THE BOOMERANG EFFECT: A DESIGN PRINCIPLE FOR HUMAN ACTION SYSTEMS

Sasan Rahmatian
Department of Information Systems
California State University, Fresno
Fresno, California 93740

ABSTRACT

Some human failures exhibit an interesting and yet alarming commonality: the actual outcome of planned change is not only different but is often the exact opposite of the intended outcome. In other words, the solutions to systems problems are sometimes themselves part of the problem they attempt to solve. It is hypothesized that this phenomenon, known as "counterintuitive behavior," occurs when a system defines its boundary too narrowly, leaving out of consideration critical elements and their impacts. The boomerang effect is said to occur whenever a system impacts its environment in such a manner as to set into motion other forces in the environment which themselves ultimately impact the system itself. This paper explains the dynamics of counterintuitive behavior in terms of the boomerang effect and explores its implications for the design of human action systems.

COUNTERINTUITIVE BEHAVIOR

Purposeful systems, by virtue of seeking certain desirable states, regard all relevant events (i.e., relevant to their purposes) as either desirable (positively valuated) or undesirable (negatively valuated). Undesirable events are either social (i.e., human induced) or natural (i.e., non-human induced, such as an earthquake). Socially induced undesirable events are of two types: self-inflicted vs. other-inflicted. The boundary between the two is not always clear and is sometimes subject to controversy. In such cases, where other-inflicted miseries are seen as really self-inflicted, we tend to resort to explanations such as "you asked for it" or "he invites trouble." Assuming that there are legitimate, clearcut instances of other-inflicted problems (such as physical injury due to somebody

else's drunken driving), it becomes logically valid to conceptually isolate self-inflicted problems and to further break them down into deliberate vs. unintended. Deliberately self-inflicted problems are commonly known to be manifestations of masochistic tendencies and are not of interest to us here. The focus of this paper is on unintentionally self-inflicted problems. We leave it to our psychoanalyst colleagues to decide whether such problems are "really" motivated by an unconscious urge to hurt oneself!

The unintentional infliction of problems upon oneself never occurs in a vacuum. The outcome which we interpret as self-inflicted suffering is typically a response to a larger problem one is trying to solve. In solving a problem, we adopt a course of action which sometimes, unbeknownst to us, turns out to exacerbate--rather than ameliorate--the problematic situation at hand. Under such circumstances, the actual outcome of planned change is not only different but is the exact opposite of the intended outcome. The solution to the problem we try to solve becomes part of that problem itself. This phenomenon is commonly referred to as "counterintuitive behavior" (cf. Forrester, 1969) as it is descriptive of behaviors running counter to our intuitive understanding of a situation. The following case stories, all of them real, are presented in order to further illuminate the above concept.

The Import Tariff Case. In order to create more jobs, an industry threatened by foreign imports obtains tariff protection. To retaliate, the country whose exports are thus affected places import duties on the first country's exports. There have been instances where, as a result, more jobs were lost because of a cutback on (the first country's) exports than were gained by reducing imports to the country. Hence, overall, unemployment soared despite initial expectations to the contrary.

The Snake Elimination Case. The Italian government faced the problem of how to eliminate poisonous snakes which posed a serious threat to the people of Sicily. As a solution, a generous bounty was given for every snake turned in, dead or alive. This produced a significant increase in the number of snakes as people started raising snakes in captivity in order to maximize the gain from the bounty.

The Chinese Family Case. In order to control the rapidly expanding population which depleted an inordinate amount of its scarce resources and jeopardized its national stability, the Chinese government passed a law requiring people to reach the age of 26 before getting married and rewarding families for having no more than two children. This law disregarded the fact that in the traditionally patriarchal Chinese family, male offsprings are essential to the continuation of the family line. They also bring more money into the family. Moreover, by bearing male children, the wife gains social prestige and respect. In reaction to the above law, many Chinese husbands started beating their wives for bearing females and also resorted to genocide, killing female children immediately after birth. As a result, the divorce rate rose dramatically, and many wives committed suicide to avoid disgracing their families. Despite lower birth rates, China further deteriorated its national stability

because it had to use its scarce resources to alleviate the dysfunctions caused by governmental objectives not coinciding with familial values.

The Cotton Yield Case. Peru in the 1920's experienced a significant drop in its cotton yield. The reason was diagnosed to be pests which damaged the crops. It was, therefore, believed that spraying with a pesticide would solve the problem and improve cotton yield. The spraying of the pesticide did produce a decline in the number of pests. However, it also caused the emergence of a new and worse species of insects whose predators were the pests eliminated by the spraying. As a result, cotton yield dropped even further.

