Accenture / Fjord Dublin (via teleconference) 21 September 2020

Systems Theory in Design

Second-order Systems + Learning

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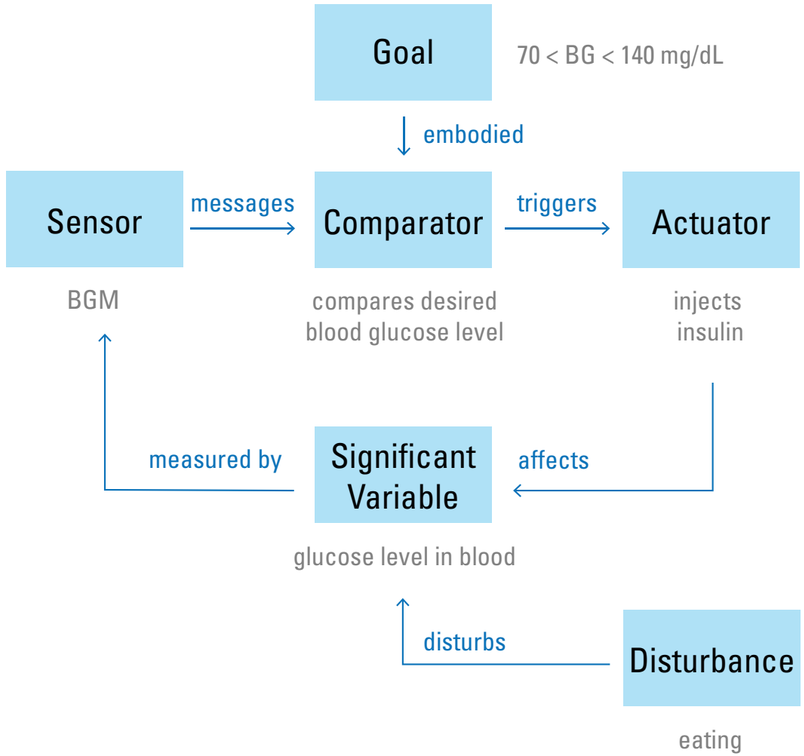
A few more thoughts on Variety and Requisite Variety

Eating carbs increases blood glucose (BG) levels, which should prompt the body to produce insulin.

Insulin aids cells in absorbing the glucose, maintaining the BG level in range.

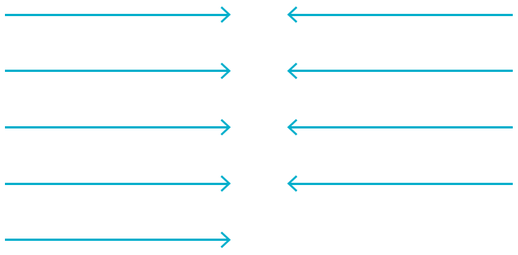


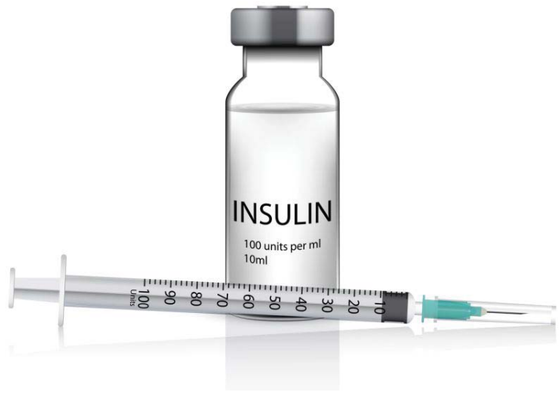
Some people are not able to produce enough insulin, a condition known as ‘diabetes’.

A person with diabetes lacks the variety needed to resist disturbances to their BG level.

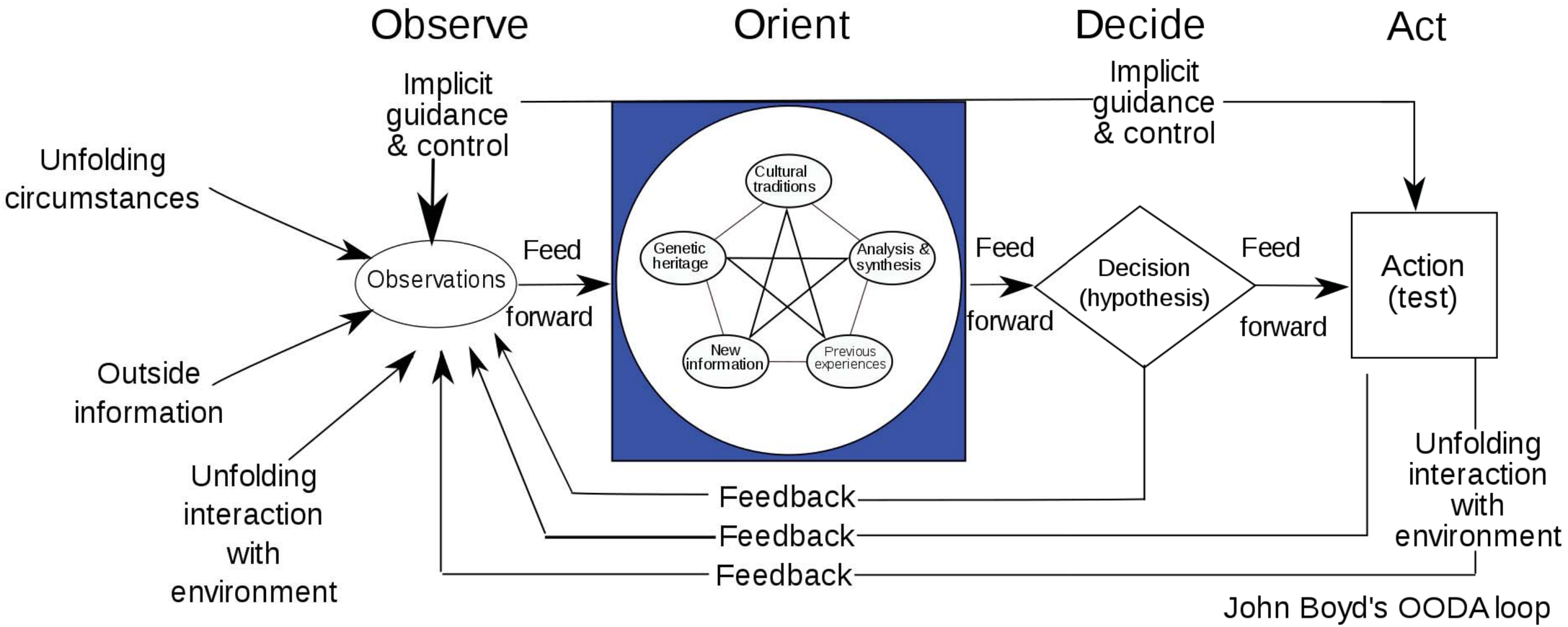
A solution is to ‘count carbs’ —
i.e., estimating the amount of food to be eaten,
converting portion size to calories,
converting calories to insulin required,
and then injecting the required amount of insulin.

The ‘variety’ in the mealtime insulin bolus
cancels out the variety of carbs in the meal.





The OODA Loop — Observe, Orient, Decide, Act — is an application of regulation to the military.



"In order to win,

we should operate at a faster tempo or rhythm than our adversaries —

or, better yet,

get inside [the] adversary's Observation-Orientation-Decision-Action [loop] ...

Such activity will make us appear ambiguous (unpredictable)

thereby generate confusion and disorder among our adversaries

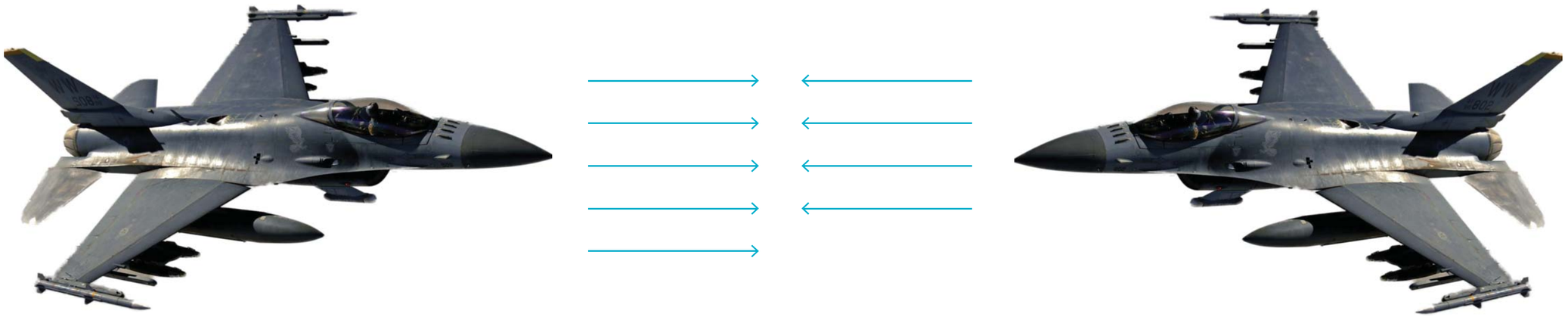
since our adversaries will be unable to generate mental images or pictures

that agree with the menacing, as well as faster transient rhythm or patterns,

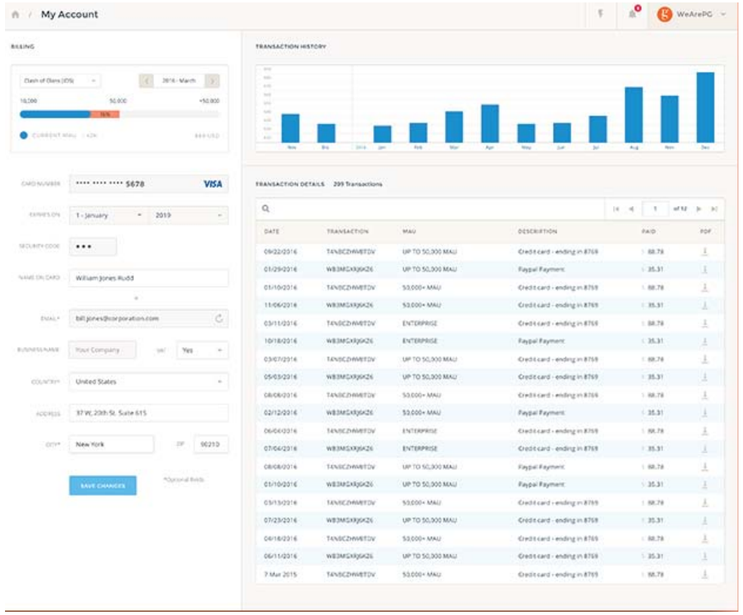
they are competing against."

