THE ART OF CAUSAL LOOP DIAGRAMMING

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ABSTRACT

How should a causal loop diagram be drawn to explain structure as clearly as possible? Two basic rules are formulated: Feedback-loops should be drawn with loop-form, and influence should be unidirectional through each variable. An example shows that application of the two rules leads to enhanced clarity. Artistic deviations from the two rules can be used to produce memorable figures. Current practise in causal loop diagramming indicates a potential for improvements.

INTRODUCTION

In this paper I present two simple rules, which are helpful in increasing the clarity of causal-loop diagrams. I do not embark on a discussion of logical content, what variables to present, or possible problems with causal-loop diagrams. My only purpose is to show how structure can be better explained through careful drawing. The rules I present might also be applied to flow-diagrams.

FIRST RULE: FEEDBACK-LOOPS LOOK LIKE LOOPS

The basic consept in system dynamics is the feedback-loop. The feedback-loop structure of a system gives rise to complicated behavior which needs to be explained. Terms such as "vicious circle" indicate that it is natural to associate a feedback-loop with something circular, once circular causality is revealed. Therefore feedback-loops should be drawn like loops.

Figure 1 shows a causal-loop diagram with one feedback-loop. The arrows indicate direction of causality. A is a cause and B is an effect. B is a cause and C is an effect. C is a cause and A is an effect. The circle is closed, and a feedback-loop results. Because of time delays between causes and effects, the feedback-loop does not collapse into a set of simultaneous events without a defined direction of causality.

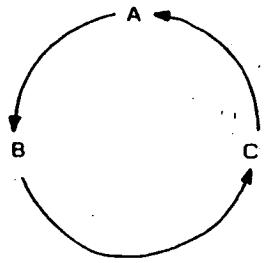


Figure 1. First rule: A Feedback-loop looks like a loop.

The causal-loop diagram visualizes very well the main assumptions that are made about the structure of a system. This is a very important first step when discussing a problem. As a second step the causal-loop diagram can be used to illustrate the effects of different policies. If A is increased by a policy, the effect of the policy will be weakened or strengthened by the feedback-loop through B and C. This is easily seen because of the circular shape of the loop through A, B and C.

If the three variables A, B, and C, do not make up a feedback-loop, the arrows should not form a loop. Figure 2 shows the causal-loop diagram when the causality between C and A is reversed. There is clearly no feedback in this diagram. If, on the other hand, the arrow between C and A in Figure 1 had been pivoted, the visual impression of a feedback-loop would have remained.

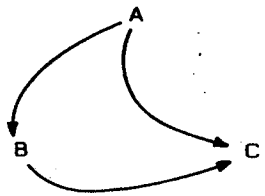


Figure 2. Causal-loop diagram of a structure without feedback.

SECOND RULE: UNIDIRECTIONAL FLOW THROUGH EACH VARIABLE

Figure 3 illustrates the second rule. All influences on each variable come from one side. This gives the impression that all influences flow in the same direction through the variable. All causes are grouped together and are easily singled out. Similarly all variables that are affected by the variable, are easily visualized.

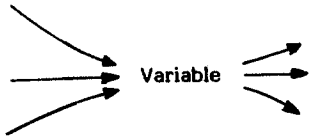


Figure 3. Second rule: Unidirectional flow through each variable.

TYPICAL PATTERNS ARISING FROM THE TWO RULES

When the two rules, loop-shape and unidirectional flow, are applied, some typical patterns arise in the causal-loop diagrams. Figure 4 shows some characteristic combinations of loops. Various loops, more or less shaped like circles, are combined. Note that no line is broken at any point. At each cross-section, every line coming in, has a natural continuation in every line going out. This is a main principle in traditional Norwegian wood carving. Figure 5 shows a piece of wood carving where the acanthus is the main motive.

