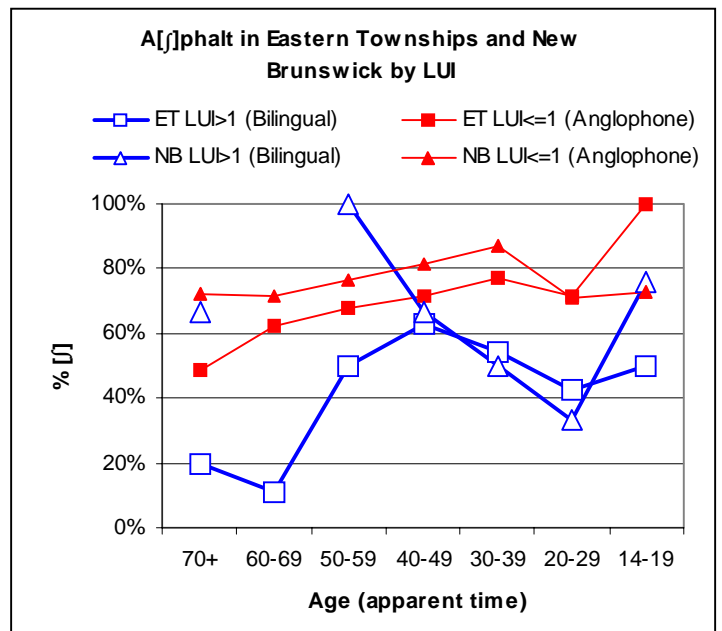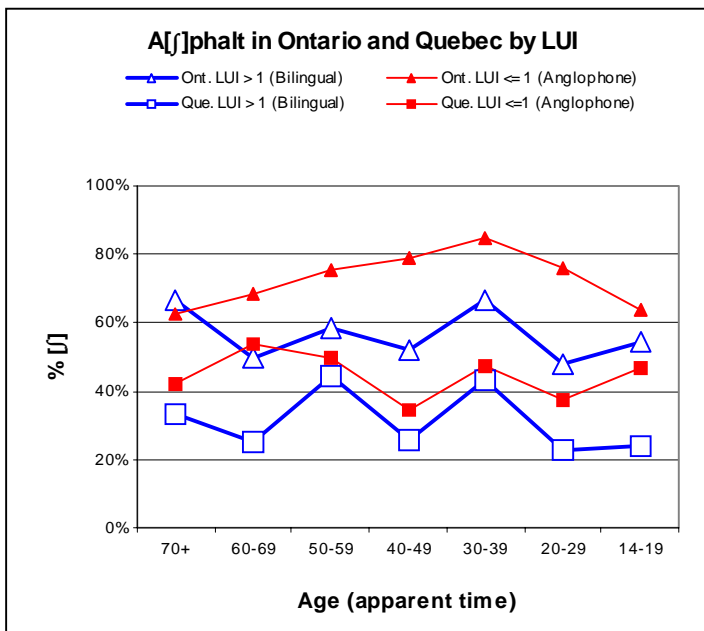| Question #/Desc.	Canadian variant	Can	US	Diff.
39: Athletic shoes	runn- (vs. sneak-)	91%	0%	91%
43: Shone	[a] (vs. [o])	85%	2%	83%
5: Garden knob	tap (vs. faucet)	89%	6%	83%
4: Sink knob	tap (vs. faucet)	84%	5%	79%
58: Anti	tee (vs. tie)	86%	16%	70%
8: Vase	ause/ays (vs. ace)	76%	7%	69%
57: Semi	me (vs. my)	89%	25%	64%
62: Z	zed (vs. zee)	64%	5%	59%
6: Cloth for face	facecloth (vs. washcloth)	66%	11%	55%
40: wants (to go) out	out (vs. to go out)	61%	8%	53%
37: Asphalt has [sh]	sh (vs. z)	80%	27%	53%
35: Lever	[eaver] (vs. [ever])	66%	16%	50%
36: Avenue	you (vs. oo)	82%	34%	48%
16: Mom	um (vs. om)	46%	3%	43%
11: Soda pop	pop (vs. soda)	94%	53%	41%
19: Evening meal	supper (vs. dinner)	51%	20%	31%
64: Progress	go (vs. got)	49%	19%	30%