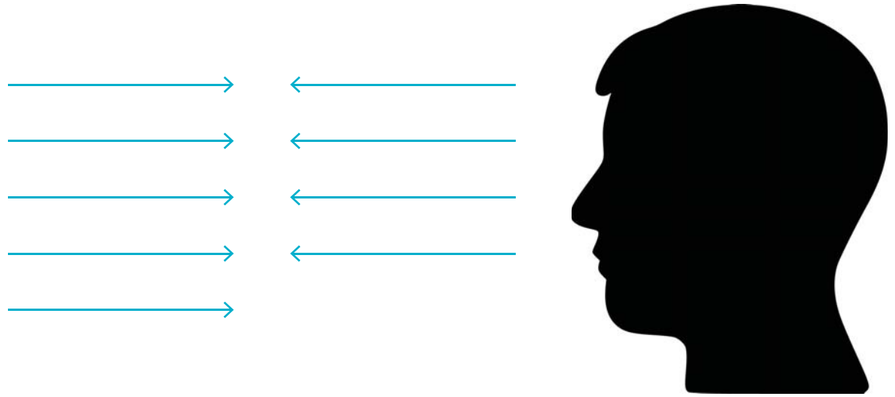
— Colonel John Boyd

Competition (e.g., combat) may also be seen through the lens of ‘variety’. The winning side will have more variety than the losing side.



UX designers sometimes focus on ‘cognitive load’ — the amount of ‘working memory’ required by a task. If cognitive load is too great, users can be overwhelmed, i.e., the variety of the task swamps the variety of the user.



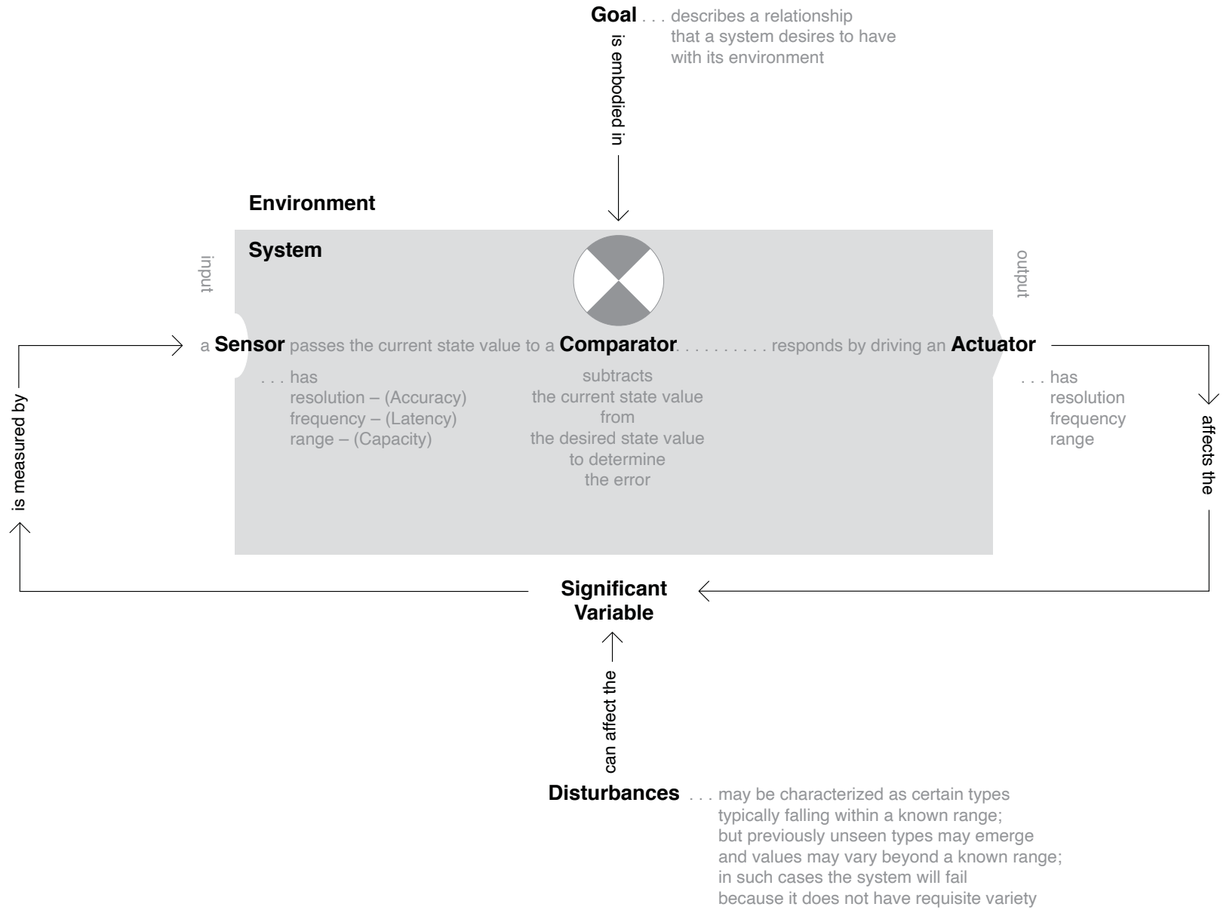


More generally, designers need to consider ‘bio-cost’ —
time, energy, attention, and stress people expend to achieve a goal —
to get what they want.
Bio-cost depletes ‘gumption’ — our ‘reserves’, e.g., enthusiasm.

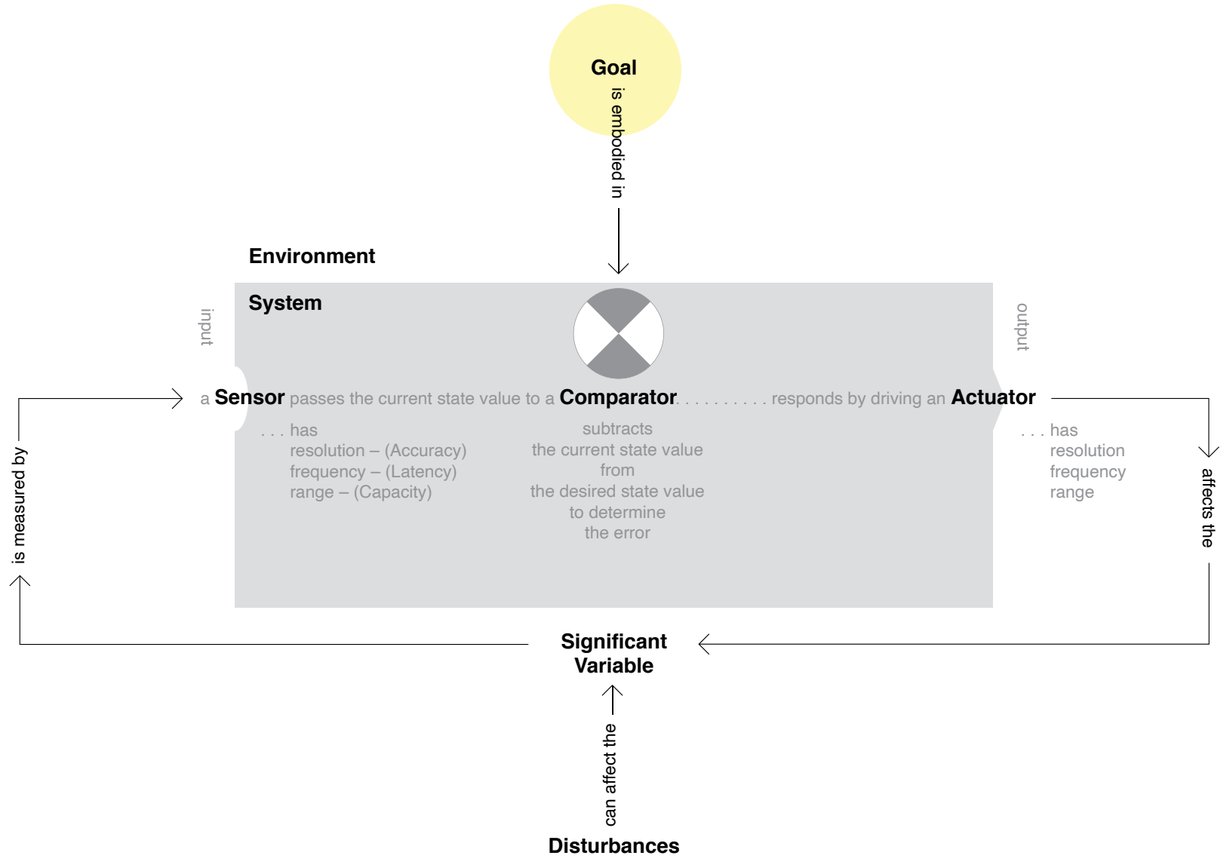
If the bio-cost of a task is too great, users can be overwhelmed,
i.e., the variety of the task swamps the variety of the user.

