Viewing the world systemically.

ATIS: Dynamic Analysis of Intentional Systems

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System-Predictive Technologies

Submitted as Part of the
Proffitt Grant Research "Analysis of Patterns in Time and Configuration"
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Overview

Whereas an analysis of the structure of a system can predict the behavior of that system, an analysis of the dynamics of the system is also required in order to determine the boundaries of that behavior.

What system dynamics help to answer is why it is; for example, that even the best college football team just does not have a chance of winning even against the weakest professional NFL football team. The teams seem to play the same game, and yet, if they were matched in the same game, the college football team would not only lose, but would be physically "beaten into the ground." Football is chosen as an example here because in two other sports there are two notable exceptions—in basketball and hockey. A small school in Indiana did at one time become state high school champion in basketball by beating what should have been a far superior team. And, then, of course, there were the amateur U.S. hockey players who beat the professional USSR hockey team in the Olympics. But, in both of these, especially in hockey, although there is physical contact, such contact is not the focus of the play as it is in football. Having thus qualified the conclusion made here, it is again asserted that there is no college football team that can ever beat even the lowest-ranked professional NFL football team. (Another qualification: Of course, there are "minor league" football teams that can probably be beat by several college football teams, which is why the "NFL" qualification is used.)

Taking this example now at face value, what is it that distinguishes the two teams? They play the same game, they play on the same type of fields, they use the same type of footballs, etc. Why are the professionals so much better? Some of the reasons can be recognized as follows:

- Physical maturity
- Time dedicated to practice
- Time dedicated to lifting weights
- Development of mental attitude to being hit
- Receiving a substantial income
- They are highly selected from the *Toput* pool!

With respect to the last criterion, it has been empirically observed that in any field of human endeavor, if you select the exceptional exemplars within that field you will have a group of people who do exceptionally well as a group at what they do, whether that exceptional behavior is the result of the group dynamics or of their individual abilities.

These are the qualities that we find when conducting a dynamic analysis of a system.

As a brief summary, system properties have been classified by Theodore W. Frick as *Basic*, *Structural* and *Dynamic*, and are defined as follows:[1]

Basic Properties are those properties that are descriptive of a system.
Structural Properties are those properties that show how system components are connected or related to each other.
Dynamic Properties are those properties that describe patterns in time as change occurs within or between a system and its negasystem.

The *Basic Properties* consist of the components and component-connectedness that define the system—the components of the object-set and the relational elements of the relation-set. These properties inform us as to what it is that we are observing.

The *Structural Properties* inform us about the nature of the component-connectedness.

The *Dynamic Properties* inform us about the change in structure over time as well as the limiting results of that structure.

In order to analyze a system properly, a more extended definition of system had to be developed than what is frequently used. Most often, a system is defined as a *Mesarović system*—commonly seen as the ordered pair (**S**, $\mathfrak{R}$), object-set and relation-set. In a *Mesarović system* definition this ordered pair is extended to any *n*-tuple and a system is defined as a relation on *n* non-empty sets:

$$S \subset \prod \{V_i : i \in I\}; \text{ where 'I' is an index set.}$$

Y. Lin has shown that the Mesarović system can be extended so that multiple relations with a varying number of variables may be defined without having to change the object set, and defines *system*, A, more conventionally as an ordered pair consisting of an object set, M, and a relation set, F; that is, A = (M, F).

Steiner and Maccia followed this convention and defined *system* as follows:

System, $\mathbb{S}$, =$_{\text{df}}$ A *group* with at least one affect relation that has information.

$$\mathbb{S} =_{\text{df}} (\mathbf{S}, \mathfrak{R}) = (\mathbb{S}_o, \mathbb{S}_\phi); \text{ where } \mathbf{S} = \mathbb{S}_o \text{ and } \mathfrak{R} = \mathbb{S}_\phi.$$

A **system** is an ordered pair defined by an *object-set*, $\mathbb{S}_o$, and a *relation-set*, $\mathbb{S}_\phi$.

For *ATIS*, the notation is changed but also requires that $\mathbb{S}_\phi$ is only a nonempty set, not necessarily one that has *information*. For *ATIS*: $\mathbb{S} =_{\text{df}} (\mathcal{P}, \mathcal{A})$, where $\mathcal{P}$ is a component portioning set and $\mathcal{A}$ is a family of affect relations set.

[1] See the works of Theodore W. Frick at: http://educology.indiana.edu/Frick/index.html

The above definitions define *system* and not *general system*. To define *general system* we do so in a manner suggested by Wymore that will more clearly define: (1) the topology and/or relatedness of a system by its object-sets and relation-sets; (2) the dynamics of a system with respect to the movement of components within the system; and (3) the dynamics of system state transition; and allow for a more rigorous and comprehensive development of the system logic required for a logical analysis utilizing the *Predicate Calculus* and higher-order *Logical Schemas*.

There is a general assumption, or axiom of the metatheory, that is critical to the application of *ATIS* to any analysis of an empirical system. This axiom of the metatheory states:

> **Axiom:** A *General System*, empirically recognized, is defined within a ***Universe of Discourse***, $\mathcal{U}$, that includes the system and its environment.

The only thing that demarcates the system under consideration is the *Universe of Discourse*. And, while that universe may be somewhat *fuzzy*, whatever system is being considered must be well defined. The importance of this axiom is seen when APT or APT&C, measures developed by Theodore W. Frick, are utilized to evaluate a system. As he clearly develops, empirical systems are certainly *fuzzy*, and depend upon clearly defining the perspective of the observer with respect to the system. However, once the system has been well-identified, then the analysis of the system proceeds with respect to the parameters thereby defined.

The importance of system-identification and definition is also important when one attempts to compare systems to determine if they are the same in terms of *ATIS*; that is, do they have the same affect relations and do those affect relations define the same properties, both in terms of type of properties and the scale of the properties—remember the distinction between a professional NFL team as compared to any college football team. Two systems are the same in terms of *ATIS* if they are homomorphic with respect to components and affect relations.

Once the affect relations have been determined for two distinct systems and shown to be the same, and then the properties for the two systems have been shown to be the same, which they may not be, then they are homomorphic and whatever is determined to be true for one system can be asserted as true for the other. This is a very important and critical benefit for utilizing *ATIS*.

For example, what this asserts is that if we can establish that two different schools or school systems are homomorphic, then whatever empirical outcomes and predictions can be made concerning one school or school system can also be made about the other with no further empirical testing required.

It will be seen that *induction* is the logical process by which theory is evaluated. This is the testing of a theorem (logically-derived hypothesis) by which empirical observations are obtained to confirm or reject the theorem/hypothesis.

That is, *induction* is the process by which a general assertion is validated by specific observations. Looked at this way the concept of *induction* is quite similar to the common notion of its meaning. *Induction* is frequently defined as a process by which a general rule or "law" is obtained by observing specific instances—we move from the specific to the general. To that extent, nothing is new. What is new is the interpretation of the specific in relation to the general. In a separate paper it has been argued that in fact patterns of empirical observations do not and in fact cannot be used to develop theory or generalizations about what we observe. Those general statements come from some other source by means of a retroductive process.

But, specific observations do help in the development of those general statements by way of providing validation of those statements. It is in this way that we move from the specific to the general. We do so by utilizing specific observations, not to create or devise the general statements, but to validate them, to confirm them as "true" or acceptable pronouncements upon which we can rely.

ATIS provides the means by which a theory is developed or devised from an existing system, *A*. The *ATIS*-derived theory is then empirically investigated by evaluating the *ATIS*-theory-derived theorems with respect to *A*. This evaluation is accomplished by evaluating whether the theorems are supported by empirical evidence derived from appropriate empirical testing relevant to system *A*.

The process of *induction* is thus the analysis that takes place when specific observations are used to validate theorems/hypotheses deduced from the theory devised for system *A*. To that extent, induction relates to the common notion of the specific giving rise to the general. The only real difference is that the general is a statement that has been deductively obtained from a theory rather than the theory having been devised from specific observations, which it cannot do.

Since the theory is validated with each inductive analysis, and the "preponderance of evidence" continues to strengthen the validity of the theory, then it can be relied upon to assist in predicting outcomes deduced from the theory. Pursuant to *ATIS*, if two systems are homomorphic then whatever is true of one system is true of the other. When two systems are homomorphic then the empirical validation that provides the "preponderance of evidence" for the theory is provided with each application of the theory. No further empirical testing is required when a specific theorem has already been validated. Further, when two systems are homomorphic then any theorem that has already been validated requires no further validation, regardless of which system is under consideration. Redundancy may be pursued, but is not required. If system *X* is homomorphic to system *A*, then it is irrelevant which system is used for the validation of a theorem since the results of one will provide identical results for the other.

It is clear that whatever empirical evidence is required to establish that the two systems are homomorphic must be obtained prior to establishing in fact that they are homomorphic.

If, however, system *X* is not homomorphic to system *A*, then nothing can be concluded concerning system *X* from any validation of system *A*. Under such conditions, the *ATIS*-derived-theory for system *X* must proceed independently from system *A*, and the theorems deduced for system *X* are independent from those deduced from the theory for system *A*.

It is conceivable that certain archetypal systems may be identified that provide a basis for analyzing additional systems that would preclude extensive testing with respect to new systems. This may be especially relevant when hundreds and thousands of systems are known; for example, as in school systems. This identification process would help to preclude open-ended testing that is currently required when applying any new concept to a school that is distinct from the one where any initial testing has taken place. Again, however, if the components and affect relations of a new system are not homomorphic to an archetypal system, then the *ATIS*-derived theory from the new system must be developed and the predictions can be made from there.

However, the argument for the predictive outcomes of this new theory is even stronger than at present. With the continued validation of numerous theories that are *ATIS*-derived, the validity of the *ATIS*-derived theory *process* continues to be validated with a "preponderance of the evidence" with each new theory validation. As a result, even with respect to new *ATIS*-derived theories from new systems, it will no longer be necessary to carry out empirical validation of the new theory. The predictions; that is, theorems, of the new theory can be relied upon as being validated by the very *process* that gave rise to them. It is the *ATIS-theory-derived process* that is being validated with each new theory validation, and not just the specific theory.

The goal is to establish the *ATIS-theory-derived process* as a valid theory-development approach with the realization that whatever theory is derived, there is great confidence in the outcomes—the theorems/hypotheses that are deduced from any such theory, since the process itself has been validated by the "preponderance of the evidence" that *ATIS* does in fact devise legitimate and valid theory.

The following notes of a conversation help to clarify the *ATIS-theory-derived process*.

> If this understanding is correct, induction occurs not in the statistical sense of making an inference from a sample of systems to a population of systems, but only when evaluating a new archetypal system about which we have not validated *ATIS* theorems for that archetype.
>
> > *This is correct. Induction is not about trying to establish generalizations from statistical patterns, but about validating the general from specific observations.*
>
> First, do I understand your position and are the procedural implications described above consistent with that position?
>
> > *I believe that my rendering of what you have asserted is clear.*
>
> Second, is there precedent in any science or other kind of discipline for this approach?
>
> > *This approach is standard fare in physics. For example, the often-cited "bending of light rays" validation. What was being done? The "test" was derived from a "hypothesis/theorem" deduced from the theory of relativity. The observation validated the theorem, which thereby further validated the theory. There was absolutely no accumulation of "evidence" by which "patterns" were generated which somehow gave rise to the theorem. This whole "pattern to theory" mythology is something that has been fabricated by the social scientists and statisticians who had no clue how scientific theory development actually occurs. The whole thing is a myth. (BTW, no offense to statisticians. They have done good work, but they have failed to realize the limits of their occupation.) There is nothing new or revolutionary about this approach.* ***It is used routinely in any scientific enterprise that is founded on theory****.*

Continuing now with our discussion about the ***Universe of Discourse*** and ***Dynamic Analysis***:

$\mathcal{U}$ is partitioned into two disjoint systems, $\mathfrak{S}$ and $\mathfrak{S}'$. Therefore, ***Universe of Discourse*** has the following property:

$$\mathcal{U} = \mathfrak{S} \cup \mathfrak{S}'; \text{ such that, } \mathfrak{S} \cap \mathfrak{S}' = \emptyset.$$

The disjoint systems of $\mathcal{U}$, $\mathfrak{S}$ and $\mathfrak{S}'$, are defined as *system* and *negasystem*, respectively.