Canada/U.S. Shibboleths across the Niagara River
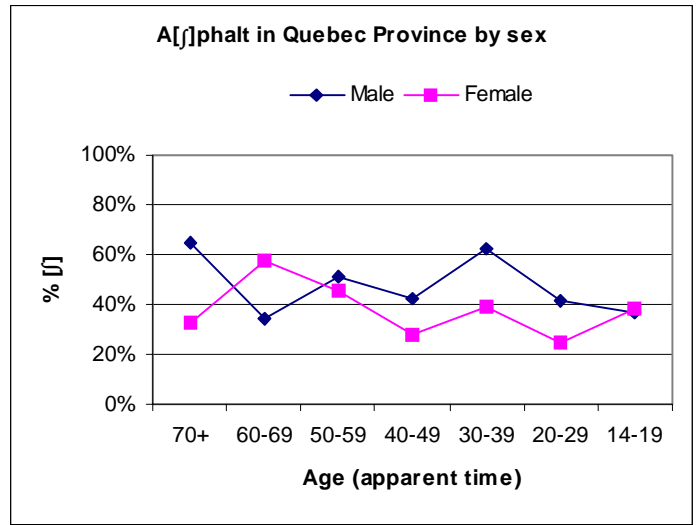
Canada/U.S. Shibboleths averaged

Dialect Topography questionnaire explicitly discourages dual responses:
"Your first answer is likely to be the best one."

Christine Zeller (1990, 1993) received many more multiple responses:
"Feel free and give as much information as you want" and "if you have more than one word in answer to a question, please list them all, but indicate (if possible) the one most often used by you and your friends by underlining it" (Zeller 1990:7).

Divergence of a[ʃ]phalt in Ontario and Quebec

A[ʃ]phalt in Quebec Province by LUI

Legend: LUI>1, LUI<=1

X-axis: Age (apparent time) — 70+, 60-69, 50-59, 40-49, 30-39, 20-29, 14-19
Y-axis: % [ʃ] — 0% to 100%

A[ʃ]phalt in Quebec Province by Education

Legend: Primary/Secondary, Post-secondary

X-axis: Age (apparent time) — 70+, 60-69, 50-59, 40-49, 30-39, 20-29, 14-19
Y-axis: % [ʃ] — 0% to 100%

A[ʃ]phalt in Quebec Province by RI

Legend: RI <= 2, RI > 2

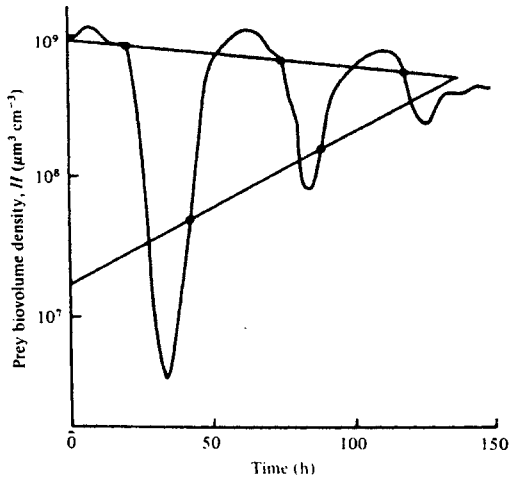X-axis: Age (apparent time) — 70+, 60-69, 50-59, 40-49, 30-39, 20-29, 14-19
Y-axis: % [ʃ] — 0% to 100%

A[ʃ]phalt in Quebec Province by sex

Legend: Male, Female

X-axis: Age (apparent time) — 70+, 60-69, 50-59, 40-49, 30-39, 20-29, 14-19
Y-axis: % [ʃ] — 0% to 100%

A[ʃ]phalt in Ontario and Quebec by LUI

Legend: Ont. LUI > 1 (Bilingual), Ont. LUI <= 1 (Anglophone), Que. LUI > 1 (Bilingual), Que. LUI <=1 (Anglophone)

X-axis: Age (apparent time) — 70+, 60-69, 50-59, 40-49, 30-39, 20-29, 14-19
Y-axis: % [ʃ] — 0% to 100%

A[ʃ]phalt in Eastern Townships and New Brunswick by LUI

Legend: ET LUI>1 (Bilingual), ET LUI<=1 (Anglophone), NB LUI>1 (Bilingual), NB LUI<=1 (Anglophone)