Second-order Systems

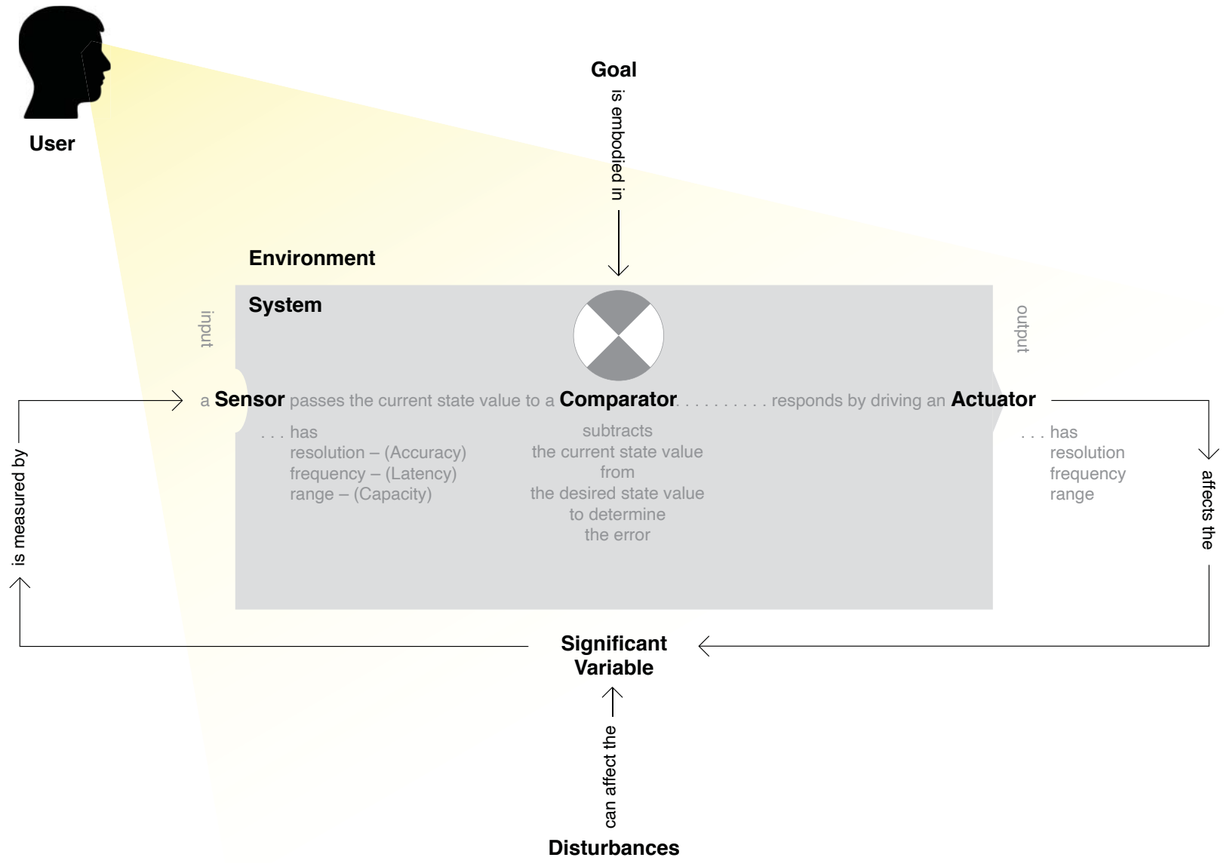
The standard model of a self-regulating system entails a feedback loop. We might call this a single-loop or first-order system.



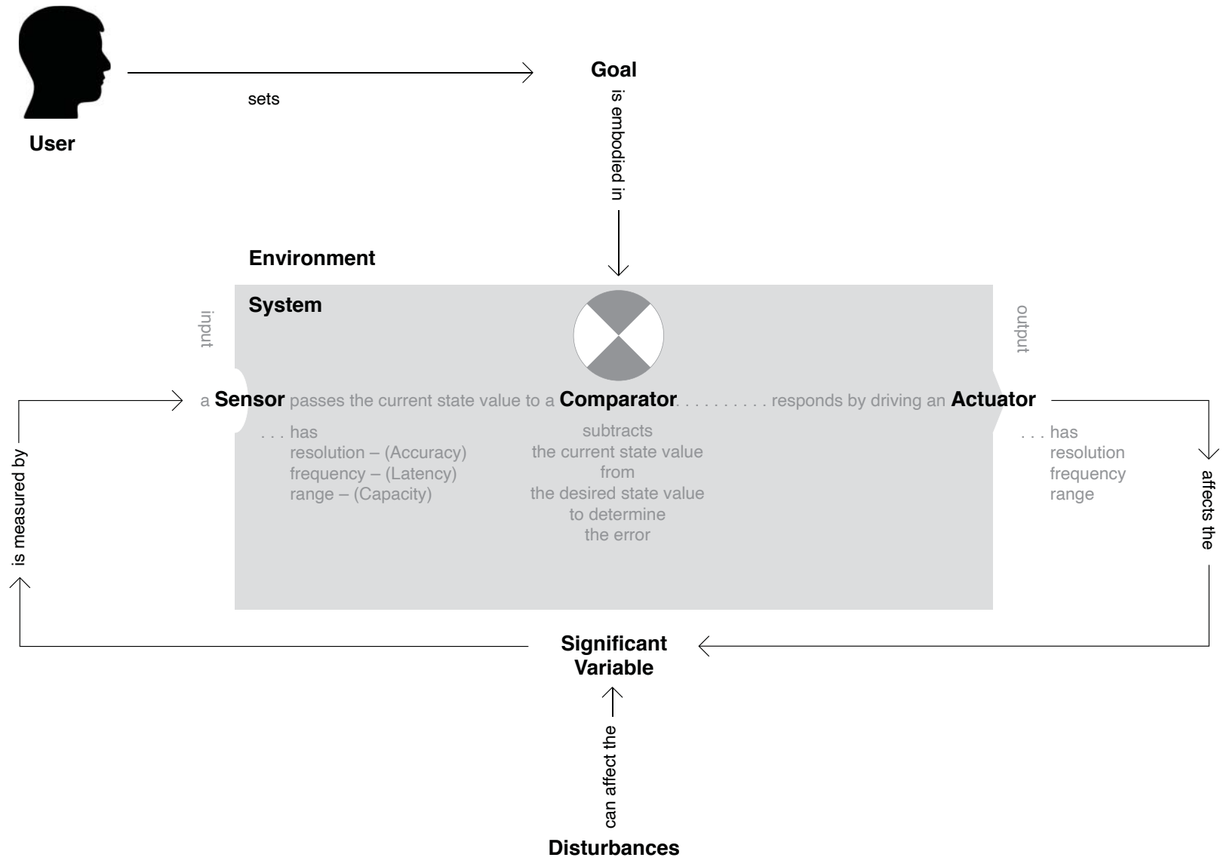
In a first-order system, the goal or set-point is given (i.e., it is assumed).



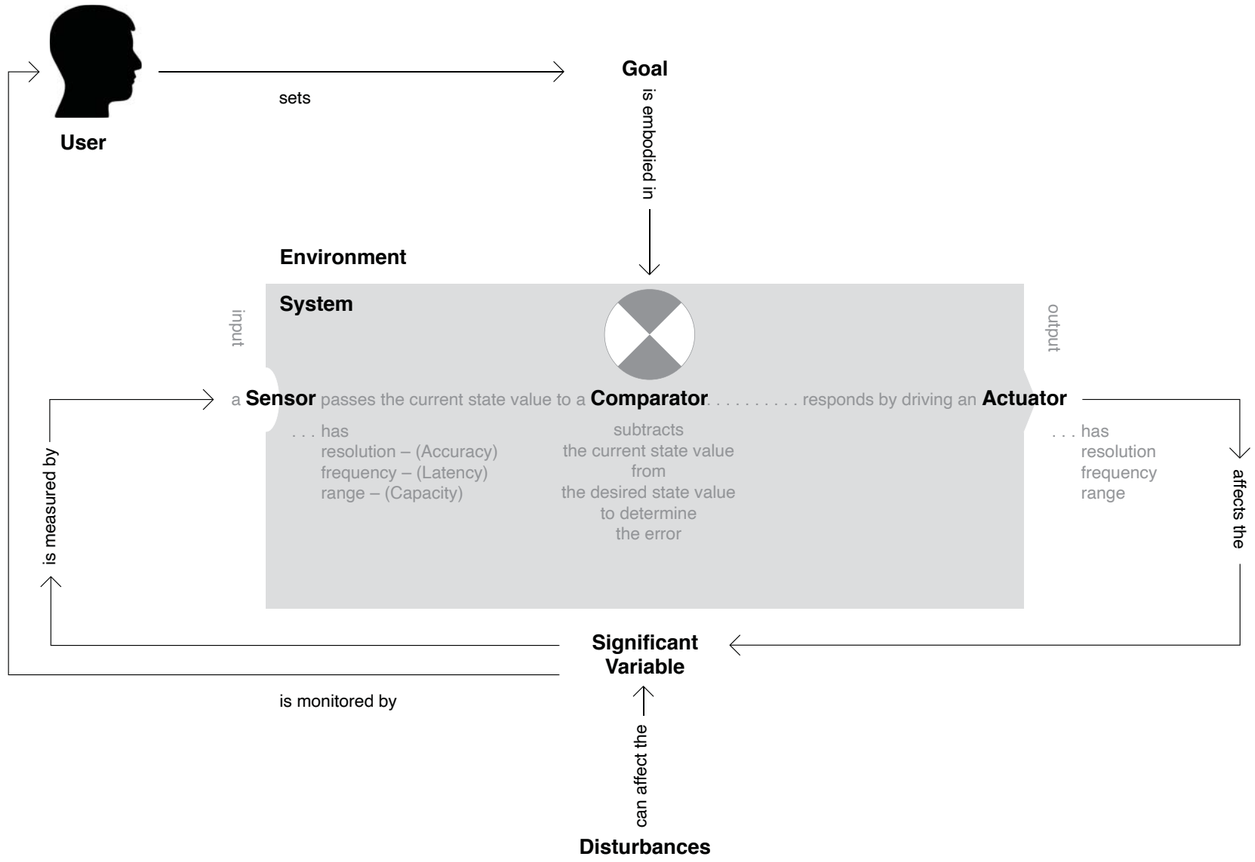
In practice, the first-order system is often observed by another system.