System environment and *negasystem environment* are defined as follows:

System environment, $\mathfrak{S}'$, $=_{df}$ The system's corresponding negasystem, $\mathfrak{S}'$.

Negasystem environment, $\mathfrak{S}$, $=_{df}$ The negasystem's corresponding system, $\mathfrak{S}$.

General System

A ***General System***, $\mathcal{G}$, is defined by the following parameters:

- *Component Partitioning Set*, $\mathcal{P}$;
- *Family of Affect Relations Set*, $\mathcal{A}$;
- *Transition Function Set*, $\mathcal{T}$;
- *Linearly Ordered Time Set*, $\mathscr{T}$;
- *Qualifier Set*, $\mathcal{Q}$; and
- *System State-Transition Function*, σ.

That is:

General system, $\mathcal{G}$, $=_{df}$ A set of partitioned components, affect relations, transition function set, time set, qualifier set, and a system state-transition function.

$$\mathcal{G} =_{df} (\mathcal{P}, \mathcal{A}, \mathcal{T}, \mathscr{T}, \mathcal{Q}, \sigma)$$

The sets that define $\mathcal{G}$ have the following elements:

$T_P, I_{\mathcal{P}}, F_P, O_P, S_P, \mathfrak{S}_{B0}, \mathfrak{S}'_{B0} \in \mathcal{P}$;

$\mathcal{A}_1, \mathcal{A}_2, \ldots, \mathcal{A}_n \in \mathcal{A}$;

$f_I, f_O, f_T, f_B, f_S \in \mathcal{T}$;

$t_1, t_2, \ldots, t_k \in \mathscr{T}$; and

$\mathscr{L}, \mathscr{L}' \in \mathcal{Q}$.

$T_{\mathcal{p}}$, $I_{\mathcal{p}}$, $F_{\mathcal{p}}$, $O_{\mathcal{p}}$, $S_{\mathcal{p}}$, $\mathfrak{S}_{B0}$, and $\mathfrak{S}'_{B0}$ represent the following sets:

‘$T_{\mathcal{p}}$’ represents “toput.”

‘$I_{\mathcal{p}}$’ represents “input.”

‘$F_{\mathcal{p}}$’ represents “fromput.”

‘$O_{\mathcal{p}}$’ represents “output.”

‘$S_{\mathcal{p}}$’ represents “storeput.”

‘$\mathfrak{S}_{B0}$’ represents “system background components.”

‘$\mathfrak{S}'_{B0}$’ represents “negasystem background components.”

$\mathscr{L}$, and $\mathscr{L}'$ represent the following sets:

‘$\mathscr{L}$’ represents “system logisticians” or “system qualifiers.”

‘$\mathscr{L}'$’ represents “negasystem logisticians” or “negasystem qualifiers.”

System behavior is defined as a sequence of *system states*.

A consistent pattern of system states defines *System Dispositional Behavior*.

The transition functions required for state-transition analysis are described as follows:

f_I, f_O, f_T, f_B, f_S, f_N, f_E are the transition function-sets and represent the following functions:

- ‘f_I’ is “feedin.”
- ‘f_S’ is “feedstore.”
- ‘f_N’ is “feedintra.”
- ‘f_O’ is “feedout.”
- ‘f_B’ is “feedback.”
- ‘f_T’ is “feedthrough.”
- ‘f_E’ is “feedenviron.”

System Component Transitions—The Dynamic Process

The elements of the *Transition Function Set*, $\mathcal{T}$, define the movement of system components between the elements of the *Component Partitioning Set*, $\mathcal{P}$.

The dynamics of how a system changes over time is determined by the *System State Transition Function*, σ. This is accomplished by an analysis of the *Feed– functions*, the *–Put properties* and the *State Transition Functions*.

The *Feed Functions* are defined in a manner to allow for temporal analysis of the system and will follow the schema given below.

State Transition-Function Schema: The *feed- functions*, $\mathfrak{f}_V$; that is, $\mathfrak{f}_I$, $\mathfrak{f}_N$, $\mathfrak{f}_S$, $\mathfrak{f}_F$, $\mathfrak{f}_O$, $\mathfrak{f}_T$, $\mathfrak{f}_B$, and $\mathfrak{f}_E$, are *component transition functions* between two disjoint sets of the *Component Partitioning Set*, $X_{\mathcal{P}}$ and $Y_{\mathcal{P}}$. These are related by σ to arrive at a *System State Transition*.

'$\sigma(\mathfrak{x}_{X\mathcal{P}})$' designates that σ is operating on $\mathfrak{x}$ with respect to $X_{\mathcal{P}}$.

'$(\mathfrak{f}_V \circ \mathfrak{g} \circ f)$' is a *composition* over which $\mathfrak{x}$ is defined, starting with f, then $\mathfrak{g}$, and then $\mathfrak{f}_V$. That is, find the value of f first with respect to $\mathfrak{x}$, then find the value of $\mathfrak{g}$ with respect to the f-value, then find the value of $\mathfrak{f}_V$ with respect to the $\mathfrak{g}$-value. This will map $\mathfrak{x} \in X_{\mathcal{P}} \rightarrow \mathfrak{x} \in Y_{\mathcal{P}}$; that is, $\mathfrak{f}_V(\mathfrak{x}_{X\mathcal{P}}) = \mathfrak{x}_{Y\mathcal{P}}$.

$$\sigma(\mathfrak{x}_{X\mathcal{P}})(\mathfrak{f}_V \circ \mathfrak{g} \circ f) \in Y_{\mathcal{P}} \mid \sigma(\mathfrak{x}_{X\mathcal{P}}) = \mathfrak{x}_{Y\mathcal{P}}\text{ ; where } f\text{: } X_{\mathcal{P}} \times {}_{X\mathcal{P}}\mathscr{L}_C \rightarrow \{\perp, \top\}\text{, and}$$

'${}_{X\mathcal{P}}\mathscr{L}_C$' designates the "$X_{\mathcal{P}}$ logistic-control qualifier."

$$\mathfrak{g}(\mathfrak{x}_{X\mathcal{P}}) = \begin{cases} \varnothing, \text{ if } f = \perp \\ \mathfrak{x}_{X\mathcal{P}}, \text{ if } f = \top \quad \text{and} \end{cases}$$

$$\mathfrak{f}_V\text{: } W \subset X_{\mathcal{P}} \rightarrow Y_{\mathcal{P}} \mid (\mathfrak{g}(\mathfrak{x}_{X\mathcal{P}}) \neq \varnothing \supset \mathfrak{g}(\mathfrak{x}_{X\mathcal{P}}) = \mathfrak{x}_{X\mathcal{P}} \in W) \wedge \mathfrak{f}_V(\mathfrak{x}_{X\mathcal{P}}) = \mathfrak{x}_{Y\mathcal{P}} \in Y_{\mathcal{P}}$$

–**Put Sets**.

Although the *–Put properties* are *Structural Properties*, they will be restated here since they are an integral part of the system transition schemas.

–Put properties: The "**–Put**" properties, $V_{\mathcal{P}}$; that is, $T_{\mathcal{P}}$, $I_{\mathcal{P}}$, $S_{\mathcal{P}}$, $F_{\mathcal{P}}$, and $O_{\mathcal{P}}$, are disjoint object-sets of the system that are defined below.

Toput, $\mathbf{T}_{\mathcal{P}}(\mathbb{S})$, $=_{df}$ *Negasystem* components for which *system toput control qualifiers* are "true."

$$\mathbf{T}_{\mathcal{P}}(\mathbb{S}) =_{df} \{x \mid x \in \mathbb{S}'_0 \wedge \exists P(x) \in {}_{T\mathcal{P}}\mathcal{L}_{\mathcal{C}}\, [f(x)(T_{\mathcal{P}} \times {}_{T\mathcal{P}}\mathcal{L}_{\mathcal{C}}) = \mathsf{T}]\}.$$

Toput is defined as the set of *negasystem* components and there exist toput control qualifiers such that there is a function from the product of the toput components and toput control qualifiers that is "true."

$\mathcal{M}$**: Toput measure,** $\mathcal{M}(\mathbf{T}_{\mathcal{P}}(\mathbb{S}))$, $=_{Df}$ a measure of toput components.

$$\mathcal{M}(\mathbf{T}_{\mathcal{P}}(\mathbb{S})) =_{Df} |T_{\mathcal{P}}(\mathbb{S})| \qquad (1)$$

$$\mathcal{M}(\mathbf{T}_{\mathcal{P}}(\mathbb{S})) =_{df} \log_2(|T_{\mathcal{P}}(\mathbb{S})|) \div \log_2(|\mathbb{S}_0|) \qquad (2)$$

The choice of measure will depend on the application. Measure (1) is of value where the size of the toput set is required for comparison, say, to the input set; that is, a comparison of actual feedin is desired. Measure (2) is of value where a comparison to the system or between systems is desired that relates the amount of toput as a fraction or percentage of the total system.

Input, $\mathbf{I}_{\mathcal{P}}(\mathbb{S})$, $=_{df}$ Resulting transmission of *toput* components; that is, system components for which *system input control qualifiers* of *toput* components are "true."

$$\mathbf{I}_{\mathcal{P}}(\mathbb{S}) =_{df} \{x \mid x \in \mathbb{S}_0 \wedge \exists \sigma(\sigma(x_{T\mathcal{P}} \in T_{\mathcal{P}}) = x_{I\mathcal{P}})\}.$$

Input is defined as the set of *system* components for which there exists a system-transmission function that results in the transmission of the toput components to input components.

$\mathcal{M}$**: Input measure,** $\mathcal{M}(\mathbf{I}_{\mathcal{P}}(\mathbb{S}))$, $=_{Df}$ a measure of input components.

$$\mathcal{M}(\mathbf{I}_{\mathcal{P}}(\mathbb{S})) =_{Df} |I_{\mathcal{P}}(\mathbb{S})| \qquad (1)$$

$$\mathcal{M}(\mathbf{I}_{\mathcal{P}}(\mathbb{S})) =_{df} \log_2(|I_{\mathcal{P}}(\mathbb{S})|) \div \log_2(|\mathbb{S}_0|) \qquad (2)$$

The choice of measure will depend on the application. Measure (1) is of value where the size of the input set is required for comparison, say, to the toput set; that is, a comparison of actual feedin is desired. Measure (2) is of value where a comparison to the system or between systems is desired that relates the amount of input as a fraction or percentage of the total system.

Storeput, $\mathbf{S}_{\mathcal{P}}(\mathbb{S}_x)$, $=_{df}$ *System input components* for which *system fromput control qualifiers* are "false."

$$\mathbf{S}_{\mathcal{P}} =_{df} \{x \mid x \in \mathbb{S}_0 \wedge \exists P(x) \in {}_{F\mathcal{P}}\mathscr{L}_C\ \exists\sigma[f(x_{S\mathcal{P}})(F_{\mathcal{P}} \times {}_{F\mathcal{P}}\mathscr{L}_C) = \bot \wedge \sigma(x_{I\mathcal{P}} \in I_{\mathcal{P}}) = x_{S\mathcal{P}})]\}.$$

Storeput is defined as the resulting transmission of input components and there exists fromput control qualifiers such that there is a function of the product of fromput and fromput control qualifiers that are "false," and there is a transmission function from input components to storeput components.

$\mathcal{M}$**: Storeput measure,** $\mathcal{M}(\mathbf{S}_{\mathcal{P}}(\mathbb{S}_x))$, $=_{Df}$ a measure of storeput components.

$$\mathcal{M}(\mathbf{S}_{\mathcal{P}}(\mathbb{S}_x)) =_{Df} |S_{\mathcal{P}}(\mathbb{S}_x)| \qquad (1)$$

$$\mathcal{M}(\mathbf{S}_{\mathcal{P}}(\mathbb{S})) =_{df} \log_2(|S_{\mathcal{P}}(\mathbb{S})|) \div \log_2(|\mathbb{S}_0|) \qquad (2)$$

The choice of measure will depend on the application. Measure (1) is of value where the size of the storeput set is required for comparison, say, to the input set; that is, a comparison of actual feedstore is desired. Measure (2) is of value where a comparison to the system or between systems is desired that relates the amount of storeput as a fraction or percentage of the total system.