The Infant Nutrition Case. In order to improve infant nutrition in underdeveloped countries, a new infant formula is created. Mothers abandon breast-feeding, as a result of which babies lose their natural immunization from mother's milk. Moreover, the formula has to be prepared with water, which in most underdeveloped countries is unsanitary and of very poor quality. Having lost natural immunization and being exposed to unhygienic milk, the infant's nutritional situation is further deteriorated.

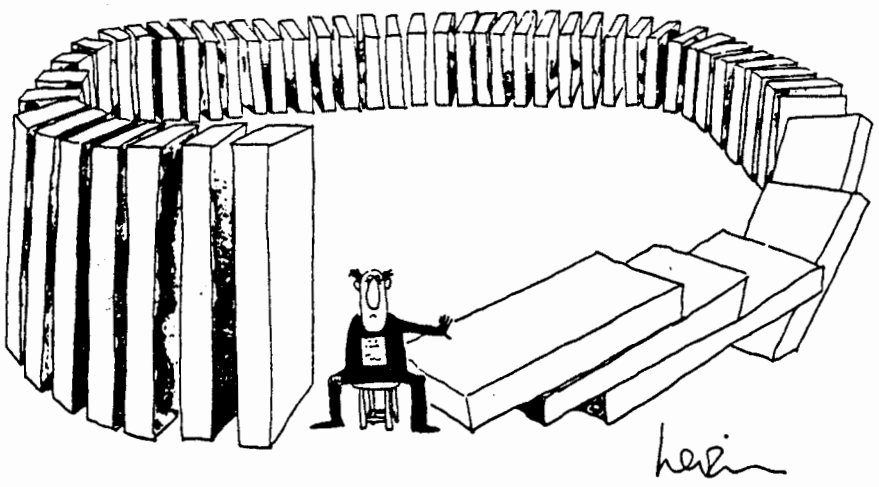
The Foreign Aid Case. Foreign aid from developed to underdeveloped countries is aimed at helping these countries develop, thus preventing violent political upheaval and social unrest. However, such financial assistance typically contributes to increased spending by the elite and privileged sectors of the society, with little effect on the standard of living of the poor majority. The rich get richer, and the poor get poorer. Having contributed to the inequitable distribution of income, foreign aid thus generates even more political upheaval and social unrest.

All of these cases illustrate the nature of counterintuitive behavior in specific situations. The concept of counterintuitive behavior is a generalization from such empirical realities. The concept describes a class of events. It does not explain why these events occur the way they do. In this paper, we explain the dynamics of this phenomenon in terms of the "boomerang effect."

THE BOOMERANG EFFECT

The boomerang is a flat, curved stick that can be thrown so that it will return to the thrower, and is used as a weapon by Australian aborigines. Figuratively, it symbolizes those actions which result in harm to their originator. One of the earlier uses of "boomerang," in this figurative sense, can be found in Holmes' Poems (1844), where he writes, "Like the strange missile which the Australian throws, your verbal boomerang slaps you on the nose" (Oxford English Dictionary).

More precisely, the boomerang effect is said to occur whenever a system impacts its environment in such a manner as to set into motion other forces in the environment which themselves ultimately impact the system itself. In other words, the effect of the system impacting its environment comes back to the system. The following cartoon illustrates the process very clearly:

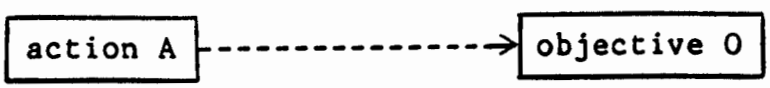


Drawing by Levin; © 1976 The New Yorker Magazine, Inc.

As can be seen, a man is pushing a block which sets into motion a domino process which, in due time, is going to impact the man himself. From this drawing, we may become inspired to think of the boomerang effect in terms of a closed-loop domino process. It is obvious that with an open-loop domino process we are not going to get the boomerang effect.

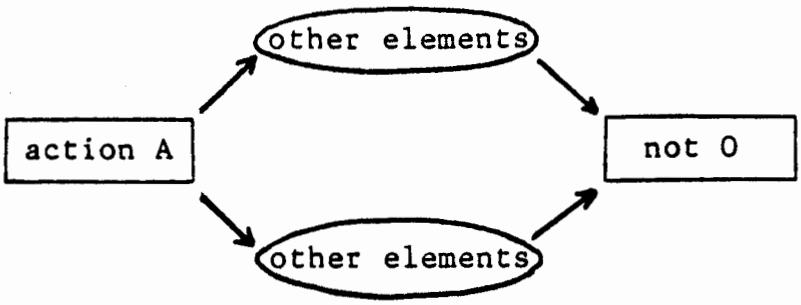
The concept of closed-loop impact is not new. It has been explicated by Maruyama (1963) and Weick (1979), among others. What this paper emphasizes is the workings of a causal loop from the viewpoint of a specific system situated as a link in the closed chain, rather than as an observer standing outside of the loop and analyzing it somewhat impartially (or "scientifically"). In other words, we are interested in purposeful social systems which act upon their environment in order to produce certain changes which they deem desirable. Hence the phrase "human action system" in the title. The boomerang effect, then, has a purposeful system as its point of origination as well as its point of return.