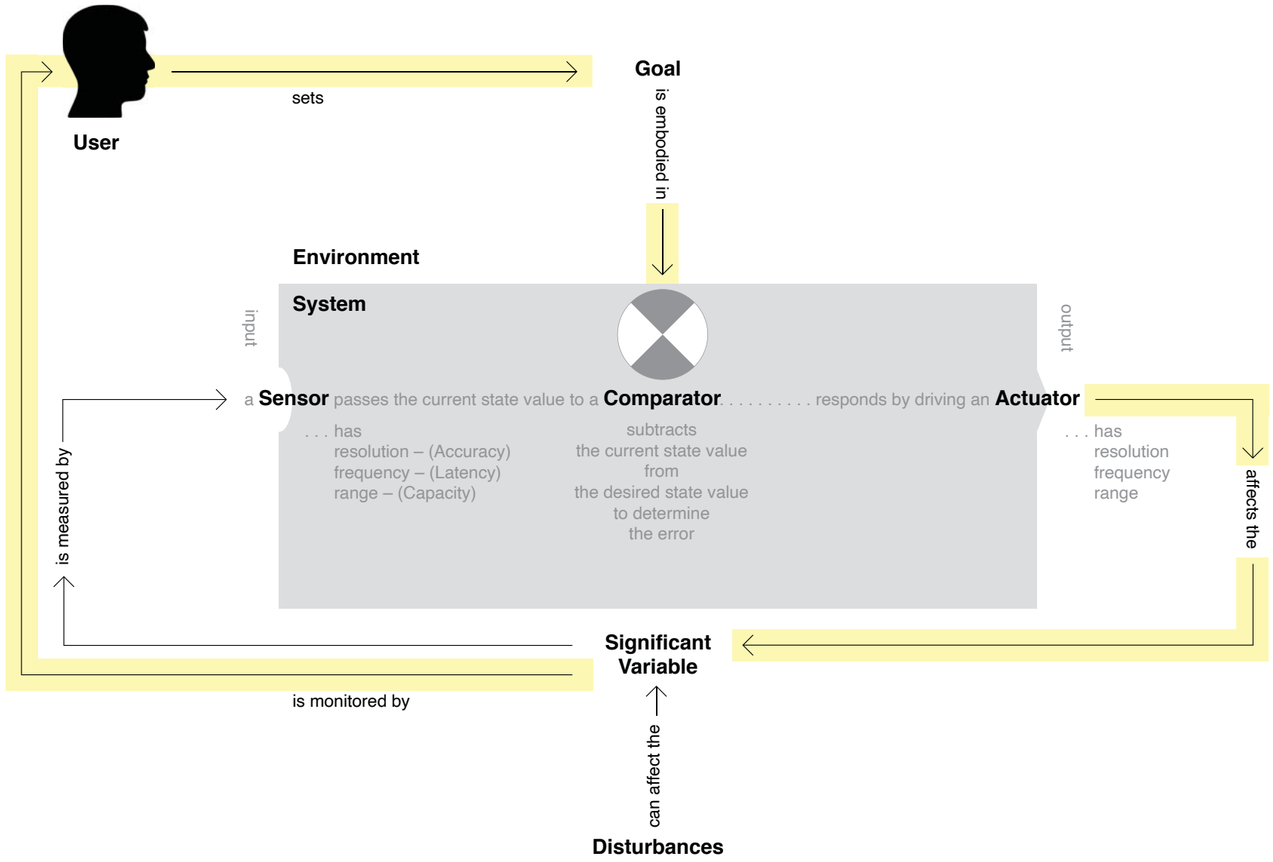
A ‘user’ may set the goal or fix the set-point.



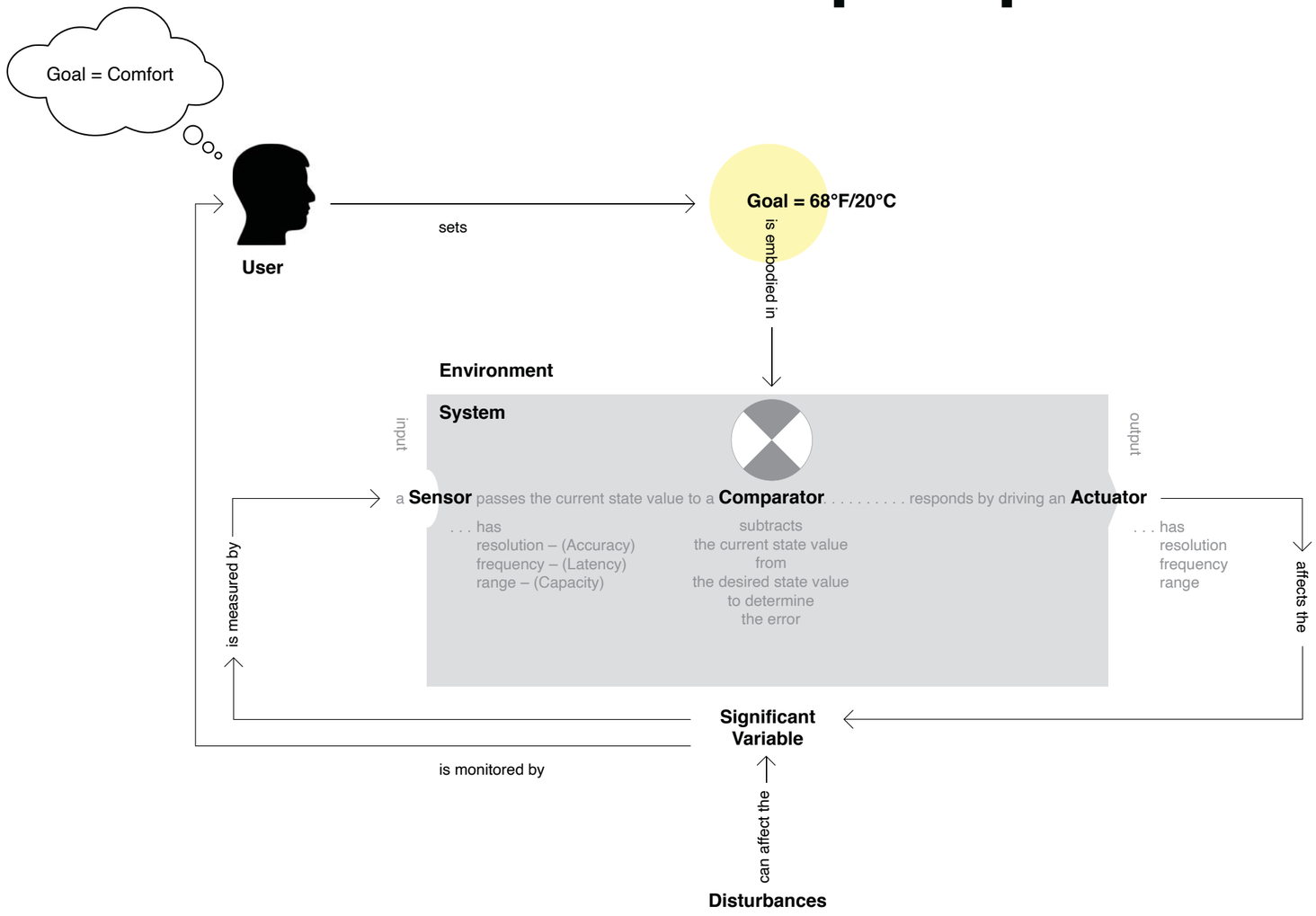
In addition, the user may monitor the significant variable.



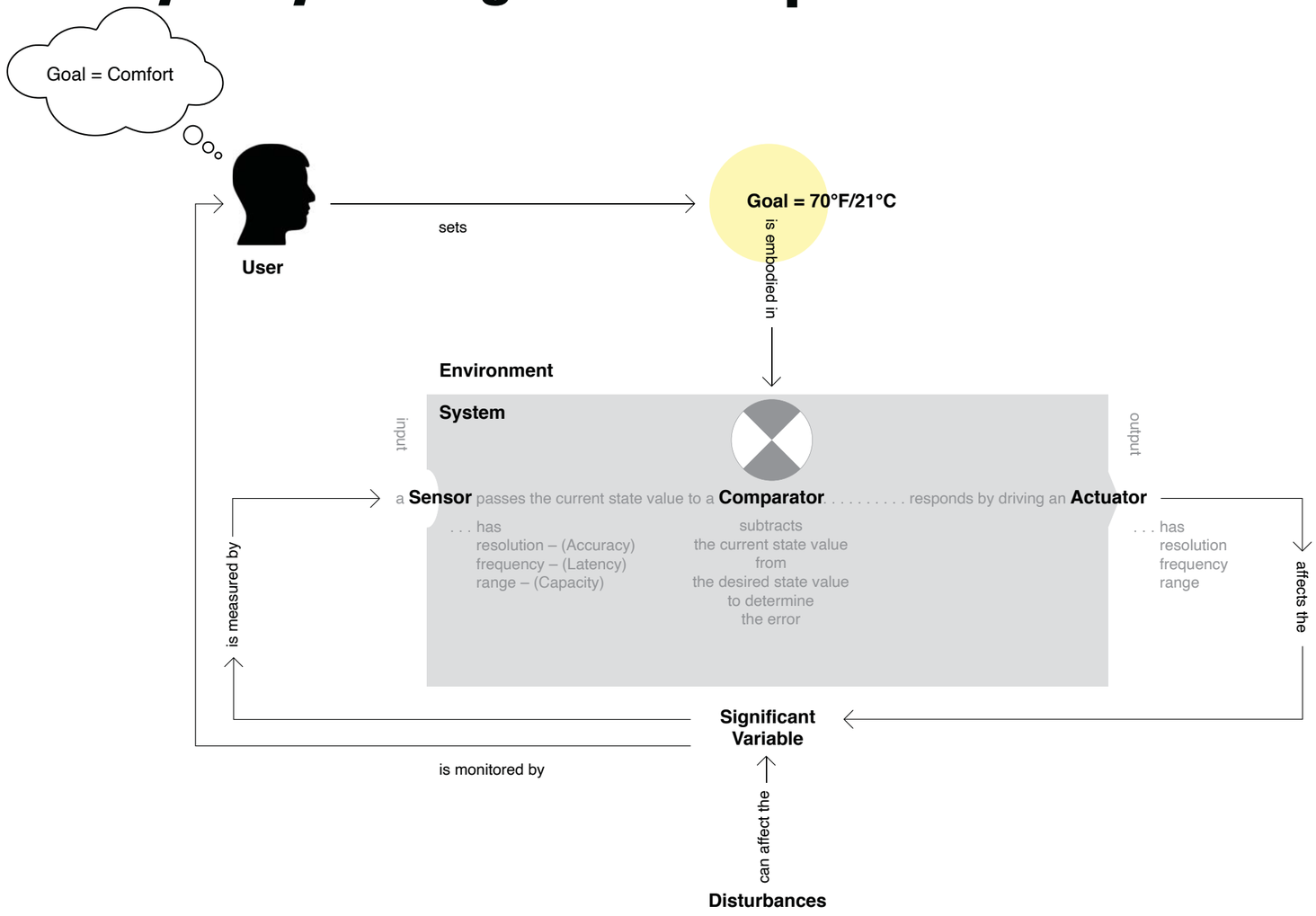
A second feedback loop appears above the first — creating a double-loop or second-order system.