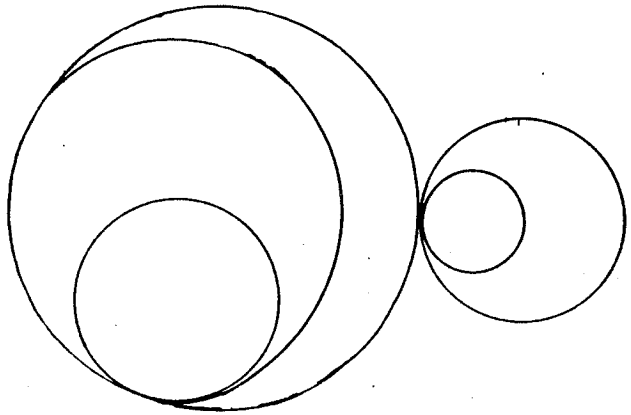
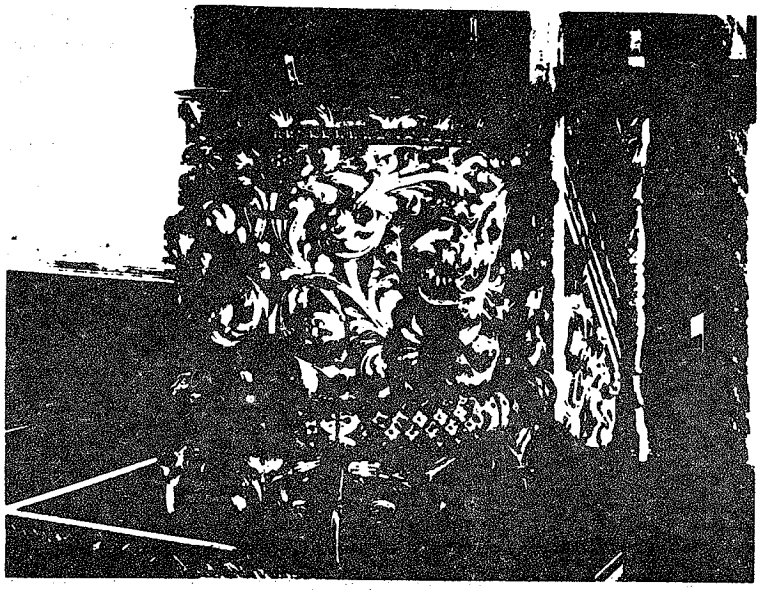


Figure 4. Typical combinations of loops.

The point I want to make is that a causal-loop diagram does not have to be something one associates with logics only. The diagram might also have artistic qualities. Nice and effectual compositions are easily remembered. As such they serve as a simple mean to memorize complicated structures.



Pulpit from the 1760's carved by Osten Kjørn. Kvikne Church in the Gudbrandsdal. A good replica of Jakob Bersveinsson Klukstad's pulpit in Heidal Church from 1754.

Figure 5. An example of traditional Norwegian wood carving.
Source: Haugli et.al.: "Native art of Norway", Oslo, Dreyer c. 1965.

AN EXAMPLE

I have found a nice and clean causal-loop diagram in the literature. Since this diagram does not fully adhere to the two rules I have postulated, it is a good starting point for a reformulation. Figure 6 shows the causal loop diagram.

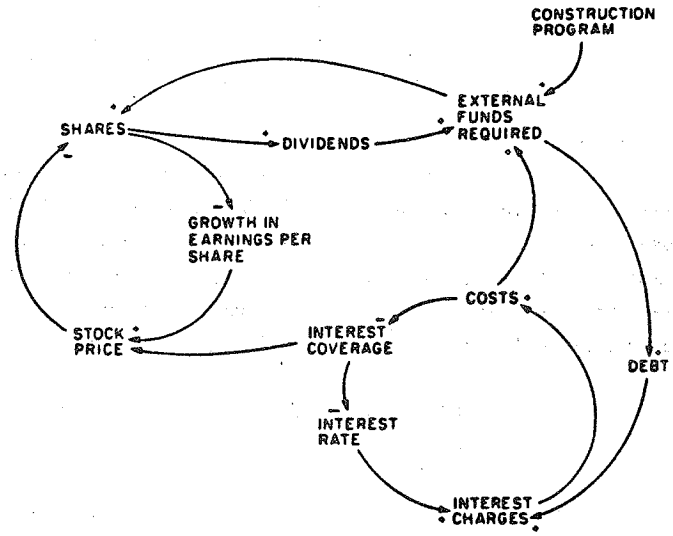


Figure 6. Example of causal-loop diagram.
Source: Lyneis & Geraghty: "Regulatory Policy and the Performance of Electric Utilities". The 1983 System Dynamics Conference, Volume II, p. 620.

A reformulated version of the diagram in Figure 6 is shown in Figure 7. Assume that "construction program" is the policy variable. It can easily be seen that there are two major feedback-loops influencing the effect of the policy. Three minor loops complicate behaviour. In the original diagram the three minor loops are most easily distinguished while the two major loops only can be found through careful inspection.