Let us gain a deeper understanding of the boomerang effect by looking at the system's anticipation of its action/objective linkage. Against the backdrop of the system's anticipation of its action/objective linkage, which can be depicted as follows:



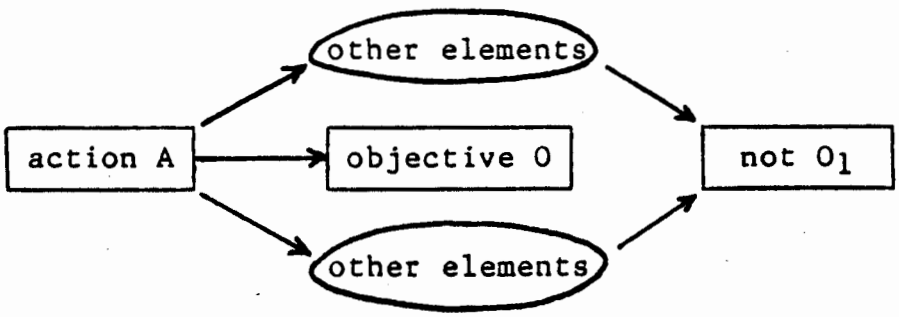
we face two types of boomerang effects:

Type I:



and,

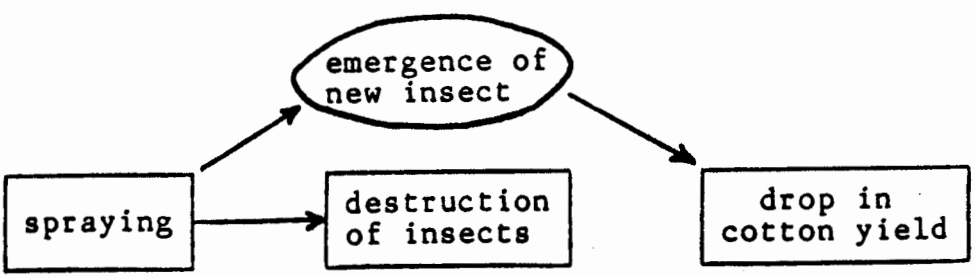
Type II:



The distinction between type I and type II boomerang effects is of utmost importance. In type I, action A impacts other elements (hitherto considered irrelevant to the system's objective) which result in an outcome (not 0) antithetical to the system's objective. For instance, in the Infant Nutrition case, the action (use of infant formula) produced an outcome (deterioration in the infant's nutritional condition) diametrically opposed to the objective desired, due to lack of consideration of other elements (such as loss of immunization from mother's milk and also unsanitary water) hitherto regarded irrelevant to the action system. In type II effect, however, action A does produce the expected lower objective (objective 0); but it also impacts other elements which lead to the failure of the higher objective (not O_1) in the hierarchy of objectives (Rahmatian, 1985). For example, in the Cotton Yield case, the lower objective was to destroy the pests which damaged the crops. The adopted action (spraying) did indeed produce this outcome. But at the same time, it impacted other elements (the new species of insects) which adversely affected the higher objective (to increase cotton yield). Graphically:

Anticipated:

Actual:



Having somewhat clarified the boomerang effect and its connection with counterintuitive behavior, we now proceed to explicate the notion of design before presenting the boomerang effect as a design principle.

UNDERSTANDING DESIGN

The act of design constitutes an essential aspect of all creative problem-solving. The non-creative decision-maker usually looks only at those alternative courses of action that conveniently present themselves to him and come to his attention most naturally. He looks at choices already available in his decision environment, and then formulates the problems as, "which choice should I take?" The creative problem-solver, on the contrary, does not obtain premature closure on the number/nature of alternative solutions. While searching his environment carefully for available choices, he also entertains the possibility that an ingenious solution may not already exist, and may therefore have to be invented. Thus, functionally speaking, we define "design" as the act of generating an alternative course of action which does not already exist in the problem environment. In choosing a solution, we commit ourselves to an available course of action, whereas in designing a solution, we create a novel course of action.

Design can also be conceptualized structurally. Structurally, we define "design" as the act of creating new and useful wholes out of parts which are not necessarily either new or useful (i.e., useful in the same way). The design of a system involves bringing together things in such a manner as to create a new whole performing a useful function. The ingenuity of a design lies not in the parts but in the way they are brought together; i.e., in the way they are related to one another (structured) in order to produce a novel effect.

Combining the functional and the structural perspectives of design, we arrive at the following set of questions as germane to any design effort:

* What is (are) the objective(s) of the system?
* What are the elements of the system?
* What type of relationships among the above elements enable the system to reach the above objective?

