Modeling Compliance as Instrumental Conditioning

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Introduction

Safety of individuals or organizations against accidents, and security of information, assets or people against malicious threats are complex, dynamic problems. They involve human behavior shaped in subtle ways by technology and (work) environment. The interplay of technology, environment and human factors in such systems has necessarily *dynamic complexity*, a term subsuming the compounded impact of temporal change, feedback, time delays, nonlinearity, soft factors (incl. perceptions), and interdisciplinary aspects.

There is a huge literature on safety and security, incl. its human aspects, but the dynamics of such systems has been comparatively little studied. *The* methodology for studying systems with feedback, nonlinearity, delays and soft factors is system dynamics (Forrester, 1961; Sterman, 2000). Until recently, system dynamics studies of safety and security problems were rare. Yet the goal of system dynamic studies – to trace propagation of effects linked by causative mechanisms and to explore policies to improve system performance – ought to be at the core of research to increase the causal understanding of failures of safety and security, to ascertain mechanisms for preventing failures and to minimize the impact of failures when they do happen.

Many factors have been proposed to explain the erosion of compliance, e.g. throughput pressure, by imposing higher priority on production and less on security (Reason, 1997); behavioral economics, incl. problems with various rules and feedback affecting perception of personal gains and losses (Battmann & Klumb, 1993); conflicts between personal and organizational goals (Reason, Parker, & Lawton, 1998) – both acting to the detriment of security goals; … and finally risk, or rather perceived risk (Gonzalez, 2002a, 2002b; Gonzalez & Sawicka, 2002, 2003a; Wilde, 1994).

The role of risk perception is particularly interesting. First, performance in both safety and security settings is well characterized by the "unrocked boat" metaphor: Organizations become accustomed to their apparently safe state, thus misperceiving risk and allowing themselves to drift into regions of greater vulnerability, until (near) accidents temporarily induce greater risk awareness. The resulting pattern is oscillatory, with varying amplitude and typically leading to disaster. While other potential influences (e.g. throughput pressure) may or may not be present, the high volatility of risk perception makes this parameter indispensable for theories of human compliance with safety and security regulations. Second, a powerful mechanism – viz. instrumental conditioning – would imply that alertness to risk has a positive impact on compliance. A lamentable aspect of instrumental conditioning – viz. extinction of conditioned behavior – is likely to be a key reason for why compliance tends to decay over time.

Instrumental Conditioning and Compliance

Several authors have argued that the erosion of compliance is driven by a reinforcement mechanism (see e.g. Battmann & Klumb, 1993; Dörner, 1989, 1996; Gonzalez, 1995). (Dörner, 1996, p. 31) expresses this mechanism (in connection with the disaster in Chernobyl) so: "Another likely reason for this violation of the safety rules was that operators had frequently violated them before. But as learning theory tells us, breaking safety rules is usually reinforced, which is to say, it pays off. Its immediate consequence is only that the violator is rid of the encumbrance the rules impose and can act more freely. Safety rules are usually devised in such a way that a violator will not be instantly blown sky high, injured or harmed in any other way but will instantly find that his life is made easier."

Behavior Regulation Theory

According to the behavior regulation theory of instrumental conditioning (Allison, 1989; Timberlake, 1980) each individual has a preferred distribution of activities. For a particular activity the actual preference can be viewed as a set-point in the sense of control theory. The collection of set-points for the relevant activities is a point in a vector space – the behavioral bliss point (BBP).

The introduction of an instrumental contingency constrains the relative access to one of the responses – viz. the reinforcer. The resulting disruption produces a change in another activity, viz. the instrumental response that counteracts the direction of the disruption.

We developed a system dynamic model of a text-book case of instrumental conditioning (Domjan, 2000, p. 130ff). We extended the model to include relaxation and reimposition of the instrumental contingency depending on how the agent enforcing the conditioning procedure perceives the subject's behavior. Our simulation model shows a homeostatic pattern of responses (Gonzalez & Sawicka, 2003a).

A similar homeostatic behavior (the "unrocked boat" behavior) is observed regarding compliance with security and safety regulations. An extension of the simulation model to compliance is readily made by observing that risk perception plays the role of conditioning procedure (Gonzalez & Sawicka, 2003b). The strength of the instrumental contingency fluctuates. The decay of risk perception in periods when no incidents occur is the mechanism causing the volatility of the instrumental contingency affecting compliance.

Our model shows that conditioning of compliance only occurs during a short interval in a cycle. Misperception of risk and the rare occurrence of accidents even when compliance is low – modern technology is forgiving – act during a much longer interval to extinguish conditioned behavior, promoting noncompliance. In the extinction zone there is contiguity between noncompliant behavior and lack of accidents: The "extinction zone" is a favorable setting for "superstitious learning" (Hogarth, 1987; Sterman, 1997).

Discussion

Interpretation of findings

The hypothesis that the erosion of compliance is driven by reinforcement (Battmann & Klumb, 1993; Dörner, 1989, 1996; Gonzalez, 1995) is not quite correct: Instead of reinforcement of noncompliance, there is transient reinforcement of compliance while risk is perceived as high, and lack of reinforcement of compliance when risk is perceived as low… implying a return to the BBP, i.e. an accident and attack prone situation.

Policies suggested by our model

First, the most important and sustainable way to improve compliance should be to modify the BBP – e.g. through sustainable learning and social engineering (Cialdini, 1993).

Second, it is crucial to entrench instrumental conditioning while risk perception is high and, indeed, to sustain perception of high risk (to prolong the zone of perception of high risk) by education and campaigns.

Third, it is important to counteract extinction of conditioned behavior. Indications of noncompliance should be detected as soon as possible. Conditioned behavior is not "extinguished" – rather, it is inhibited. Hence, there is a potential for quick reactivation of compliance.

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