Fromput, $\mathbf{F}_{\mathcal{P}}(\mathbb{S})$, $=_{df}$ *system* components for which negasystem fromput control qualifiers are "true."

$$F_{\mathcal{P}}(\mathbb{S}) =_{df} \{x \mid x \in \mathbb{S}_0 \wedge \exists P(x) \in \mathscr{L}'_C\ [f(x)(F_{\mathcal{P}} \times {}_{F\mathcal{P}}\mathscr{L}'_C) = \top]\}.$$

Fromput is defined as the set of *system* components for which there exist negasystem control-qualifiers such that there is a function from the product of the fromput components and the negasystem control qualifiers that are "true."

$\mathcal{M}$**: Fromput measure,** $\mathcal{M}(\mathbf{F}_{\mathcal{P}}(\mathbb{S}))$, $=_{Df}$ a measure of fromput components.

$$\mathcal{M}(\mathbf{F}_{\mathcal{P}}(\mathbb{S})) =_{df} |F_{\mathcal{P}}(\mathbb{S})| \qquad (1)$$

$$\mathcal{M}(\mathbf{F}_{\mathcal{P}}(\mathbb{S})) =_{df} \log_2(|F_{\mathcal{P}}(\mathbb{S})|) \div \log_2(|\mathbb{S}_0|) \qquad (2)$$

The choice of measure will depend on the application. Measure (1) is of value where the size of the fromput set is required for comparison, say, to the output set; that is, a comparison of actual feedout is desired. Measure (2) is of value where a comparison to the system or between systems is desired that relates the amount of fromput as a fraction or percentage of the total system.

Output, $\mathbf{O}_{\mathcal{P}}(\mathbb{S})$, $=_{df}$ Resulting transmission of *fromput* components; that is, negasystem components for which *negasystem output-control qualifiers* of *fromput* components are "true."

$$\mathbf{O}_{\mathcal{P}}(\mathbb{S}) =_{df} \{x \mid x \in \mathbb{S}'_0 \wedge \exists\sigma(\sigma(x_{F\mathcal{P}} \in F_{\mathcal{P}}) = x_{O\mathcal{P}})\}.$$

Output is defined as the set of *negasystem* components for which there exists a system-transmission function that results in the transmission of the fromput components to output components.

$\mathcal{M}$**: Output measure,** $\mathcal{M}(\mathbf{O}_{\mathcal{P}}(\mathbb{S}))$, $=_{Df}$ a measure of output components.

$$\mathcal{M}(O_{\mathcal{P}}(\mathbb{S})) =_{df} |O_{\mathcal{P}}(\mathbb{S})| \qquad (1)$$

$$\mathcal{M}(O_{\mathcal{P}}(\mathbb{S})) =_{df} \log_2(|O_{\mathcal{P}}(\mathbb{S})|) \div \log_2(|\mathbb{S}_0|) \qquad (2)$$

The choice of measure will depend on the application. Measure (1) is of value where the size of the output set is required for comparison, say, to the fromput set; that is, a comparison of actual feedout is desired. Measure (2) is of value where a comparison to the system or between systems is desired that relates the amount of output as a fraction or percentage of the total system.

Now we return to considering those properties and measures that define the **Dynamic Properties**; that is, the transmission of components within a system.

<u>State-Transition Function Schema</u>. The **state-transition function**, σ, is defined by the following composition:

$$\sigma_x(f_{H|P} \circ f_{Pt} \circ f_F) = \nu = 0 \supset x \in f_F(P).$$

System state-transition function, σ**,** $=_{df}$ the function that maps a current system state to a subsequent system state.

$$\sigma =_{df} f \mid f: \mathcal{S}_{t(1)} \rightarrow \mathcal{S}_{t(2)}$$

Now that effective procedures have been established for determining the object-sets, relation-sets and state transitions, effective procedures for describing the system state must be determined.

The descriptive analysis of an empirical system will be accomplished by using an *APT Analysis* developed by T. W. Frick, Indiana University.[2] G. Salter, University of Western Sydney, recognizes the value of an *APT Analysis*:

> "(An *APT Analysis*) can be used for prediction and to suggest areas of possibly fruitful further research." ["Quantitative Analysis of Multimedia Audit Trails."]

Further, the direct approach taken by an *APT Analysis* makes it readily applicable to a computer-based analysis of an $\bar{I}_B$ (Information Base). T.W. Frick describes the process as follows:

> Analysis of patterns in time (APT) is a method for gathering information about observable phenomena such that probabilities of temporal patterns of events can be estimated empirically. [With an appropriate analysis] temporal patterns can be predicted from APT results.
>
> The task of an observer who is creating an APT score is to characterize simultaneously the state of each classification as events relevant to the classifications change over time.
>
> An APT score is an observational record. In APT, a score is the temporal configuration of observed events characterized by categories in classifications.
>
> [This contrasts significantly from the linear models approach (LMA) common to most research.] The worldview in the LMA is that we measure variables separately and then attempt to characterize their relationship with an appropriate mathematical model, where, in general, variable Y is some function of X. A mathematical equation is used to express the relation. In essence, the relation is modeled by a line surface, whether straight or curved, in *n*-dimensional space. When such linear relations exist among variables, then a mathematical equation with estimates of parameters is a very elegant and parsimonious way to express the relation.
>
> In APT, the view of a relation is quite different. First, a relation occurs in time. A relation is viewed as a set of temporal patterns, not as a line surface in *n*-dimensional space. A relation is measured in APT by simply counting occurrences of relevant temporal patterns and aggregating the durations of the patterns. This may seem rather simplistic to those accustomed to the LMA, but Kendall (1973) notes,
>
> > "Before proceeding to the more advanced methods, however, we may recall that in some cases forecasting can be successfully carried out merely by watching the phenomena of interest approach. Nor should we despise these simple-minded methods in the behavioral sciences."

For this research, *APT Analysis* lends itself quite readily to establishing patterns that indicate new objects and relations that should be added to the system.

System state is defined by system properties. System properties are defined by the connectedness of the system components; which defines the system structure.

[NOTE: "APT" has been expanded to "APT&C" as defined in Frick's report found at: https://www.indiana.edu/~aptfrick/overview/.]

[2] Theodore W. Frick: https://www.indiana.edu/~tedfrick/apt/aerj.pdf

Dynamic Properties describe patterns in time, their temporal change, as change occurs within a system or between a system and its negasystem.

Primary Dynamic Properties – State Descriptive

State, $\mathcal{S}$, $=_{df}$ System properties at a given time.

$$\mathcal{S} =_{df} (\langle P(x_1)\rangle, \langle P(x_2)\rangle, \ldots, \langle P(x_n)\rangle)$$

where "⟨…⟩" designates a property descriptor.

$\mathcal{M}$**: State measure,** $\mathcal{M}(\mathcal{S})$, $=_{Df}$ a measure of each property that determines the state.

$$\mathcal{M}(\mathcal{S}) =_{df} \mathcal{A}(\langle P(x_1)\rangle, \langle P(x_2)\rangle, \ldots, \langle P(x_n)\rangle) = (\mathcal{A}\langle P(x_1)\rangle, \mathcal{A}\langle P(x_2)\rangle, \ldots, \mathcal{A}\langle P(x_n)\rangle)$$

$\mathcal{A}(\langle P(x_k)\rangle) = m$; where "$m$" is an appropriate measure for the property descriptor, $\langle P(x_k)\rangle$.

"$\mathcal{A}$" is an APT score.

System behaviors are now defined in terms of the system state.

Behavior, $\mathcal{B}$, $=_{df}$ A sequence of system states.

$$\mathcal{B}(\mathbb{S}) =_{df} (\mathcal{S}_1^{\mathfrak{R}}, \mathcal{S}_2^{\mathfrak{R}}, \ldots, \mathcal{S}_n^{\mathfrak{R}})$$

$f: \mathcal{S} \rightarrow \mathfrak{R} = \mathcal{S}^{\mathfrak{R}}$ maps system parameters into the real numbers to define a time set.

Dispositional behavior, ${}_{\mathfrak{D}}\mathcal{B}(\mathbb{S})$, $=_{df}$ A sequence of similar system states.

$${}_{\mathfrak{D}}\mathcal{B}(\mathbb{S}) =_{df} (\mathcal{S}_1, \mathcal{S}_2, \ldots, \mathcal{S}_n) \mid \mathcal{M}(\mathcal{S}_1, \mathcal{S}_2, \ldots, \mathcal{S}_n)$$

Dispositional behavior of a system is a sequence of system states that are homomorphic.

System environmental change, $\Delta\mathbb{S}'$**,** $=_{df}$ Change in the negasystem state.

$$\Delta\mathbb{S}' =_{df} \mathcal{A}(\mathcal{S}')_{t(1)} \neq \mathcal{A}(\mathcal{S}')_{t(2)}.$$

System environmental change is a change in its state over time.

Negasystem environmental change, $\Delta\mathbb{S}$, $=_{df}$ Change in the system state.

$$\Delta\mathbb{S} =_{df} \mathcal{A}(\mathcal{S})_{t(1)} \neq \mathcal{A}(\mathcal{S})_{t(2)}.$$

Negasystem environmental change is a change in system state over time.

Bifurcated behavior, $_{\mathfrak{B}}\mathcal{B}(\mathbb{S})$, $=_{df}$ a change in dispositional behavior.

$$_{\mathfrak{B}}\mathcal{B}(\mathbb{S}) =_{df} \Delta_{\mathfrak{D}}\mathcal{B}(\mathbb{S}) \equiv \mathcal{A}(_{\mathfrak{D}}\mathcal{B})_{t(1)} \neq \mathcal{A}(_{\mathfrak{D}}\mathcal{B})_{t(2)}$$

Bifurcated behavior is a change in system dispositional behavior.

Converging behavior, $_{\mathcal{C}}\mathcal{B}(\mathbb{S})$, $=_{df}$ a time-interval sequence of system behaviors with an increasing similarity of system states.

$$_{\mathcal{C}}\mathcal{B}(\mathbb{S}) =_{df} \mathcal{B}(\mathbb{S})_{t(1)}, \mathcal{B}(\mathbb{S})_{t(2)}, \ldots \mathcal{B}(\mathbb{S})_{t(n)} \mid \mathcal{A}(\mathcal{B}(\mathbb{S})_{t(j)}) \succ \mathcal{A}(\mathcal{B}(\mathbb{S})_{t(j+1)})$$

Converging behavior is defined as a sequence of system behaviors; such that, the APT&C score at time t_j is *approaching similarity to* the APT&C score at time t_{j+1}.

Lagged behavior, $_{\mathscr{LG}}\mathcal{B}(\mathbb{S})$**,** $=_{df}$ regulation of system behavior at time t_2 as the result of a change in negasystem behavior at time t_1.

$$_{\mathscr{LG}}\mathcal{B}(\mathbb{S}) =_{df} \Delta\mathcal{B}(\mathbb{S}')_{t(1)} \Vdash \mathscr{R}(\mathcal{B}(\mathbb{S}))_{t(2)}$$

Lagged behavior is defined as a change in negasystem behavior at time t_1 that yields regulation of system behavior at time t_2.

Leading behavior, $_{\mathscr{L}}\mathcal{B}(\mathbb{S})$**,** $=_{df}$ regulation of system behavior at time t_1 as the result of a predictive state in negasystem behavior at time t_2.

$$_{\mathscr{L}}\mathcal{B}(\mathbb{S}) =_{df} \mathscr{R}(\mathcal{B}(\mathbb{S}))_{t(1)} \mid \mathscr{P}[\mathcal{B}(\mathbb{S}')_{t(2)}]$$

Leading behavior is defined as a regulation of system behavior at time t_1 given a predictive negasystem behavior at time t_2.