We will now proceed to discuss the above questions in the context of the boomerang effect.

THE BOOMERANG EFFECT AS A DESIGN PRINCIPLE

Human action systems are characterized by their pursuit of objectives and their ability to identify elements and organize them into structures which help produce desired effects. In this section, we will take the three design questions posed at the end of the previous section and explore the implication that the boomerang effect has for each.

The first question was, "What is (are) the objective(s) of the system?" The boomerang effect has two implications here. First, the boomerang effect (type II) is likely to happen when the system acts with a view towards accomplishing its lower objectives (dubbed "O" earlier) without worrying too much about the higher objectives (O_1). For instance, in the Chinese Family case, the highest objective was national stability, the one lower was efficient resource allocation, the one still lower was population control, and the lowest (the action) was the no-more-than-two-children law. It is likely that at some point, for some governmental bureaucracy, population control became an end in itself. The action (passing the law) did positively affect that objective, but it jeopardized the higher-level expected outcomes.

Second, the boomerang effect teaches us that whether a lower objective produces a higher objective sometimes depends on how (through what action) the lower objective itself was accomplished. For instance, in the Cotton Yield case, whether the elimination of pests produced a rise in cotton yield depended on how pests were eliminated. One type of spray produced the emergence of a worse species of pest; another may have not.

Another issue germane to design is "What are the elements of the system?" This is perhaps the point where the boomerang effect becomes most relevant to design. A plan of action backfires typically when the system considers as impertinent elements which indeed turn out to be relevant. In the Import Tariff case, for instance, the country whose exports were affected by the first country's tariffs was seen as external to the first country's unemployment problem. Had that country and its possible responses to the tariffs been regarded as a significant element of the action system aimed at reducing unemployment, the counterintuitive behavior may have been avoided.

The point raised here can be misunderstood easily. It may be argued that systems theory, all along, has been dealing with this situation in the concept of "transactional environment." This type of environment is defined as the set of all those elements which affect, and are affected by, the system. In response to this objection, it is necessary to make a distinction between: a) the elements which affect <u>and</u> are affected by the system; and b) the elements which affect <u>because</u> and <u>when</u> they are affected by the system. The boomerang effect calls our attention specifically to type b element whose effect is triggered by the system's impact on it. "And" is the

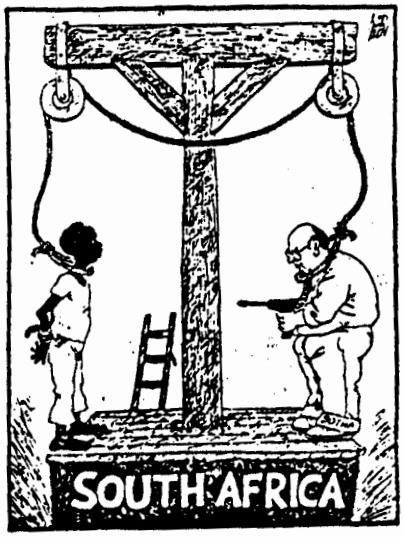
most general conjunctive in logic. Therefore, logically, type b element is a subset of type a. Nevertheless, making the distinction is crucial in that it serves to sensitize the systems planner to the boomerang effect in terms of anticipating (thereby avoiding) it.

In systems where type b elements are other social systems (as in the Import Tariff case), it becomes interesting to find ingenious ways of forecasting (if not controlling) the system-triggered impacts of other elements. One way of doing this is through simulation (gaming). Another is through negotiation and bargaining.

The creation of appropriate relationships among system elements is the third concern of a system designer. The difference between this and the second concern (identification of system elements) is that here the elements are properly identified, but their impacts are probably misjudged. This was witnessed in the Snake Elimination case. Therefore, the challenge to the system designer in this third category is to entertain the possibility that a familiar system element may behave in unexpected, unfamiliar ways. Scenario construction techniques are an effective way of anticipating improbable impacts.

Let us briefly summarize the above points. The major implication of the boomerang effect for the system designer has to do with the way the designer defines the boundary of the system. The boomerang effect is likely to happen when the system defines its goal boundary too narrowly, or sets its action boundary in such a way as to leave out critical elements and their unexpected impacts. In a way, the boomerang effect calls our attention back to what I believe to be the very essence of the systems approach, namely respect for all those Others who, in truth, are part of the real Me, all of Us being actors in an almost inexplicable causal web.

I bring this explication of the "inexplicable" to an end with an analogy and with a cartoon. The analogy is between the boomerang effect and the plight of the man who set his enemy's ship on fire in the middle of the ocean only to realize that he himself was on the same ship. He reached the goal of destroying his enemy, but! The following cartoon is a good example of a contemporary boomerang in action.



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