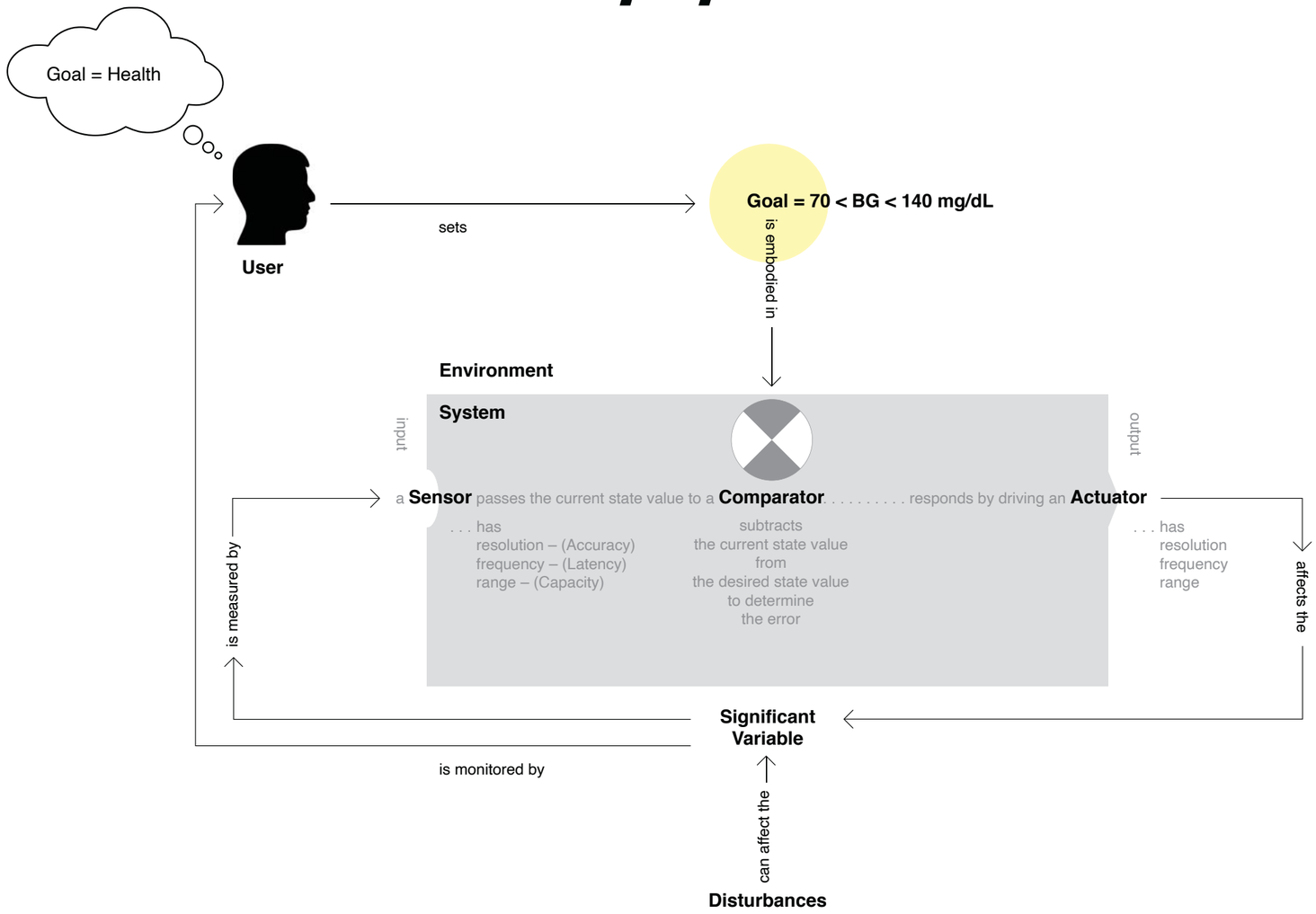
In the classic thermostat example, users have the goal of ‘comfort‘, and they set the thermostat to maintain perhaps 68°F or 20°C.



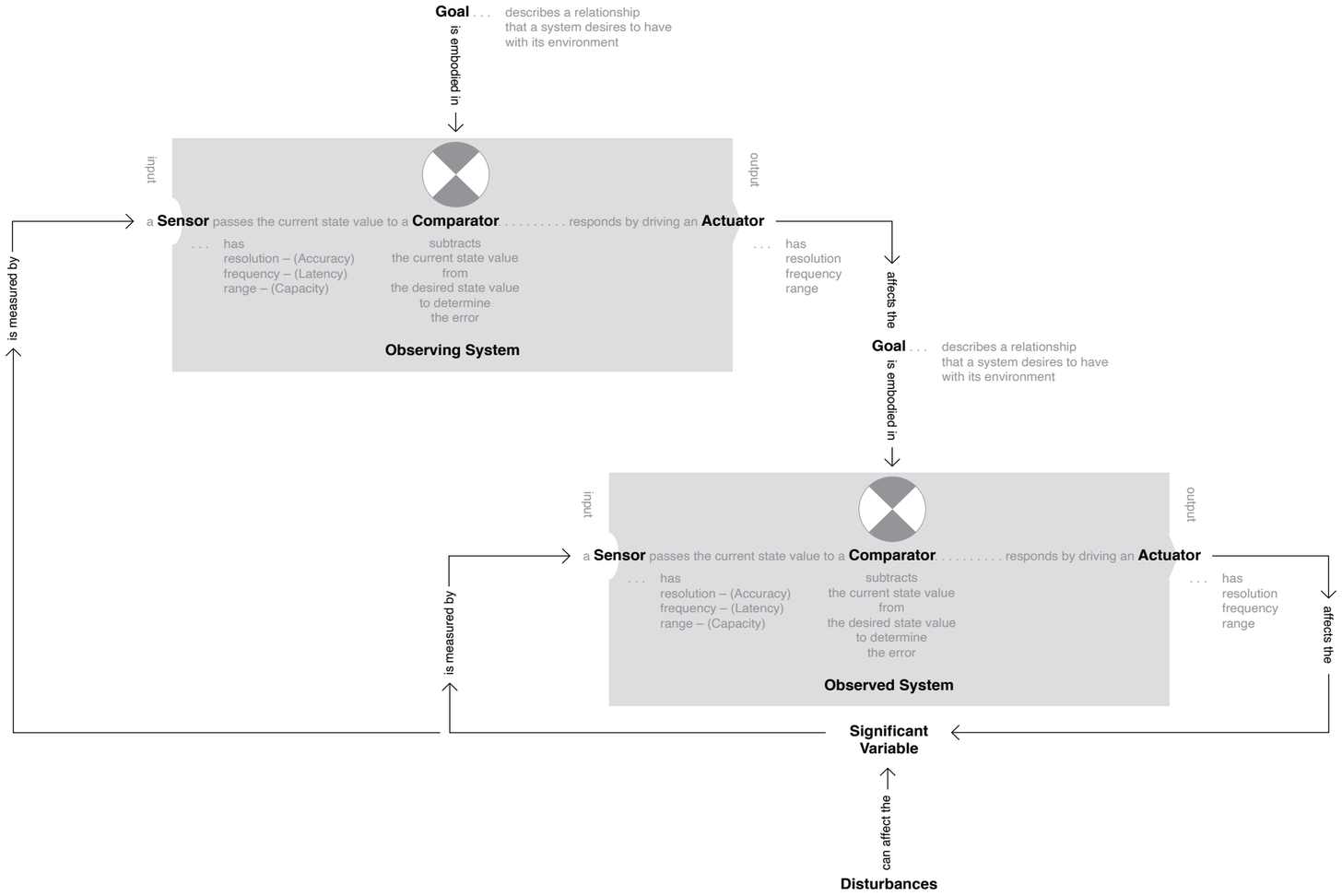
Later, users may decide that 68/20 is too hot or cold — not comfortable. In response, they may change the set-point of the thermostat.



Likewise, a physician might change the desired range for an automated insulin delivery system.



The second feedback loop is also a control system; the action of the second loop is to regulate the goal of the first loop.