Coordinated states, $_{CD}\mathscr{S}$**,** $=_{df}$ derivability of the state of a family of coterminous systems from the preceding family states.

$$_{CD}\mathscr{S} =_{df} \forall\mathscr{S}(_{CT}\mathbb{S}_i)\in\mathscr{F}(_{CT}\mathbb{S})\ [\mathscr{S}(_{CT}\mathbb{S}_{1:\ t(1)}), \mathscr{S}(_{CT}\mathbb{S}_{2:\ t(1)}), \ldots, \mathscr{S}(_{CT}\mathbb{S}_{n:\ t(1)}) \supset \mathscr{S}(\mathscr{F}(_{CT}\mathbb{S}_{t(2)}))]$$

Coordinated states are defined as all states of the family of coterminous system states at time t_1 implies the state of the family at time t_2. **Coordinated systems** determine the predictability of a family of system outcomes from preceding states of the systems of the family.

Coorientated state, $_{CR}\mathscr{S}$**,** $=_{df}$ derivability of the state of one system from the coordinated states of coterminous systems.

$$_{CR}\mathscr{S} =_{df} \mathscr{S}(\mathbb{S}_n \mid \mathscr{F}(_{CT}\mathbb{S})) \mid {_{CD}\mathscr{S}}(_{CT}\mathbb{S}) \Vdash \mathscr{S}(\mathbb{S}_n)$$

Coorientated state is defined as the state of a system given the related family of coterminous systems such that the coordinated states of the coterminous systems yield the system state of the system.

Developing states, $_{DV}\mathcal{S}$**,** $=_{df}$ a sequence of system states.

$$_{DV}\mathcal{S} =_{df} (\mathcal{S}_{t(1)}, \mathcal{S}_{t(2)}, \ldots, \mathcal{S}_{t(n)})$$

Developing states is a sequence of system states over time. Developing states may or may not also represent the system behavior. The difference would be the fineness of the time interval, the more fine the interval, the more representative it is of the system behavior. The difference is essentially one of intent—why is the sequence being considered? Is it to determine the system behavior, in which case a fine time-interval is desired, or is it to determine the long-term pattern of system states to determine long-term change?

Predictive state, $_{PD}\mathcal{S}$**,** $\mathcal{P}$**,** $=_{df}$ a state that yields future system behavior.

$$\mathcal{P} =_{df} \mathcal{S}_{\mathbb{S}:\, t(1)} \Vdash \mathcal{B}(\mathbb{S})_{t(2)}$$

Predictive state is a system state at time t_1 that yields system behavior at time t_2.

Prediction literally means, “Knowing something outside the range of an observer’s experiences.” Minimally, prediction is a mere extrapolation of given data into the future (forecasting) or into the past (retrodiction). It is usually justified by reference to general theories or models that serve as the basis for drawing inferences from available data to phenomena outside their range. Thus, predictions are the conclusions drawn from the premise of available data using theories and models as a kind of syllogistic device.

System Descriptive Dynamic Properties

Segregation, $_{SG}\mathbb{S}$**,** $=_{df}$ Maintenance of independence under change of environmental state.

$$_{SG}\mathbb{S} =_{df} \Delta\mathcal{S}'_{t(1)\rightarrow t(2)} \Vdash \mathcal{M}([_{I}\mathcal{C}_{t(1)}, {}_{I}\mathcal{C}_{t(2)}] < \alpha$$

Segregation is a change in environmental state from time t_1 to time t_2 yields a measure of independence at times t_1 and t_2 that is less than α.

Integration, $_{IG}\mathbb{S}$**,** $=_{df}$ Maintenance of wholeness under change in system state.

$$_{IG}\mathcal{C} =_{df} \Delta\, \mathcal{S}_{t(1)\rightarrow t(2)} \Vdash \mathcal{M}([_{W}\mathcal{C}_{t(1)}, {}_{W}\mathcal{C}_{t(2)}]) < \alpha$$

Integration is defined as a change in system state from time t_1 to time t_2 yields a measure of wholly connected components at times t_1 and t_2 that is less than α.

(**Integration** in SIGGS has been misidentified as being the result of a change in the environment, whereas the change actually occurs within the system; hence, a change in system state.)

Open system, $_{O}\mathbb{S}$**,** $=_{df}$ A system that has feedin.

$$_{O}\mathbb{S} =_{df} \mathbb{S} \mid \mathbb{S}(f_I) \supset \mathcal{A}(\boldsymbol{f}_I) = \langle \boldsymbol{f}_I \rangle$$

Open system is a system; such that, the system has feedin.

Examples: Practically all social systems are open; that is, they all have feedin of some kind. In particular, with few exceptions, schools are open systems.

Closed system, $_{\sim O}\mathbb{S}$**,** $=_{df}$ a system that has no feedin; that is, that is not open.

$$_{C}\mathbb{S} =_{df} \sim(_{O}\mathbb{S})$$

Closed system is defined as a system that is not open.

Examples: There are probably no truly closed social systems. Even communities existing in mountains, remote areas, rain forests, jungles, etc. will probably have contact with other such communities, making each one an open system. However, certain schools may strive to be closed. Religious or certain paramilitary schools attempt to indoctrinate their students with certain beliefs and block all influences that could “corrupt” the desired vision or instruction. Such schools are selectively closed.

Derived production output, $_{DP}f_T$**,** $=_{df}$ Feedthrough with a high dissimilarity of toput and output in which output is significantly more complex.

$$_{DP}f_T =_{df} f_T \mid \exists \mathcal{B} \subset \mathcal{A}\ (T_{\mathcal{P}}(\mathcal{B}) \Vdash O_{\mathcal{P}}(\mathcal{B}) \wedge \mathcal{M}\,[\mathcal{X}(T_{\mathcal{P}}(\mathcal{B})] \ll \mathcal{M}\,[\mathcal{X}(O_{\mathcal{P}}(\mathcal{B}))])$$

Derived production output is defined as feedthrough; such that, there is a family of affect relations, $\mathcal{B}$, that is a subset of the family of system affect relations, such that, the toput with respect to $\mathcal{B}$ yields the output with respect to $\mathcal{B}$, and the measure of the complexity of the toput affect-relations are substantially less than the measure of the complexity of the output affect-relations.

Examples: Manufacturing plants produce derived production output. These plants bring in raw materials from which their products are manufactured; that is, produce the derived production. A school system may be viewed as producing derived production output in that students who enter the school system are expected to change substantially as a result of their education.

Types of Systems and Their Dynamic Properties

Allopoietic system, $_{AP}\mathbb{S}$**,** $=_{df}$ an open system that has derived production output.

$$_{AP}\mathbb{S} =_{df} {}_{O}\mathbb{S}({}_{DP}f_T)$$

Allopoietic system is an open system that has derived production output.

Most systems are allopoietic systems; that is, they take in energy or material products and produce as output something other than themselves. Biological systems are allopoietic in that they reproduce rather than self-produce. Even intentional systems that attempt to establish similar systems are still allopoietic in that replication is not perfect; that is, replication is not cloning.

Examples: In franchised store operations, the product of the franchise results from the production as an allopoietic system. That is, whereas the store was set up with all of its equipment and production components, an autopoietic process, the product being produced for sale is distinct from the system, an allopoietic process. Schools are allopoietic systems; that is, their output, the students, are not a reproduction of the school, but the result of the school's production process.

Catalytic components, $\mathbb{C}(\mathfrak{S})$**,** $=_{df}$ system components that are required for derived production output that are not part of the output.

$$\mathbb{C}(\mathfrak{S}) =_{df} \mathfrak{W} \mid \mathfrak{W} \subset \mathfrak{S}_{\mathfrak{o}} \supset [\exists_{DP\mathscr{I}T}(\mathfrak{x} \in \mathfrak{W} \supset \exists_{\mathcal{DPIT}}\mathfrak{S}_{O\mathcal{P}}(\mathfrak{x}) \notin O_{\mathcal{P}})];$$

where '$_{\mathcal{DPIT}}\mathfrak{S}_{O\mathcal{P}}$' is the derived production output process.

Catalytic components comprising a set; such that, the set is a subset of the object-set implies that if there is derived production output and a component is an element of the subset, then there is a derived production output process such that the component is not in the output.

Autonomous system, $_{A\mathcal{U}}\mathfrak{S}$**,** $=_{df}$ a system that is component-closed.

$$_{A\mathcal{U}}\mathfrak{S} =_{df} {}_{C}\mathfrak{S}^{C}$$

Autonomous system is a system that is component-closed.

Examples: Autonomous systems are similar to autark systems but are not as restrictive. That is, autark systems are closed with respect to the organic-essential subsystem, whereas an autonomous system is closed with respect to the input of all system components. Biospheres, whether on earth or mars, are supposed to function as autonomous systems. With all such systems, the one excluded input is energy from the sun. Public schools, by their very organization are not autonomous. However, specialized school clubs or private clubs may be organized such that the initial members become the only members. Such organizations are autonomous systems. Autonomous systems also included those systems that are controlled by a well-defined set of management rules that are controlled by one person, group or organization. Any system that blocks entry by other components is an autonomous system.

Independent system, $_{I}\mathfrak{S}$**,** $=_{df}$ a system characterized by primary-initiating associated component affect-relations.

$$_{I}\mathfrak{S} =_{df} \mathcal{Y} \mid \forall v_i, v_j \in \mathcal{Y}(\mathcal{V}) \exists \mathcal{r}_{d(\mathcal{I})}(\mathfrak{e}) \in \mathcal{Y}(\mathcal{R})[\mathfrak{e} = (v_i, v_j) \supset \mathcal{r}_{d(\mathcal{I})}(\mathfrak{e}) \geq 1 \wedge \mathcal{r}_{d(\mathcal{T})}(\mathfrak{e}) = 0]$$

$\mathcal{M}$**: Independent system measure,** $\mathcal{M}(_{I}\mathfrak{S})$**,** $=_{df}$ a measure of primary-initiating component affect-relations.

$$\mathcal{M}(_{I}\mathfrak{S}) =_{df} [(\Sigma_{i=1,\dots,n}[|\mathcal{r}_{d(_{I}\mathfrak{S})}(\mathfrak{e}) \geq 1|) \div \log_2|\mathcal{A}_i|]) \div n] \times 100$$

Autark system, $_{AT}\mathbb{S}$**,** $=_{df}$ an organic system that is organic-essential closed.

$$_{AT}\mathbb{S} =_{df} {}_{O}\mathcal{W} \mid {}_{\mathcal{O}}\mathcal{W} = {}_{C}\mathbb{S}$$

Autark system is defined as an organic system; such that, the organic-essential subsystem is closed.

Initially an autarky was conceived as an economic system. However, the precepts of such a system being one that establishes an organic-essential closed system can be extended to any system that establishes an organic-essential closed partition. Any system that can be viewed as having its own "ecosystem" that it closes to its negasystem is an autark system. Economic autarky, biological autarky, social autarky, and education autarky are some of the systems that can be designed as autark systems.

An autark system is a self-sufficient system; for example, a system that is economically independent. A country may attempt to establish a national autarky by adhering to a policy of self-sufficiency and blocking imports and economic aid. Certain religious communities attempt to isolate themselves from the rest of the country in which they live. The Amish and initially the Mormons attempt to sustain a viable autarky. Schools established to further a particular faith attempt to further a religious autarky where they attempt to close off all other religious influences.

Examples: There are few sustainable social autark systems. North Korea comes the closest today to a society that attempts to maintain itself as an autark system; that is, a society that restricts as much as possible all input. Prior to 1970, villages on the Bolovens Plateau in Laos may have been autark systems; that is, villagers would never travel more than 5 miles from their home and the community was self-sufficient with crops and hunting. Only in very closed societies are schools an autark system in that the entire community represents the instructional process, and the community is closed to the "outside world." Further, only societies in which the school is an organic-essential entity would such schools be considered autark systems. The school is an entity of the society and receives input from the society and is, therefore, not an autark system.