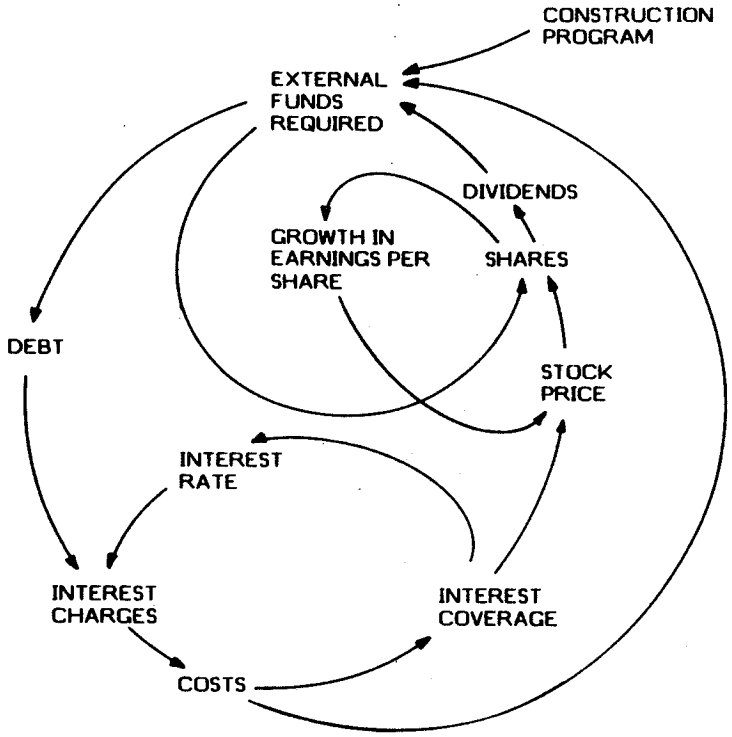


Figure 7. Reformulated causal-loop diagram. (This diagram is produced on a wordprocessor, a handy tool for flexible causal-loop diagramming.)

SPECIAL EFFECTS

Like in wood carving, a few exceptions to the basic rules might create desireable effects. For example, causal-loop diagrams that are easily associated with wellknown objects, are easily remembered. Figure 8 shows such a causal-loop diagram. The association with a flower can be enforced by calling the diagram "the liquidity flower". The diagram explains well the forces which keep liquidity in a firm within fairly narrow limits.

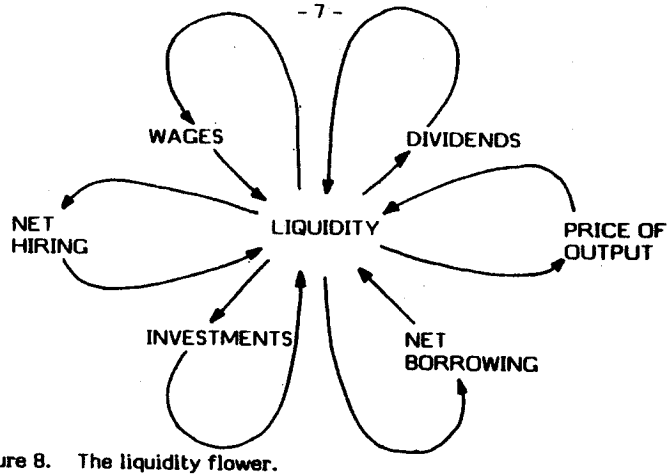


Figure 8. The liquidity flower.

It is also possible to make more fancy versions of causal-loop diagrams. Figure 9 shows a feedback-loop for the Keynesian multiplier effect. This version appeared in an advertisement for a political party in Norway. Although the text is in Norwegian, the message should be quite clear to non-Norwegian speaking people.

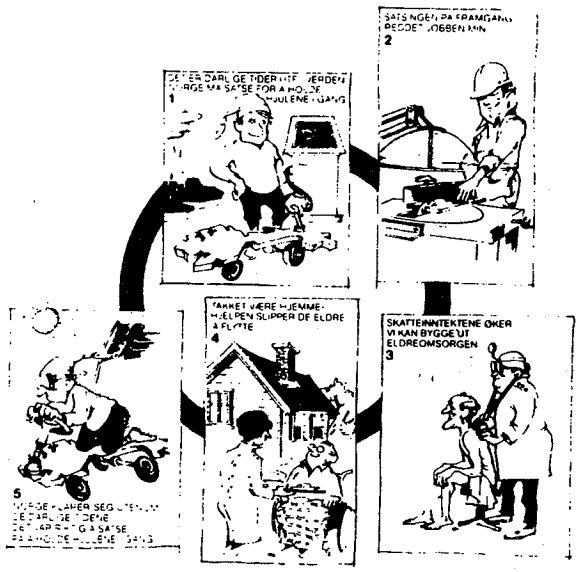


Figure 9. Keynesian multiplier effect during expansion.
Source: "Den gode sirkel", Pamphlet by Arbeiderpartiet, 1984.

ACKNOWLEDGEMENTS

I want to thank Rolf Aremark who thaught me the two basic rules during our stay at the Resource Policy Center at Dartmounth College.