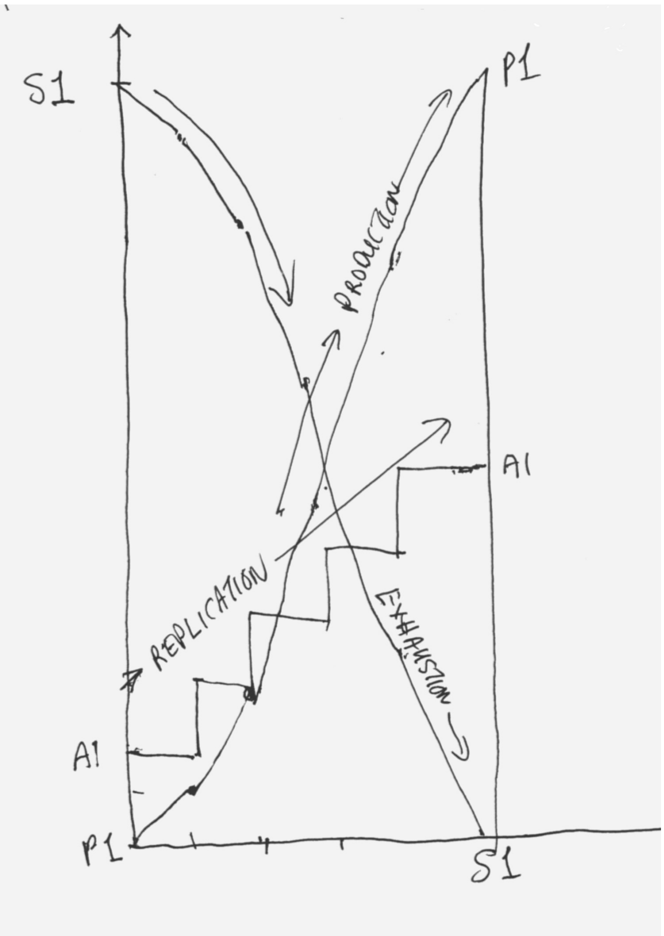
Modelling Positive Feedback

(and Graphical representations)

The enclosed images in this paper are the rough notes from an attempt to crack the crucial iterative formulae for a model simulating positive feedback, and in particular a series of such feedbacks, which overlap one another. The first sketch is a very simple graph showing how the components in a Single Positive feedback would vary during the growth and subsequent termination of the event.



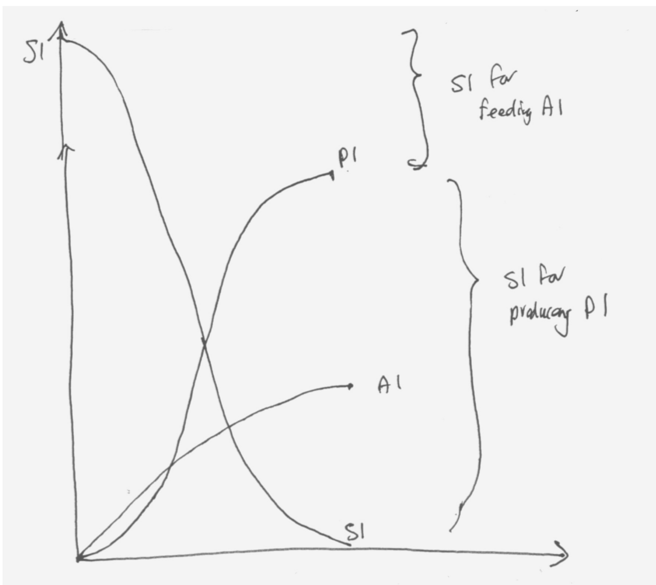
The components are

SI - the Resource
A1 - the Agent
P1 - the Product

The simple assumptions are that the Agent will convert the Resource into Product, and also replicate itself. This replication both increases the number of Agents, and hence also the amount of Product being delivered.
For each delivery of product the amount of Resource will decrease.
Because of the sustained replication of the Agents, the production of Product and the diminution of Resource will increase in speed.
The staircase across the bottom of the graph represents to increasing population of Agents.
The Resource will ultimately run out, while the Product will reach a maximum. Thereafter the feedback situation must terminate as nothing can be produced.

This image is oversimplified in several ways, but none-the-less, gives us a feel for such a process.

The second figure is a modification of the first. No mention was made in the above account of any resources required by the Agent, which is obviously an important omission.
This figure assumes that the same Resource both is used for producing Product and to feed the Agents. The symmetry of the first diagram is therefore missing in this more realistic graph.



Of course, the resources for the Agents could be quite different, and a later model should include the dynamics of this too.
Predator-Prey relations could also be involved, and finally the Single positive feedback burst, could be only part of a series, or even a cycle, of several positive feedbacks as an integrated system.