Goal-means Trees

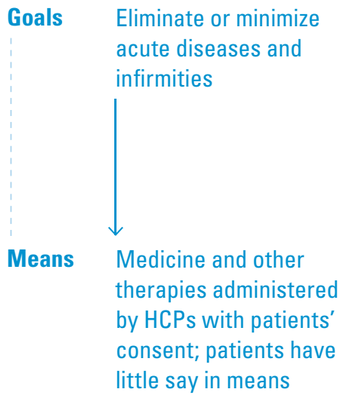
Second-order systems may be thought of as having two layers: The top layer sets goals; the bottom layer manages means (or tasks).

Goals

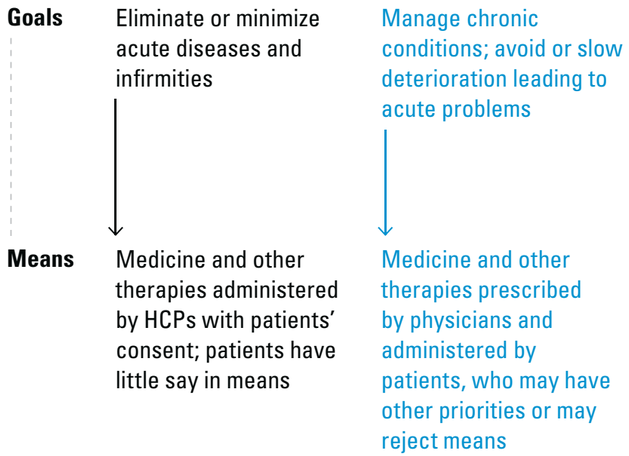
Means

A means layer can be replaced by lower-level goals and corresponding means.

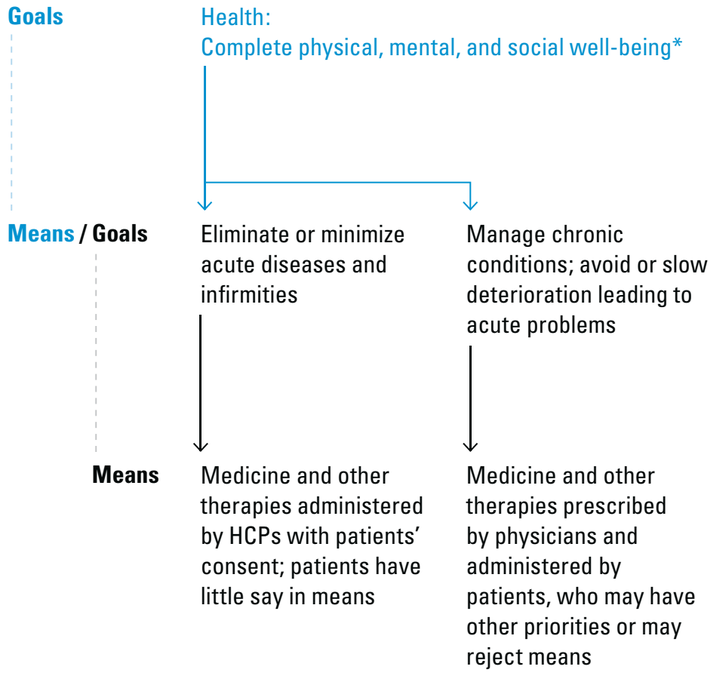
Traditional healthcare focuses on treating acute problems.



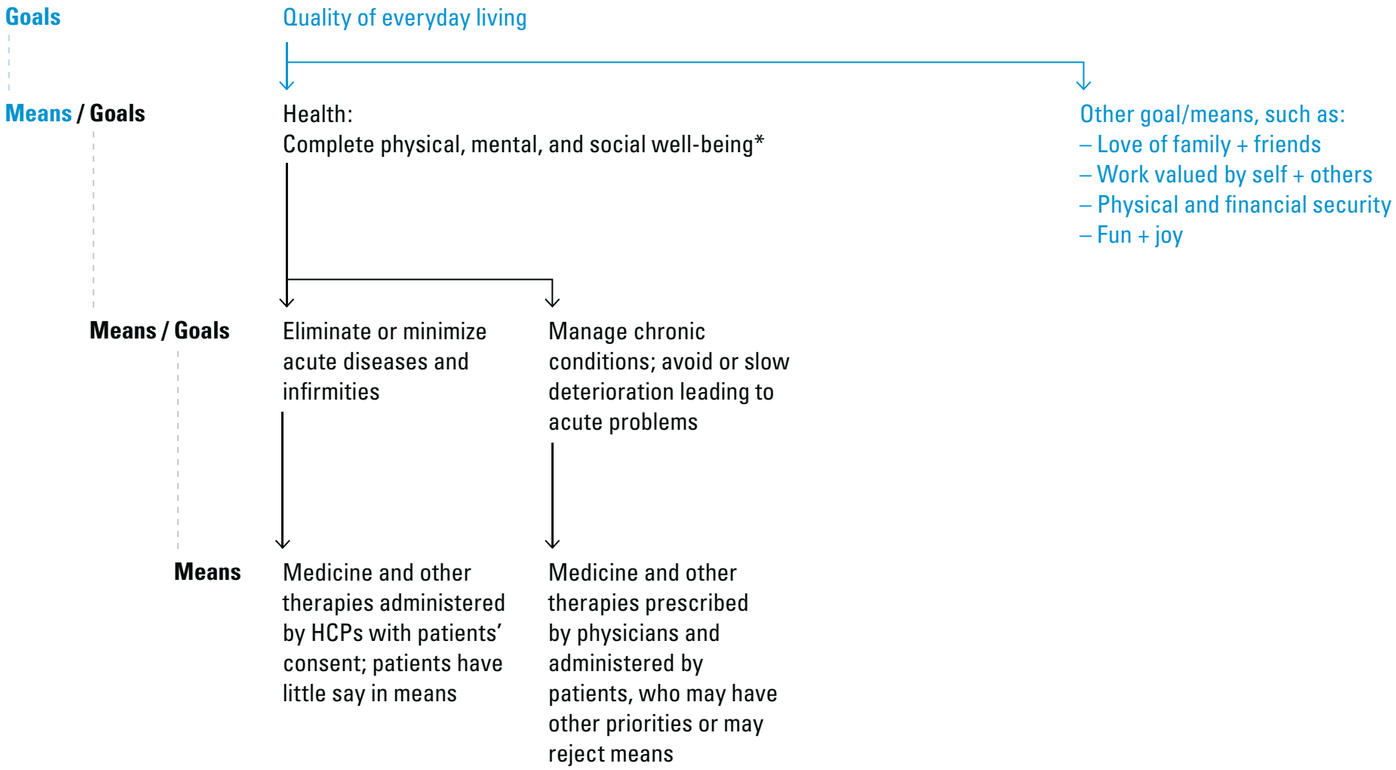
Traditional health management applies the tools of acute care to stabilizing chronic conditions.



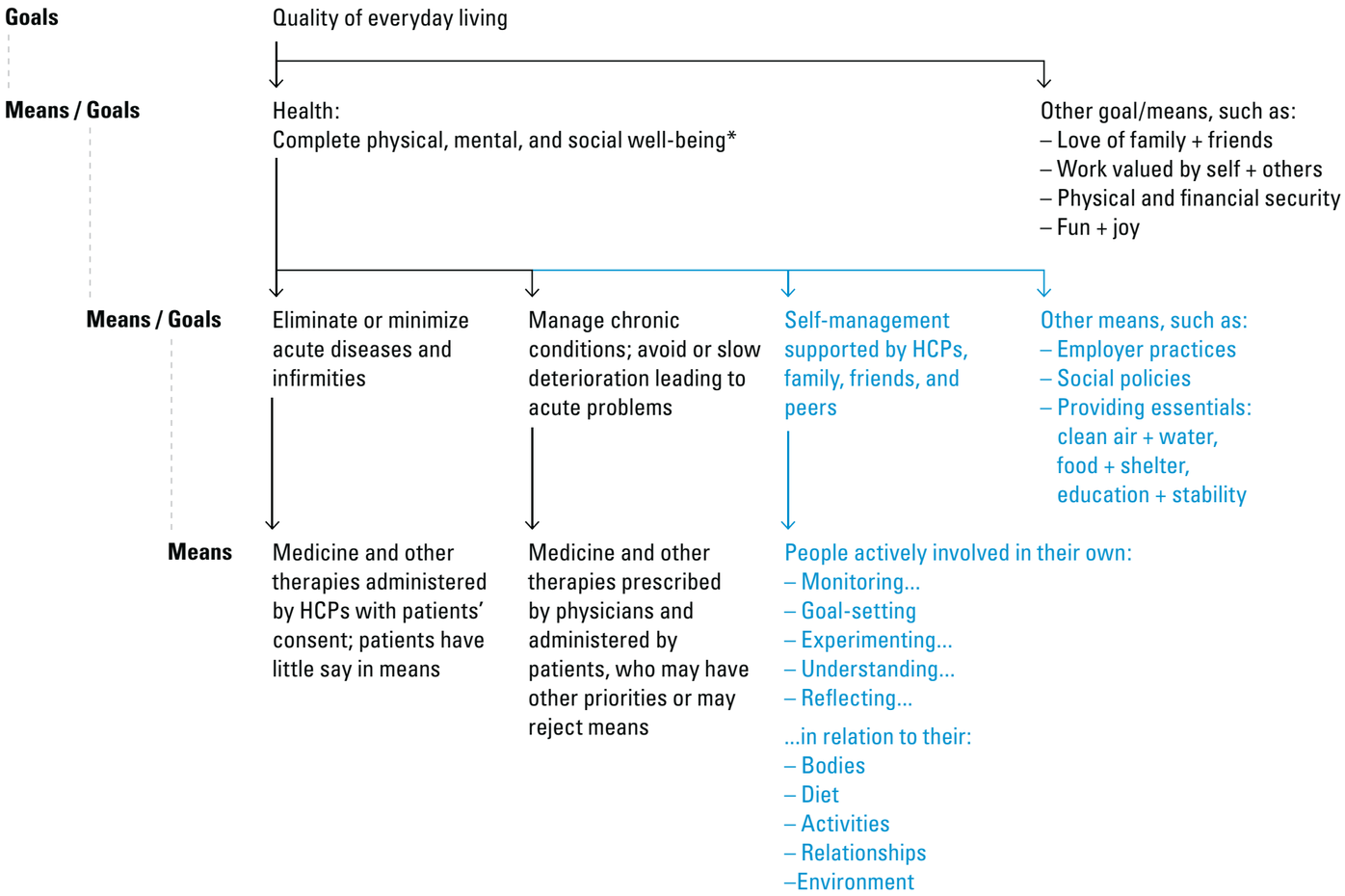
But health is more than eliminating or managing disease.