Anomie system, $_{AN}\mathbb{S}$, $=_{df}$ a system in which affect relation complexity approaches zero.

$$_{AN}\mathbb{S} =_{df} \mathbb{S} \mid \forall i[\mathcal{M}(\mathcal{X}(\mathcal{A}_i \in \mathcal{A})) \rightarrow 0]$$

Anomie system is a system; such that the measure of the affect relation complexity approaches zero.

Anarchy does not necessarily represent an anomie system. An anomie system is one in which behavioral norms are difficult to identify. Anarchy is a system that lacks a fielded military; that is, a police force that can control a population. Under these circumstances, proper behavior is still known, but is unenforceable. An anomie system is one in which there may be a generation transition from one code of behavior to another. Within each generation the norm is established, but when considered as a whole, the norms are confused—hence the continual criticism of the younger generation's behavior by the older.

Examples: A social system that is moving toward political anarchy and/or social disparity. A school system that has many individual "failing schools" may be considered an anomie system in that each school is being separated from all others in the system.

Deterministic system, $_{DT}\mathbb{S}$, $=_{df}$ a system behavior that is predictable from a preceding system behavior.

$$_{DT}\mathbb{S}, =_{df} \mathcal{B}(\mathbb{S}) \mid \mathcal{B}(\mathbb{S})_{t(1)} \Vdash \mathcal{B}(\mathbb{S})_{t(2)}$$

Deterministic system is a system such that the system behavior at time t_1 yields the system behavior at time t_2. The behavior of a deterministic system is predictable given known relevant conditions.

Examples: Strategic paralysis produces a deterministic system; that is, it is determined that by inflicting certain conditions on a system the system will behave in a non-threatening way. Product production lines are designed to be deterministic systems; that is, a company wants to make sure that every product that is produced meets the same predictable standards. A school system may strive to develop certain aspects of its subsystems as deterministic; for example, if a particular teaching method results in consistent desired outcomes, then other classes will be designed to meet the same production standards.

Autopoietic system, ${}_{A\mathcal{T}}\mathbb{S}$**,** $=_{df}$ an autonomous system that is self-producing.

$$ {}_{A\mathcal{T}}\mathbb{S} =_{df} \mathbb{S} \mid \mathbb{S} = {}_{A\mathcal{U}}\mathbb{S} \wedge (A\mathcal{T}: \mathcal{L}_{A\mathcal{T}} \times {}_{A\mathcal{U}}\mathbb{S} \to {}_{A\mathcal{T}}\mathbb{S}_{O\mathcal{P}} \mid (\underline{\mathcal{I}}({}_{A\mathcal{U}}\mathbb{S}, {}_{A\mathcal{T}}\mathbb{S}_{O\mathcal{P}})) \wedge {}_{A\mathcal{U}}\mathbb{S} \cap {}_{A\mathcal{T}}\mathbb{S}_{O\mathcal{P}} = \emptyset $$

Where '$A\mathcal{T}$' is a production process of the autopoietic system; '$\mathcal{L}_{A\mathcal{T}}$' are the controls for the production process; and '${}_{A\mathcal{T}}\mathbb{S}_{O\mathcal{P}}$' is the autopoietic system output.

Autopoietic system is a system; such that, the system is autonomous, and there is a production-process function from the product of the production process controls and the autonomous system to the autopoietic system output, such that the autonomous system and autopoietic system output are isomorphic and disjoint. **Autopoiesis** is a process of system self-production.

Examples: Corporations that franchise their stores attempt to do so as an autopoietic system; that is, they try to make every new unit the same as all the others. Societies may be autopoietic when they try to extend their own societal organization—culture, values, beliefs, etc.—onto another society. The "westernization" of the world is an autopoietic process. School expansion may be an autopoietic process whereby a successful school system attempts to replicate that experience.

Autocatalytic system, ${}_{AC}\mathbb{S}$**,** $=_{df}$ a system with an increasing number of similar existing affect relations.

$$ {}_{AC}\mathbb{S} =_{df} \mathbb{S} \mid \exists \mathcal{A}\, \forall \mathcal{A}_i \in \mathcal{A}\, ([\mathcal{A}_m, \mathcal{A}_n \in \mathcal{A} \supset \underline{\mathcal{M}}(\mathcal{A}_m, \mathcal{A}_n)] \wedge |\mathcal{A}_i|^{\uparrow}) $$

Autocatalytic system is a system; such that, there is an affect relation family with similar affect relation sets and the family has an increasing number of components.

Examples: Supply-and-demand economics may result in an autocatalytic system; that is, when those outside the initial market desire a product that is supplied, the greater demand creates an autocatalytic system. When a particular school produces high-achieving graduates, then other schools may desire to duplicate that success, creating an autocatalytic system. Autocatalysis is not the process of product production, but is the process of demand by which products have to be produced to meet the demand.

Growth, $\mathcal{G}(\mathbb{S})$**,** $=_{df}$ an increase over time of a system object-set or relation-set.

$$ \mathcal{G}(\mathbb{S}) =_{df} \mathcal{M}(\mathbb{S}_{0}) \vee \mathcal{M}(\mathbb{S}_{\phi}) \mid \mathcal{M}(\mathbb{S}_{0:\,t(1)}) \prec \mathcal{M}(\mathbb{S}_{0:\,t(2)}) \;.\!\vee\!.\; \mathcal{M}(\mathbb{S}_{\phi:\,t1}) \prec \mathcal{M}(\mathbb{S}_{\phi:\,t2}) $$

Growth is a measure of an object-set or relation-set; such that, the measure of the object-set at time t_1 is less than the measure of the object-set at time t_2, or the measure of the relation-set at time t_1 is less than the measure of the relation-set at time t_2.

Size growth, $\mathcal{Z}^+$, $=_{df}$ an increase over time of a system object-set.

$$\mathcal{Z}^+ =_{df} (\mathcal{Z}_{t(1)}) < (\mathcal{Z}_{t(2)}); \text{ or } \Delta\mathcal{Z}_t > 0$$

Size growth of a system is an increase in the cardinality of the system components. However, if the cardinality cannot be determined, then **size growth** can be evaluated as a measure in which the change can be *recognized* as greater than zero. '$\Delta\mathcal{Z}_t$' is the change in size with respect to time, t.

Complexity growth, $\mathcal{X}^+$**,** $=_{df}$ an increase over time of a system relation-set.

$$\mathcal{X}^+ =_{df} (\mathcal{X}_{t(1)}) < (\mathcal{X}_{t(2)}); \text{ or } \Delta\mathcal{X}_t > 0$$

Complexity growth of a system is an increase in the cardinality of the system connections. However, if the cardinality cannot be determined, then **complexity growth** can be evaluated as a measure in which the change can be recognized as greater than zero. '$\Delta\mathcal{X}_t$' is the change in size with respect to time, t.

Degeneration, $\mathcal{D}(\mathbb{S})$**,** $=_{df}$ a decrease over time of a system object-set or relation-set.

$$\mathcal{D}(\mathbb{S}) =_{df} \mathcal{M}(\mathbb{S}_{0}) \vee \mathcal{M}(\mathbb{S}_{\phi}) \mid \mathcal{M}(\mathbb{S}_{0:\, t(1)}) > \mathcal{M}(\mathbb{S}_{0:\, t(2)}) \;.\!\vee\!.\; \mathcal{M}(\mathbb{S}_{\phi:\, t1}) > \mathcal{M}(\mathbb{S}_{\phi:\, t2})$$

Degeneration is a measure of an object-set or relation-set; such that, the measure of the object-set at time t_1 is greater than the measure of the object-set at time t_2, or the measure of the relation-set at time t_1 is greater than the measure of the relation-set at time t_2.

Size degeneration, $\mathcal{Z}^-$**,** $=_{df}$ a decrease over time of a system object-set.

$$\mathcal{Z}^- =_{df} (\mathcal{Z}_{t(1)}) > (\mathcal{Z}_{t(2)}); \text{ or } \Delta\mathcal{Z}_t < 0$$

Size degeneration of a system is a decrease in the cardinality of the system components. However, if the cardinality cannot be determined, then **size degeneration** can be evaluated as a measure in which the change can be recognized as less than zero. '$\Delta\mathbf{SZ}_t$' is the change in size with respect to time, t.

Complexity degeneration, $\mathcal{X}^-$, $=_{df}$ a decrease over time of a system relation-set.

$$\mathcal{X}^- =_{df} (\mathcal{X}_{t(1)}) > (\mathcal{X}_{t(2)});\text{ or } \Delta\mathcal{X}_t < 0$$

Complexity degeneration of a system is a decrease in the cardinality of the system connections. However, if the cardinality cannot be determined, then **complexity degeneration** can be evaluated as a measure in which the change can be <u>recognized</u> as less than zero. '$\Delta\underline{\mathbf{X}}_t$' is the change in size with respect to time, t.

Adaptable system (adaptableness), $_A\mathbb{S}$, $=_{df}$ a system compatibility change within certain limits to maintain stability under system environmental change.

$$_A\mathbb{S} =_{df} \Delta\mathbb{S}'_{t(1),t(2)} \Vdash \Delta\,\mathscr{C}_{t(1),t(2)} < \alpha \Vdash {}_{SB}\mathbb{S}_{t(1),t(2)}$$

Adaptable system is defined as a change in system environment from t_1 to t_2, that yields a change in system compatibility within certain limits from t_1 to t_2, and that yields system stability at t_1 and t_2.

$\mathcal{M}$**: Adaptable system measure**, $\mathcal{M}(_A\mathbb{S})$, $=_{df}$ a measure of system stability at time t_1 and t_2, given a change in the environment at time t_1 and t_2, and a change in compatibility within limits at time t_1 and t_2.

$$\Delta\mathbb{S}'_{t(1),t(2)},\ \Delta\,\mathscr{C}_{t(1),t(2)} < \alpha \vdash$$

$$\mathcal{M}(_A\mathbb{S}) =_{df} \mathcal{M}({}_{SB}\mathbb{S}_{t(1)}, {}_{SB}\mathbb{S}_{t(2)}) < \beta :\equiv: |\mathcal{M}({}_{SB}\mathbb{S}_{t(1)}) - \mathcal{M}({}_{SB}\mathbb{S}_{t(2)})| < \beta;$$ where β is a value that defines a range within which the system remains stable.

'$\Vdash$' $=_{df}$ *Time-sequential yields*: *Time-sequential yields* are required in order to account for the dynamic aspect of these properties. This is not to be confused with the logical "yields," $\vdash$, of the predicate calculus. The intent is somewhat the same, but, in particular, the Deduction Theorem does not apply. For example, in the definition of adaptable system, it is first recognized, possibly by means of an APT&C analysis, $\mathcal{A}(_A\mathbb{S})$, that there is a change in the negasystem from t_1 to t_2. At those times, it is also recognized, again by $\mathcal{A}(_A\mathbb{S})$, that there is a change in compatibility; and it is also recognized by $\mathcal{A}(_A\mathbb{S})$ that stability has remained within acceptable limits. When this occurs, the system is *adaptable*. Note that for the measure of adaptability, '$\vdash$' is the "yields" of the predicate calculus.

'$\Vdash$' is ***not*** a "causal" relation, but one of recognizing system structure. The logic is one of recognition, not causality. That is, it is recognized that the first listing is observed first, followed by the second listing and then the third. As a result of this total observation, the measures are determined at each time to verify the changed values. As a result of these observations, it may be appropriate to establish a continual monitoring of the system to anticipate a validating of adaptableness, or to determine if stability is approaching its limit.

Efficiency, ${}_{EF}\mathfrak{S}$, $=_{df}$ the ratio of *input-utilized derived production output* to corresponding *feedin input-components*.

$$ {}_{EF}\mathfrak{S}, =_{df} \mathcal{M}[({}_{DP}f_T)_{\mathbf{I}\mathcal{P}} \div \mathbf{I}_{\mathcal{P}}]; \text{ where, } ({}_{DP}f_T)_{\mathbf{I}\mathcal{P}} = \mathbf{I}_{\mathcal{P}} \setminus {}_{SP}\mathfrak{S} \cup \mathbf{S}_{\mathcal{P}} $$

Efficiency is defined as a measure of *input-utilized derived-production feedthrough* divided by *input*; where *input-utilized derived-production feedthrough* equals *input* less *spillage* and *storeput*.

