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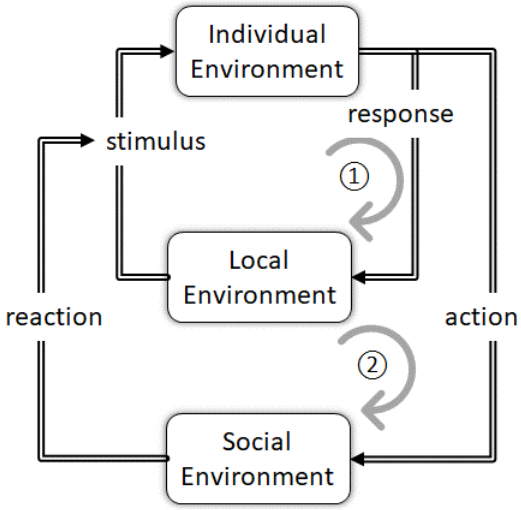
On Engineering the Subjective

The *thing* in thinking about something, is subjective, of the brain. Science and engineering begin subjectively. But this does not preclude the *thing* acquiring materiality independent of the thinker, of being objective.[1] The subjective experience of 6 billion passengers flying 57 billion nautical miles while 6 million parts of the Boeing 747 function flawlessly- was reliable, objective spacetime travel.

The terms, engineering and subjective, have traditionally not shared close company, unless in a critical context such as the analysis of the space shuttle Challenger in 1986.[2] However things are changing, for example in social risk identification and cybernetic design.

Social risk is the subjective risk of groups forming and doing real things, such as ruining brand reputation, only because of commonly held individual beliefs. Modeling the local environment (Figure 1, loop 1) identifies risks that might result from actions in the general social environment (loop 2).

Figure 1. A semiotic model of social construction.



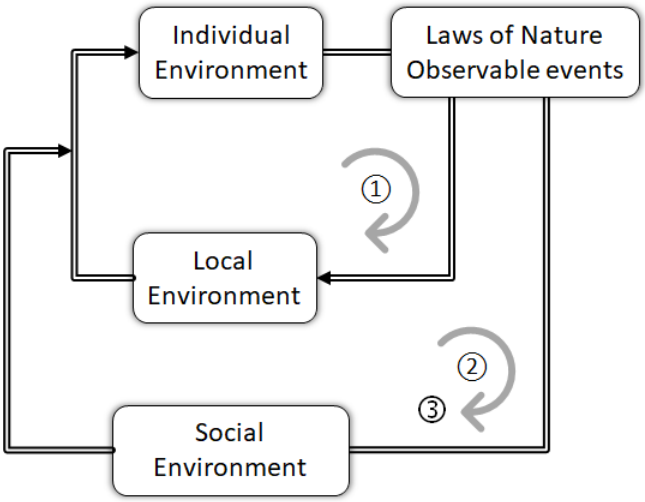
This is a process of social construction in which the ultimate result of the action, good or bad, is determined by societal reaction. If the actions are socially acceptable, the action is good and promotes affiliation, or it may be deemed bad and rejected or punished.

[1] This position comes with the inherent dualism of a brain-dependent thought about a brain-independent world (critical realism).
[2] Bell, T.E. and Esch, K. (1989).

Constructs such as truth, right and wrong are relevant only to the extent they frame the collective response of society.

If we dig deeper into the model, it is possible to see how subjective engineering leads to sound quantitative designs and yet how even these can ultimately lead to problems. This involves an additional actor, call it *Laws of Nature*.

Figure 2



The Challenger space shuttle launch in 1986 provides a stark example.

① Respected engineers (EXPERT) provide design (JUDGMENT) on O-ring performance at low ambient temperature. Early testing of JUDGMENT is successful.

② The first nine Challenger launches are successful. EXPERT JUDGMENT becomes best practice. Challenger launch number 10 is in (untested) low temperature. Best practice is followed and the launch proceeds.

③ Challenger disaster in January 1986, an example of the unintended consequences of invention.[3]

Areas of engineering exist where theory often provides inadequate guidance for design, such as hard rock mining. Subjective opinion is increasingly used to inform risk management, especially in situations of high impact that are poorly understood. Various methods of expert elicitation provide a kind of subjective probability that can be integrated with quantitative assessments for a more complete picture of risk.[4]

[3] Virilio (2007).
[4] USACE (2019), Joughin (2017).

Figure 2 is also a useful model of human-machine interaction, such as the semi-autonomous vehicle. These are cybernetic systems where a key design element is a subjective individual (driver) operating in a local environment (vehicle) in the context of the broader social environment (traffic).[5]

Definitions

Objective:	Of or relating to a material object, actual existence, or reality
Subjective:	Resulting from or pertaining to personal mindsets or experience
Engineering:	The application of the physical *and social* sciences to the needs of humanity and the development of technology
Cybernetics:	A field of systems theory concerned with the general principles of circular causal processes, including for example ecological, technological, biological, cognitive and social systems.

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[5] Evans (2022). Also Fukuda (2014) for designs accounting for affect and expectation.