Health is a means to higher goals—‘a resource for everyday life’.



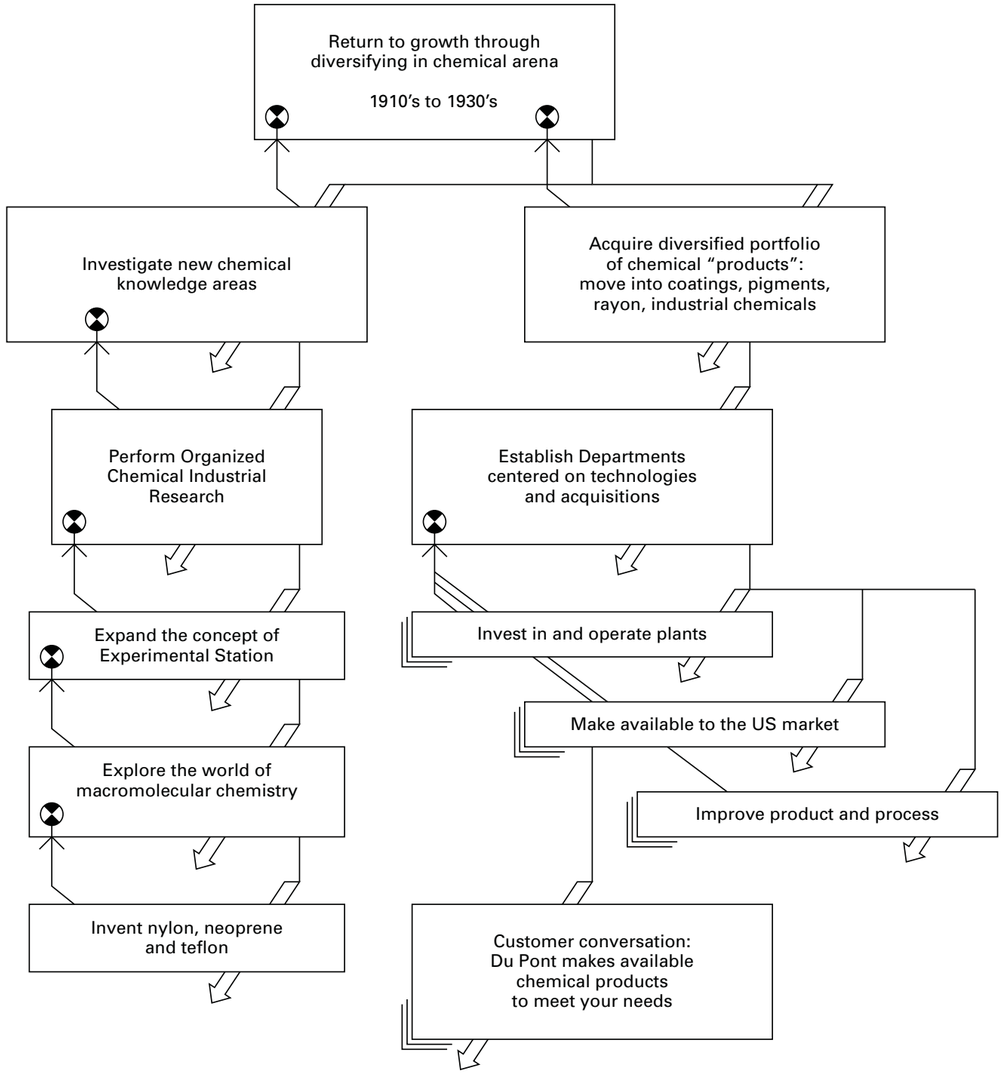
The requirements of health extend beyond traditional healthcare.



Du Pont Goal Structure

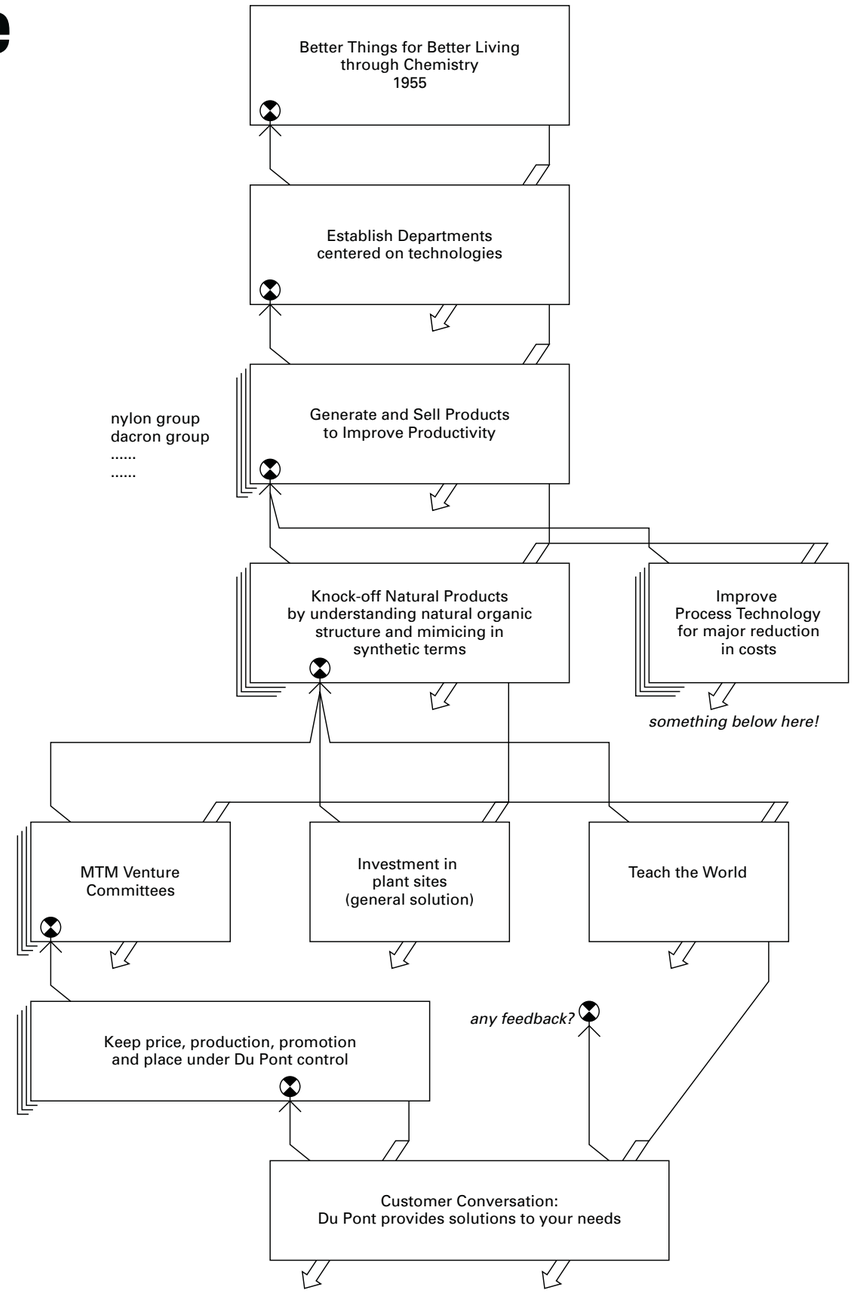
Snapshot 1910 to 1940

Laid the foundation for a new business—
“invention” phase.



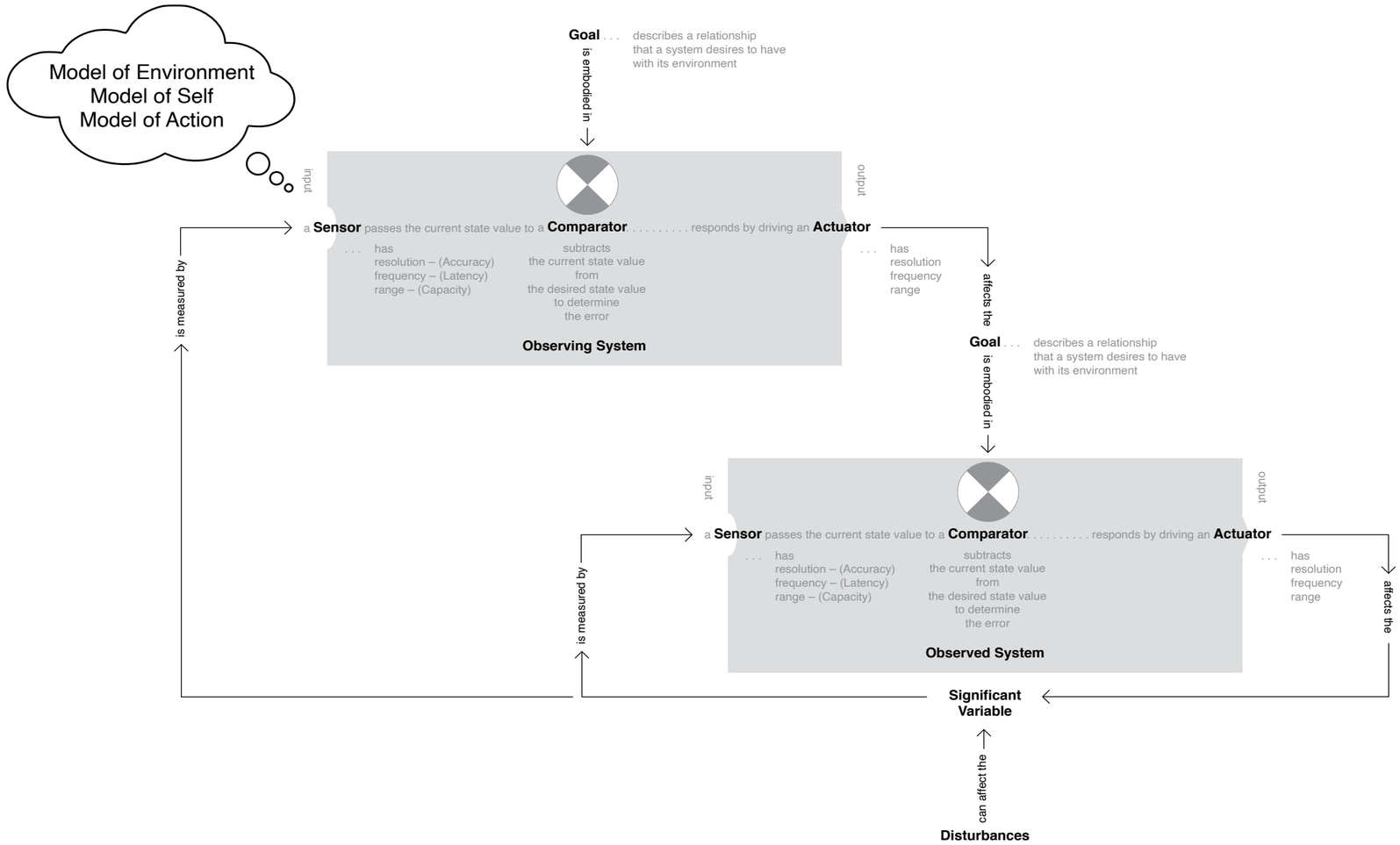
Du Pont Goal Structure
Snapshot 1940 to 1975