That is, to obtain a value for the *efficiency* of a system, we must know what *input* is being utilized, and we must consider only that *input* that is processed for *output*. That *toput* that is initiated for transmission to *input* but results in *spillage* is not considered, and neither is the *input* that remains in storage and is not made available to *fromput*.

Before considering *efficiency*, as it will be used in *ATIS*, we need to consider the fact that *efficiency* has been defined in several different ways as the development of this theory model has been pursued. Initially, SIGGS defined efficiency as follows:

Efficiency, ${}_{EF}\mathfrak{S}$, $=_{df}$ a system that has commonality between *feedthrough* and *toput*.

The problem with this definition is that *feedthrough* and *toput* are two different types of terms. *Feedthrough* is a morphism and *toput* is a set of components. Then, the first revision of the SIGGS definition made both terms the same type as follows:

Efficiency, ${}_{EF}\mathfrak{S}$, $=_{df}$ a system that has commonality between *feedthrough* and *feedin*.

$$ {}_{EF}\mathfrak{S}, =_{df} \mathcal{A}(f_T) \equiv \mathcal{A}(f_I) $$

Efficiency is a measure of the commonality of feedthrough and feedin.

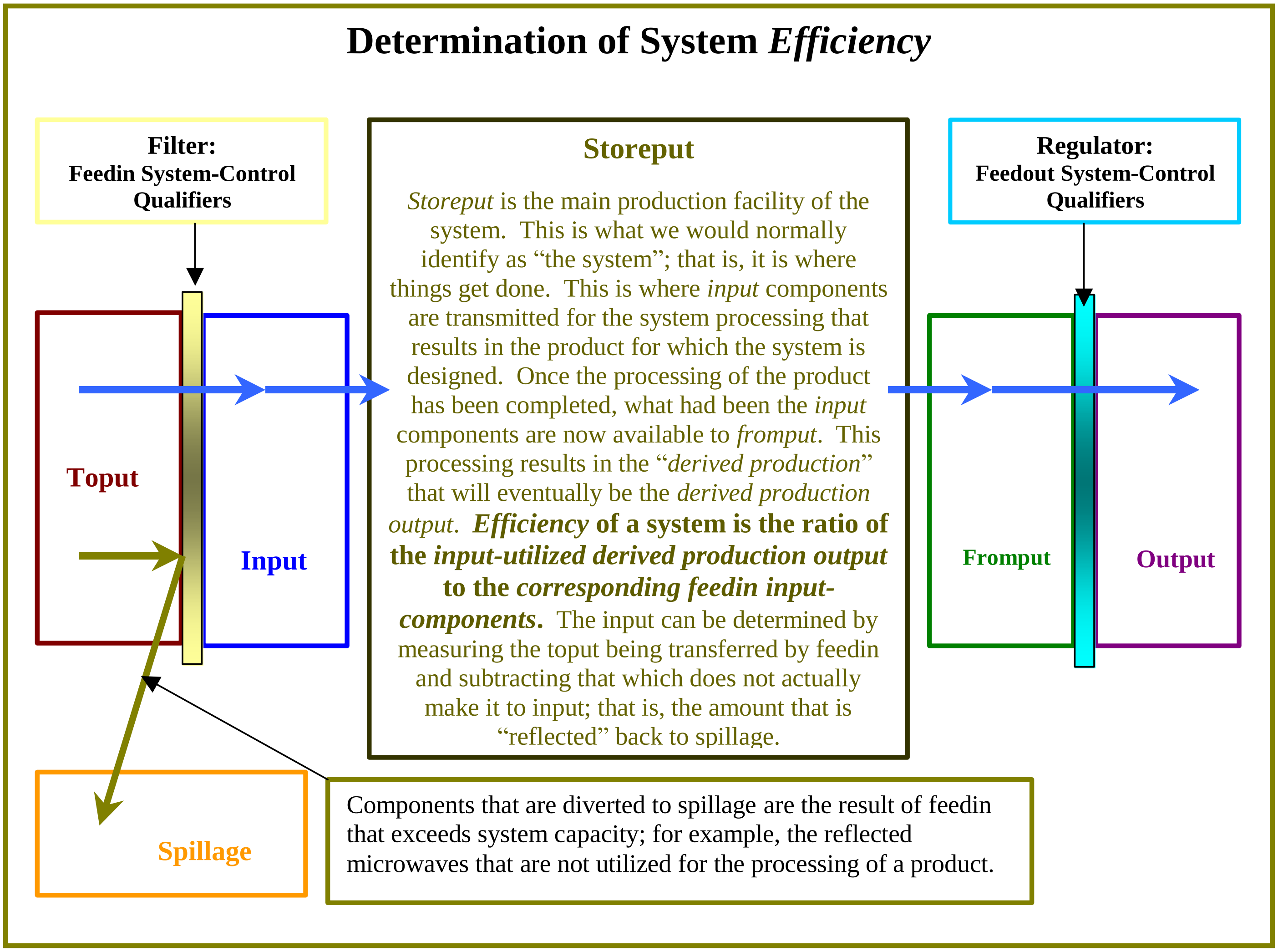
However, while this definition suggests what is wanted, we still do not have a good grasp of just what is happening and the measure that can be easily identified with the definition. As a result of these considerations, the definition provided above seems to provide the best indicator of just what is meant by *efficiency*. However, feedthrough can give us valuable perspectives on efficiency by identifying the **efficiency maximization principle** and the **efficiency minimization principle**. The **Efficiency maximization principle** results when feedin produces the largest possible feedthrough and **efficiency minimization principle** results when feedthrough is obtained with the least possible feedin. This efficiency relationship is between *feedthrough* and *feedin*, and not *feedthrough* and toput. The reason is that, as noted above, *feedthrough* and *toput* are different types of properties.

Efficiency is normally measured as a ratio of *output*:*input*. However, for *ATIS*, this ratio must be more carefully considered. For example, the efficiency of microwave energy used to dry beech wood was determined as follows:

> To investigate the energy efficiency, input and reflected microwave power were detected. Energy efficiencies with respect to MW-power of up to 80% were reached depending on the moisture content of the samples.
>
> (*Vacuum Microwave Drying of Beech: Property Profiles and Energy Efficiency*, Matthias Leiker, et al., Matthias.Leiker@mailbox.tu-dresden.de, Technische Universität Dresden, Thermal Process Engineering and Environmental Technology, 01062 Dresden, Germany. https://www.researchgate.net/publication/225454832_Energy_efficiency_and_drying_rates_during_vacuum_microwave_drying_of_wood.)

In this example, **efficiency** was determined by evaluating the amount of microwave *spillage* with respect to the energy *input*; that is, the "reflected microwave power" (*spillage*) to the microwave power *input*. In this example, **efficiency** is determined by evaluating the input that is used for *derived production output* as determined by measuring the amount of *spillage*. Therefore, **efficiency** is the ratio:

Input-utilized derived production output : *corresponding feedin input-components*.



Examples: School systems may be viewed from either a maximization or minimization efficiency principle. That is, efficiency maximization could be obtained when each student obtains the greatest achievements, and efficiency minimization could be obtained when the learning of each student is optimized with respect to resources.

Stability, $_{SB}\mathbb{S}$**,** $=_{df}$ change in initial system state or negasystem state yields a subsequent change of system state that remains within certain limits.

$$_{SB}\mathbb{S} =_{df} \Delta\mathcal{S}_{t(1)} \vee \Delta\mathcal{S}'_{t(1)} \Vdash \mathcal{S}_{t(2)} < \alpha$$

Stability is defined as a change in system or negasystem state at time t_1 yields a system change of state that is less than α at time t_2.

Steadiness, $_{S}\mathbb{S}$**,** $=_{df}$ stability under negasystem change of state.

$$_{S}\mathbb{S} =_{df\ SB} \Delta\mathcal{S}' \Vdash {}_{SB}\mathbb{S}$$

Steadiness is defined as a change in negasystem state yields system stability.

Equifinality, $_{EQ}\mathbb{S}$**,** $=_{df}$ a system that is behavior-predictable from more than one preceding system behavior.

$$_{EQ}\mathbb{S} =_{df} \mathbb{S} \mid \mathcal{B}_1(\mathbb{S})_{t(1)} \vee \mathcal{B}_2(\mathbb{S})_{t(1)} \vee \ldots \vee \mathcal{B}_n(\mathbb{S})_{t(1)} \Vdash \mathcal{B}(\mathbb{S})_{t(2)}$$

Equifinality is a system such that various system behaviors at time t_1 yield the system behavior at time t_2. The behavior of a system that results from equifinality is absolutely predictable from any of the preceding system behaviors. Equifinality determines the predictability of system behavior from more than one preceding system behavior.

Equifinality can also be applied to achieving the same output from different inputs, and as the result of different derived production processes.

Examples: The education system of the United States exhibits equifinality; that is, there are numerous distinct school systems that result in comparable student output.

Homeostatic system, $_{H}\mathfrak{S}$**,** $=_{df}$ stability of organic-essential subsystem under system environmental change.

$$_{H}\mathfrak{S} =_{df} \Delta\mathfrak{S}' \Vdash {}_{SB}\mathfrak{S}({}_{\Theta}\mathcal{W})$$

Homeostatic system is defined as a system; such that, the organic-essential subsystem is stable under a change in the negasystem.

Examples: The Cold War Balance of Power is the primary social example of homeostatic systems. Each side reacts to military advances by the other in order to maintain its organic-essential components—food resources, power resources, transportation resources, etc. Organic-essential components are those parts of the system that are absolutely essential to maintain the system identify. The evolution-creationism conflict within school systems is an on-going conflict to maintain the scientific identity of the school system. A stable scientific behavior is required if the school system is to maintain its prominence as one that produces students that are responsible scientific researchers.

Stress, $_{ST}\mathfrak{S}$**,** $=_{df}$ change of system state due to a change in negasystem state beyond certain limits.

$$_{ST}\mathfrak{S} =_{df} \Delta\,\mathcal{S}' > k \Vdash \Delta\mathcal{S}$$

Stress is defined as a change in negasystem greater than a value, k, yields a change in system state.

Strain, $_{SR}\mathfrak{S}$**,** $=_{df}$ change beyond a limit of system state.

$$_{SR}\mathfrak{S} =_{df} \Delta\mathcal{S} > k$$

Strain is defined as a change in system state greater than some value, k.

Morphostasis, $_{MS}\mathfrak{S}$**,** $=_{df}$ system stability resulting from feedin and feedout.

$$_{MS}\mathfrak{S} =_{df} {}_{SB}\mathfrak{S}(\oint_I, \oint_O)$$

Morphostasis is system stability with respect to feedin and feedout. **Morphostasis** is the process of a system retaining a structure, organization, or form through interaction with the negasystem.

Examples: To the extent that school systems attain stability of their organization, they exhibit a morphostasis system. While schools exhibit attributes of a morphogenic system, they also maintain stability during the process of complexity growth. Such schools characterize morphostasis.

Morphogenesis, $_{MG}\mathbb{S}$**,** $=_{df}$ system complexity-growth resulting from feedin.

$$_{MG}\mathbb{S} =_{df} \mathcal{G}\mathcal{X}(\mathfrak{f}\mathrm{I})$$

Morphogenesis is defined as system complexity growth with respect to feedin.

Examples: Morphogenesis is the process involved in a system-negasystem exchange that results in a more complex system structure. An education system is one such system. Schools attempt to keep pace with technological innovations, to implement them to enhance instruction. Schools also continually evolve to address new issues in the community, to instruct their students so that they can be more productive citizens.