Some points worth mentioning about the above forms:

1. Notice the classical shapes of the curves with both “hysteresis” and “plateau” forms.
2. The diagrams also assume no Searching overhead for Resource and its 100% use.

The following are tables and iterative relations that could be used in a modelling of a series of positive feedbacks that overlap. This means that the second phase of the series commences BEFORE the initial phase has played itself out. In this way phases overlap and will increasingly be happening simultaneously.

These requisite iterative (or difference) equations assume a continuing linear series, which could either go on forever, or alternatively terminate at some final process. BUT, if the product of the nth (and last term) is then seen as the resource for the 1st term, the series becomes cyclic. These later modifications are NOT present in these notes yet.

INITIAL VALUE				
100 S1	P1 = S2	P2 = S3	P3 = S4	P4 = S1
0 = P1	0 = P2	0 = P3	0 = P4	? = P1
10 = A1	10 = A2	10 = A3	10 = A4	? = A1
AT T = 0	AT T = 1	AT T = 3	AT T = 4	

To plot the Series version of these feedbacks requires a program with variable, initial values and various thresholds. The table above deals with the initial values of the parameters involved in four positive feedbacks that form a sequential series.

Effectively it consists of the initial pump priming Resource (S1), a pre-existing range of Agents for the four processes A1, A2, A3, and A4, and a system of time slots t=0, t=1, t=2, t=4 for each process to commence. These change as the designing proceeds as will be seen in the following figures.

NOTES:

1. But series a situation mitigates against “pure” positive feedback, for as soon as a Product commences being produced, it is immediately available for the NEXT process to commence. And this will be so for all subsequent phases – thus the products and sources will be kept DOWN by constant take up in overlapping following processes.
2. These overlaps will also likely result in a complete cycle of phase commencements occurring before earlier ones have completely run their course. In other words CYCLE TWO is very likely to overlap with CYCLE ONE.
3. The extreme cases will be determined by the TEMPO of the processes, and are likely to involve the range from a “pulsed” system to a “mixed” system (where everything could be happening at once.) Both these will, I am sure prove to be very interesting.

Though the proposed system “seems” very simple, it will not be cracked without either

1. A calculated on-paper run through

or

2. A complete simulation with experiments as to worthwhile parameters and speeds.

To handle the situation we will need a 2D array, with parameters for Process number and time slot. We will also simplify a little from the things laid out above. There seems to be no good reason for giving an Agent the value of 10, so we'll change this to 1. In addition a few quick scribbles indicated that a starting value for $S_{1,0}$ (i.e. Resource for Process 1 at time 0) would be best at 120 to simplify initial calculations. Finally we will set both the "requirement for" and the "production from" all Agent processes at 20.

Initially		
	S 10 = 120	A 10 = 1
	S 20 = 0	A 20 = 1
	S 30 = 0	A 30 = 1
	S 40 = 0	A 40 = 1

Initial values for the on-paper run through are shown alongside.

NOTE:
Remember these symbols would more properly look like

$S_{1,0}$ and $A_{1,0}$. As described in the paragraph above

The Table below is a re-draw of the first on-paper run through. Its purpose was to provide the data for the construction of the necessary iterative equations to be used in a computer program version.

	0	1	2	3	4	
		120 + 0 - 20	100 + 0 - 40	60 + 20 - 60		
S1	120	100	60	20		
A1	10	20	30			
P1-S2	0	0 + 20 - 0 = 20	20 + 40 - 20 = 40	40 + 60 - 40 = 60	60 + 0 - 60	
A2	10	10	20	30		
P2-S3	0	0	0 + 20 - 0 = 20	20 + 40 - 20 = 40	40 + 60 - 40 = 60	60 + 0 - 60 = 0
A3	10	10	10	20	30	
P3-S1	120	100	60	0 + 20 - 0 = 20	20 + 40 -	60

On reviewing this article for publication in Shape, the author has since noticed some errors in this chart. We plan to completely re-calculate this simulation and publish it on the blog in coming weeks. If you have any questions about this please email shape@bild-art.co.uk for more information.

The sets –of-three numbers that appear everywhere show how each new value is calculated from three components. These are

1. The Carry over from previous
2. New Product for inclusion
3. For Next Process

Careful study of these examples enables the iteratives to be put together:-

$$S_{n,t} = S_{n,t-1} + P_{n-1,t-1} - P_{n,t-1}$$

where

$$P_{n,t} = A_{n,t} * 20$$

and combining these we get

$$S_{n,t} = S_{n,t-1} + A_{n-1,t-1} * 20 - A_{n,t-1} * 20$$

(949 words)