Built on the foundation—
“discovery” phase.

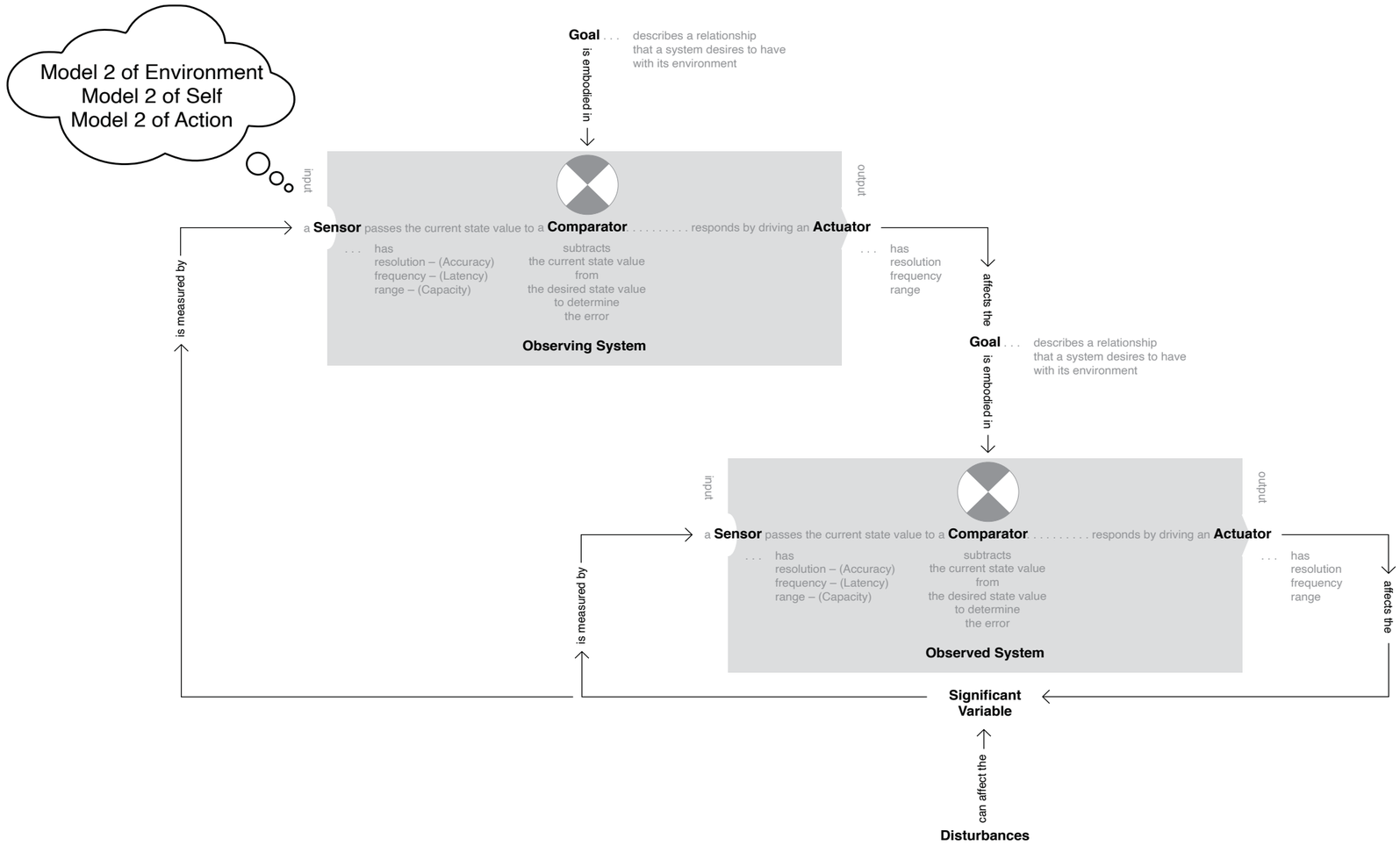


Learning Systems

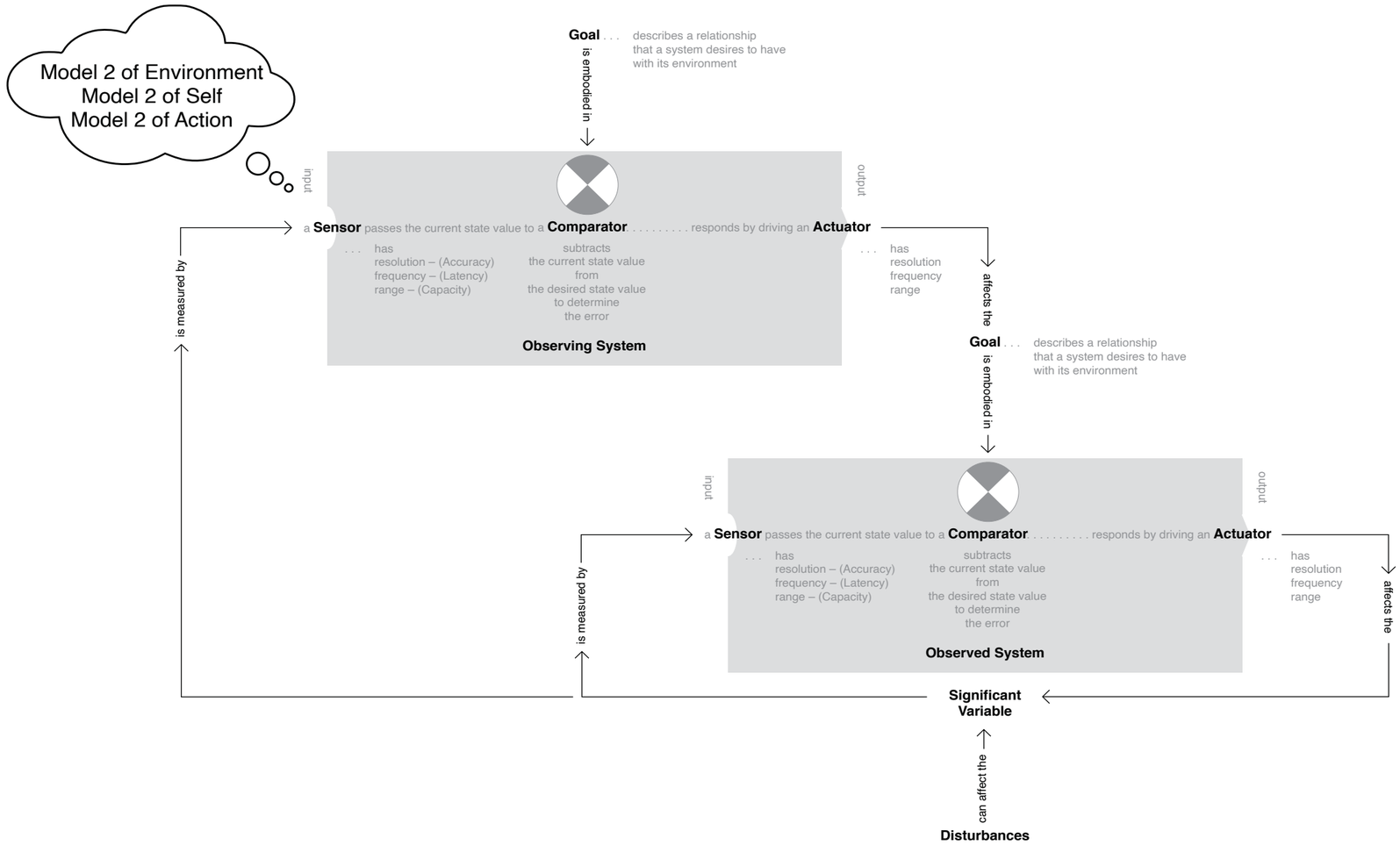
The second-order system builds models of its environment, itself, its actions — and their relationships.



The second-order system observes the effects of its actions in the environment and adjusts its models accordingly — we may call this ‘learning’.



Thus, we may say that ‘second-order systems’ are ‘learning systems’ — they observe their actions in an environment and adjust their models.



Special thanks to
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Presentation posted at
systems.dubberly.com/second-order_20200922.pdf