X-axis: Age (apparent time) — 70+, 60-69, 50-59, 40-49, 30-39, 20-29, 14-19
Y-axis: % [ʃ] — 0% to 100%

Figure 2: Prey biovolume (Saunders 1980:108)
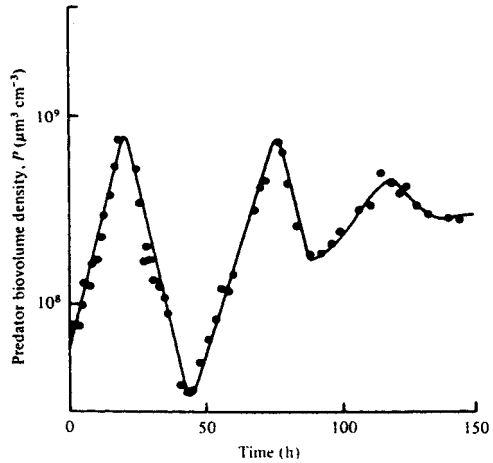

Figure 3: Predator biovolume (Saunders 1980:109)
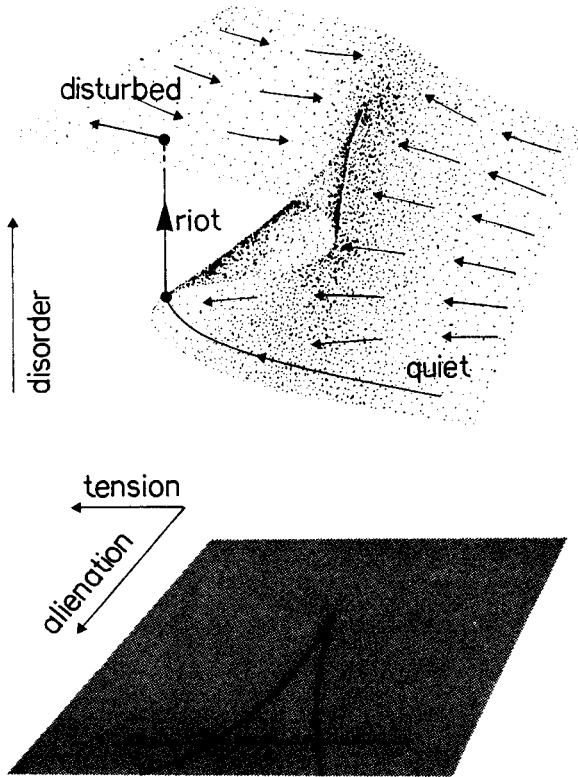

Figure 3a: The cusp catastrophe and the Gartree prison riot (Poston & Stewart 1978:417)

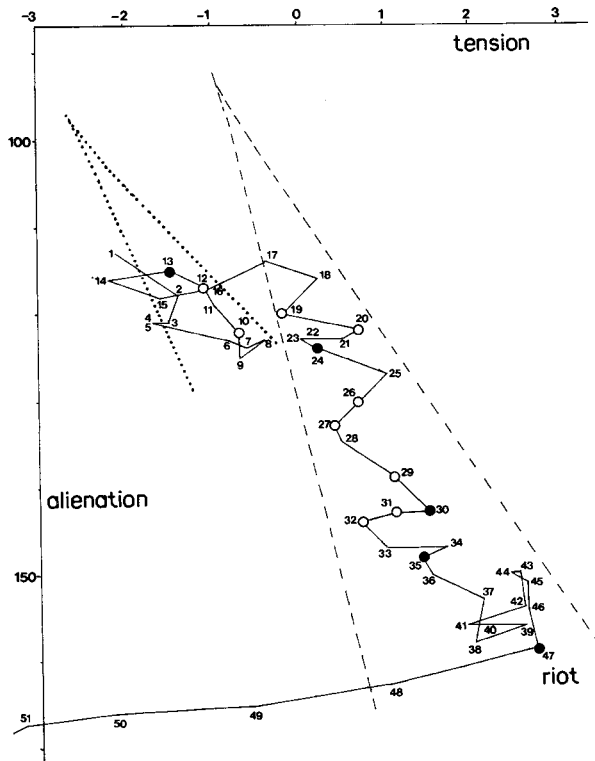**Figure 4b: Data plot for the prison riot (Poston & Stewart 1978:418)**

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