Conflict, $_{CF}\mathbb{S}$**,** $=_{df}$ two or more systems with the same toput components.

$$_{CF}\mathbb{S} =_{df} \mathfrak{F}(\mathbb{S}) \mid \mathbb{S}_{i=1\ldots n} \in \mathfrak{F}(\mathbb{S}) \wedge i > 1 \wedge \exists^1 T_{\mathcal{P}} \forall\ \mathbb{S}_i(T_{\mathcal{P}} \in \mathbb{S}'_i)$$

Conflict, or **system conflict**, is a family of systems; such that, there are two or more systems in the family, and there is unique toput such that for all systems, the toput is in the system environment.

Examples: It would seem as though most if not all social systems are involved in conflict with other systems. All systems are striving for their share of limited resources. Individual schools, in particular, are "allotted" resources that are divided among the other schools within a system. Each school attempts to present its "needs" in a manner that it will receive more of the available resources.

Ergodic system, $_{EG}\mathbb{S}$**,** $=_{df}$ A system in which there are subsystems that have dispositional behaviors similar to the system.

$$_{EG}\mathbb{S} =_{df} U \subset \mathbb{S} \ .\supset.\ {}_{\mathfrak{D}}\mathcal{B}(U) \sim {}_{\mathfrak{D}}\mathcal{B}(\mathbb{S})$$

Ergodic system is defined as a system; such that, the dispositional behavior of a subsystem is similar to the dispositional behavior of the system.

Examples: The education system of the United States attempts to be designed as an ergodic system in which every school can produce students who meet prescribed standards set by the Federal or State governments. Political polls are based on this property; i.e., it is assumed that the outcomes obtained from a "sample" reflect the outcomes that would be obtained if the entire system were analyzed in a similar manner.

Eudemonic system, $_{EM}\mathbb{S}$**,** $=_{df}$ a strategic system whose behavior converges toward predicted outcomes.

$$_{EM}\mathbb{S} =_{df} {}_{\mathcal{S}}\mathcal{W} \mid \mathcal{B}({}_{\mathcal{S}}\mathcal{W}) \rightarrow {}_{PD}\boldsymbol{\mathcal{S}}$$

Eudemonic system is defined as a strategic system; such that, the strategic system behavior converges to a predictive state.

Examples: A strategic system controls its inputs and outputs. In an eudemonic system, the strategic system controls its inputs and outputs in a manner to achieve an outcome that is valued. For a corporation that produces a product, the production is not the eudemonic system, but what the corporation values as a social entity results in an eudemonic system. A school system produces students with certain academic capabilities, but it is not these, but the desired exhibited individual personal and social values held by the students that are a result of the predicted outcomes of the eudemonic system. The D.A.R.E. program is designed as a eudemonic system. The scouting program is a eudemonic system. Sports programs and extra-curricular programs are frequently designed to promote certain values as part of a eudemonic system.

Goal, $\mathcal{G}(\mathbb{S})$**,** $=_{df}$ a system end state determined *a priori*.

$$\mathcal{G}(\mathbb{S}) =_{df} \boldsymbol{\mathcal{S}} \mid \sigma({}_{L}\mathcal{W}_{t1}) \Vdash \boldsymbol{\mathcal{S}}_{t1}, \boldsymbol{\mathcal{S}}_{t2}, \boldsymbol{\mathcal{S}}_{t3}, \ldots, \boldsymbol{\mathcal{S}}_{tn} = \boldsymbol{\mathcal{S}}$$

Goal is an end state such that; a system state-transition function defined on the leadership subsystem at time t_1 yields a sequence of system states from time t_1 to t_n, and the state at time t_n is the end state.

The operation: '$\sigma({}_{L}\mathcal{W}_{t1}) \Vdash \mathcal{S}_{t1}, \mathcal{S}_{t2}, \mathcal{S}_{t3}, \ldots, \mathcal{S}_{tn}$', is defined by an APT&C value of the state at each time as derived from ${}_{L}\mathcal{W}_{t1}$. That is, each state is the result of a system state-transition determined by the leadership subsystem.

Dynamic teleological system, $\mathcal{D}(\mathbb{S})$, $=_{df}$ Leadership subsystem-directed system behavior, such that the leadership subsystem controls the system's behavior in a manner determined by the subsystem's goals.

$$_{\mathcal{D}}\mathbb{S} =_{df} \mathbb{S} \mid \exists_{\mathcal{L}}\mathcal{W} \subset \mathbb{S}\ (\mathcal{G}{:}(_{\mathcal{L}}\mathcal{W}) \rightarrow \mathcal{B}(\mathbb{S}))$$

Where, '$\mathcal{G}$' is a goal-function-process that maps the leadership subsystem-directed goals onto the system behavior.

Dynamic teleological system is defined as a system; such that, there is a leadership subsystem of the system such that the goal-function-process maps the leadership subsystem goals onto the system behavior.

Dynamic teleology and predictability: Dynamic teleology consists of directed processes of the Leadership subsystem defined by system structure that yields a final state. It is as a direct result of the nature of this dynamic teleological process that such structure and operation implies that the system is predictable.

A basic observation of behavioral systems, whether the behavior of a person or of a system comprised of many persons, is that they are not chaotic. Such systems are observed to operate in a manner that directs them toward certain goals. This characteristic of these systems will be identified as 'intentional'; that is, these are 'intentional systems'. Further, it is asserted that for **intentional systems**, the *intent* controls the behavior and has been recognized as the best predictor of behavior. Such an assumption has long-standing support, even when applied to individuals.

With respect to individuals, in the late 1960's and early 1970's, c, as a means of predicting individual behavior, developed the *Theory of Reasoned Action* (TRA) and the *Theory of Planned Behavior* (TPB).[3] TRA/TPB were developed in the field of social psychology and were designed:

1. To predict and understand motivational influences on behavior that is not under the individual's volitional control.
2. To identify how and where to target strategies for changing behavior.
3. To explain virtually any human behavior such as why a person buys a new car, votes against a certain candidate, is absent from work or engages in premarital sexual intercourse.

Ajzen and Fishbein assert that three things determine intention:

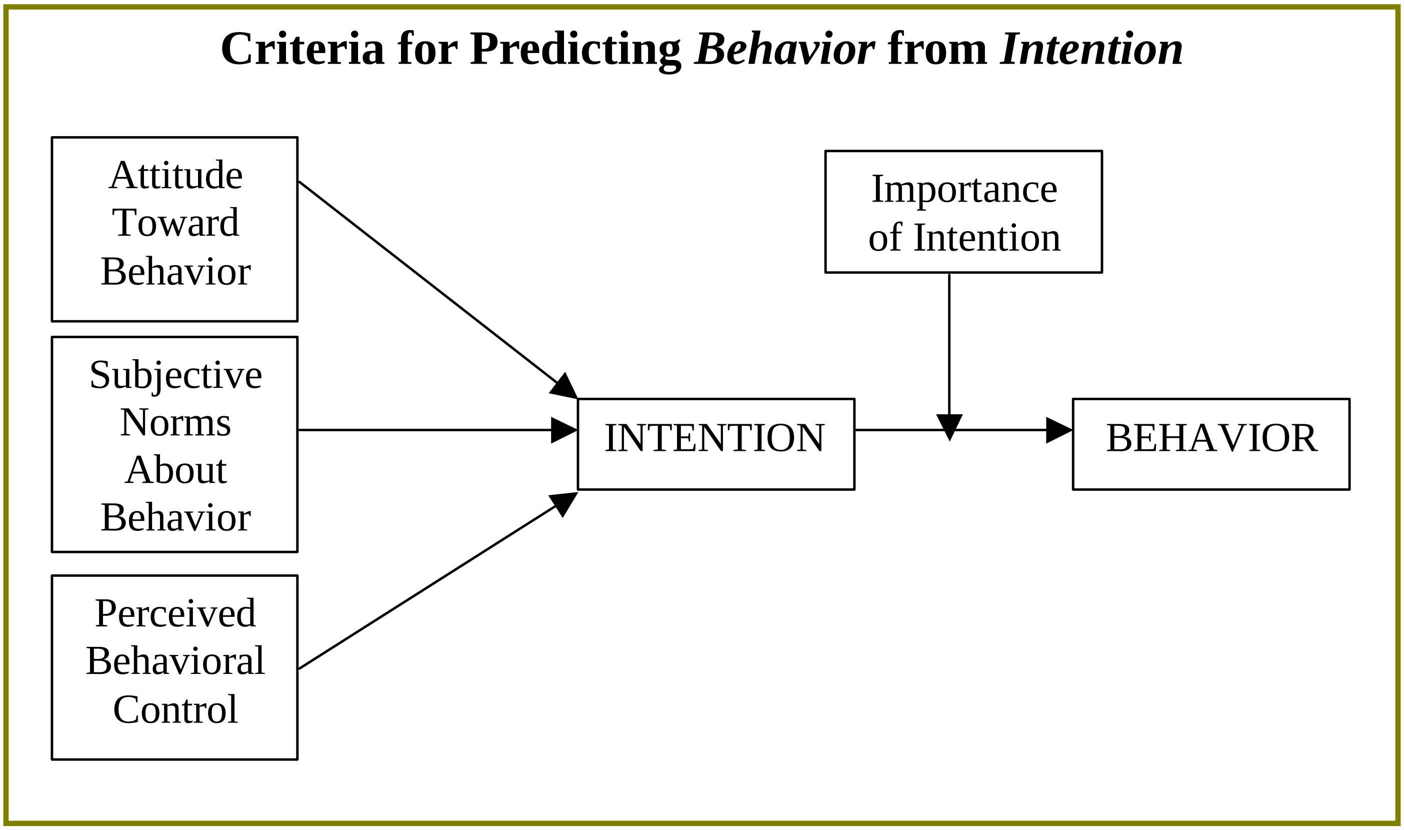
1. Attitude toward the specific behavior,
2. Subjective norms (that is, beliefs about how people they care about will view the behavior in question), and

[3] Ajzen and Fishbein: http://socyberty.com/psychology/theory-of-reasoned-action-and-theory-of-planned-behavior/

3. Perceived behavioral control.

The stronger these three factors, then the more likely it is that the person's intention will result in action—the *intended* behavior. The actual behavior is also controlled by the importance of the intention. Even though there may be actual intent, acting on that intent may be influenced by how important the outcome behavior is perceived to be. For example, I may want to and intend to have some ice cream, but to obtain it I will have to go to a store to get it when I find that there is none in the freezer. "Oh, well, it's not really that important!" The *Importance Criteria* provides a final block to the behavior, or allows it to continue to action. The chart below portrays the process for predicting behavior from intention.

Now, whereas Ajzen and Fishbein are concerned with predicting human behavior individually, even to the point of predicting (or explaining) "any human behavior," our concern is with predicting intentional systems comprised of "several" individuals. How small the intentional systems can be that are of concern for *ATIS* has yet to be determined. However, even for *ATIS*, individual predictive outcomes are available when the individual is acting as a component of the larger intentional system. And, under these conditions, the Ajzen and Fishbein criteria do apply. In fact, while the intentional systems with which *ATIS* is concerned are not the social-psychological systems of an individual, it is apparent that the three Ajzen and Fishbein criteria shown above characterize the criteria for the intention of the individuals as they relate to the larger intentional system.



That is, the very fact that the individuals are components of the larger intentional system lends support to the belief and assumption that these individuals already have the appropriate attitude, acceptance of subjective norms and behavioral control that allows them to function behaviorally in a manner that furthers the goals of the intentional system. Further, their "commitment" to the goals of the intentional system is confirmed by their presence in the system, hence it is reasonable to predict that they will act behaviorally in a manner that furthers the goals of the larger intentional system. Ajzen and Fishbein provide support for the position here taken that behavior is predictable when system intentions are known.

Examples: It appears as though all social systems are dynamic teleological systems in that they are designed to meet certain social outcomes; that is, they all have specific social goals. All schools are dynamic teleological systems in that they all have been designed with a specific goal to achieve.

State determinacy, $_{D}\mathcal{S}$, $=_{df}$ derivability of a system state from one and only one preceding system state.

$$_{D}\mathcal{S} =_{df} \mathcal{S}_{t(1)} \Vdash \mathcal{S}_{t(2)} \wedge \forall\mathcal{S}\ [\mathcal{S}_{i:\ t(1)} \Vdash \mathcal{S}_{t(2)}\ .\wedge.\ \mathcal{S}_{j:\ t(1)} \Vdash \mathcal{S}_{t(2)}\ :\supset:\ \mathcal{S}_{i} = \mathcal{S}_{j}]$$

State determinacy is defined as a unique system state at time t_1 implies the system state at time t_2.

Dynamic Property: "feed-" Transition Functions, $\mathfrak{f}_X$

The "feed-"transition functions map the movement of components from one partition to another. The movement is defined by the state-transition function. Any change in a system's components or relations is a change in state, requiring the application of the state-transition function. The transition functions define which partitions are being changed that result in a change of system state.

Feed-function schema: The "feed-" functions, $\mathfrak{f}_V$; that is, $\mathfrak{f}_I$, $\mathfrak{f}_N$, $\mathfrak{f}_S$, $\mathfrak{f}_F$, $\mathfrak{f}_O$, $\mathfrak{f}_T$, $\mathfrak{f}_B$, and $\mathfrak{f}_E$, are state transition functions between two disjoint sets, $X_{\mathcal{P}}$ and $Y_{\mathcal{P}}$, defined as follows:

$$\sigma(x_{X\mathcal{P}})(\mathfrak{f}_V \circ \mathfrak{g} \circ f) \in Y_{\mathcal{P}} \mid \sigma(x_{X\mathcal{P}}) = x_{Y\mathcal{P}}\text{; where } f\text{: } X_{\mathcal{P}} \times {}_{X\mathcal{P}}\mathcal{L}_C \to \{\bot, \top\}\text{, and}$$

'${}_{X\mathcal{P}}\mathcal{L}_C$' designates the "$X_{\mathcal{P}}$ logistic-control qualifier."

$$\mathfrak{g}(x_{X\mathcal{P}}) = \begin{cases} \varnothing, \text{ if } f = \bot \\ x_{X\mathcal{P}}, \text{ if } f = \top \quad \text{and} \end{cases}$$

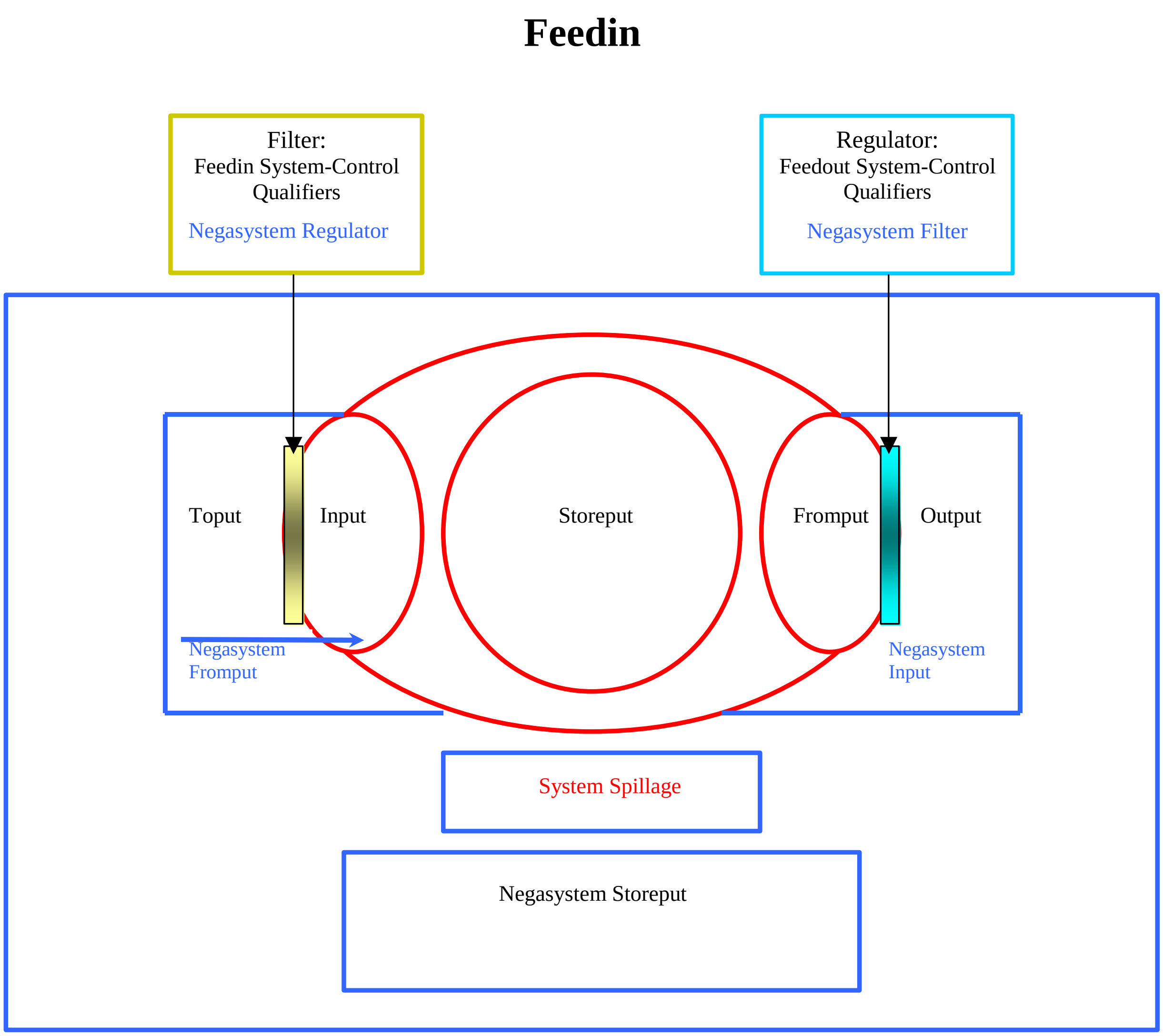
$$\mathfrak{f}_V\text{: } W \subset X_{\mathcal{P}} \to Y_{\mathcal{P}} \mid (\mathfrak{g}(x_{X\mathcal{P}}) \neq \varnothing \supset \mathfrak{g}(x_{X\mathcal{P}}) = x_{X\mathcal{P}} \in W) \wedge \mathfrak{f}_V(x_{X\mathcal{P}}) = x_{Y\mathcal{P}} \in Y_{\mathcal{P}}$$

$$\mathfrak{f}_E(\mathbb{S}_x) =_{df} \sigma(\mathbb{S}_x) \mid (\sigma\text{:} O_{\mathcal{P}} \times {}_{O\mathcal{P}}\mathcal{L}_C \to T_{\mathcal{P}})\text{; that is, } \sigma(x_{O\mathcal{P}}) = x_{T\mathcal{P}}$$

Feedin, $\mathfrak{fi}(\mathbb{S})$, $=_{df}$ transmission of *toput* to *input*.

$$\mathfrak{fi}(\mathbb{S}_x) =_{df} \sigma(\mathbb{S}_x) \mid (\sigma\!:\! T_{\mathcal{P}} \times T_{\mathcal{P}}\mathcal{L}_C \to I_{\mathcal{P}}); \text{ that is, } \sigma(x_{T\mathcal{P}}) = x_{I\mathcal{P}}$$

Feedin is a *system state-transition function*; such that, the state transition is defined from the product of *toput* and the *toput-control qualifiers* to *input*.

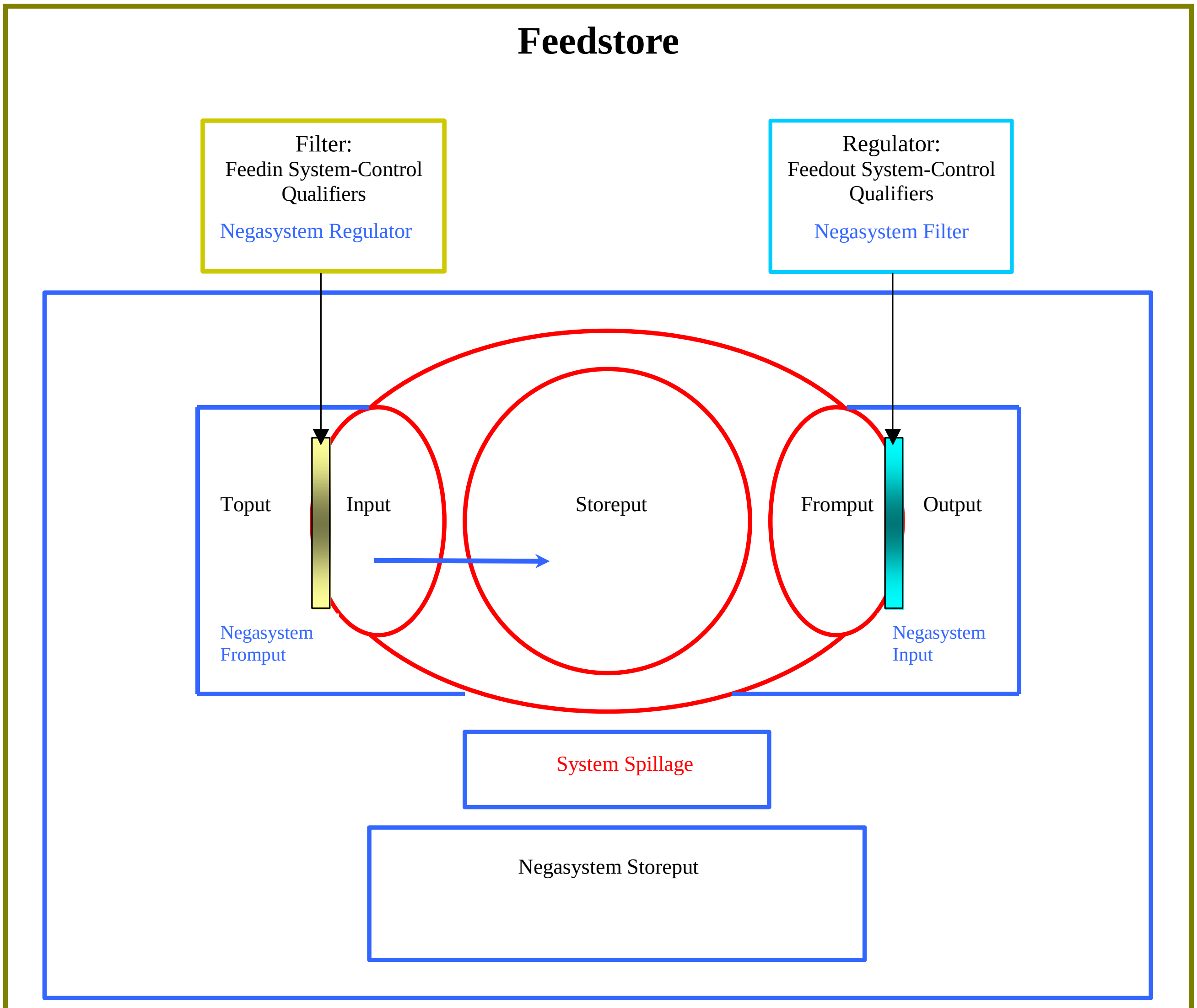


Feedin is shown as it is initiated in *toput* and transmitted to *input*. As seen here, the *filter* may influence *feedin* (see *filtration*).

Feedstore, $\mathfrak{f}_S(\mathbb{S}_{\mathsf{x}})$**,** $=_{df}$ transmission of in*put* to *storeput*.

$$\mathfrak{f}_S(\mathbb{S}_{\mathsf{x}}) =_{df} \sigma(\mathbb{S}_{\mathsf{x}}) \mid (\sigma{:}\mathrm{I}_{\mathcal{P}} \times {}_{\mathrm{I}\mathcal{P}}\mathscr{Q}_{\mathrm{C}} \rightarrow \mathrm{S}_{\mathcal{P}}); \text{ that is, } \sigma(\mathsf{x}_{\mathrm{I}\mathcal{P}}) = \mathsf{x}_{\mathrm{S}\mathcal{P}}$$

Feedstore is a *system state-transition function*; such that, the state transition is defined from the product of *Input* and the *input-control qualifiers* to *storeput*.



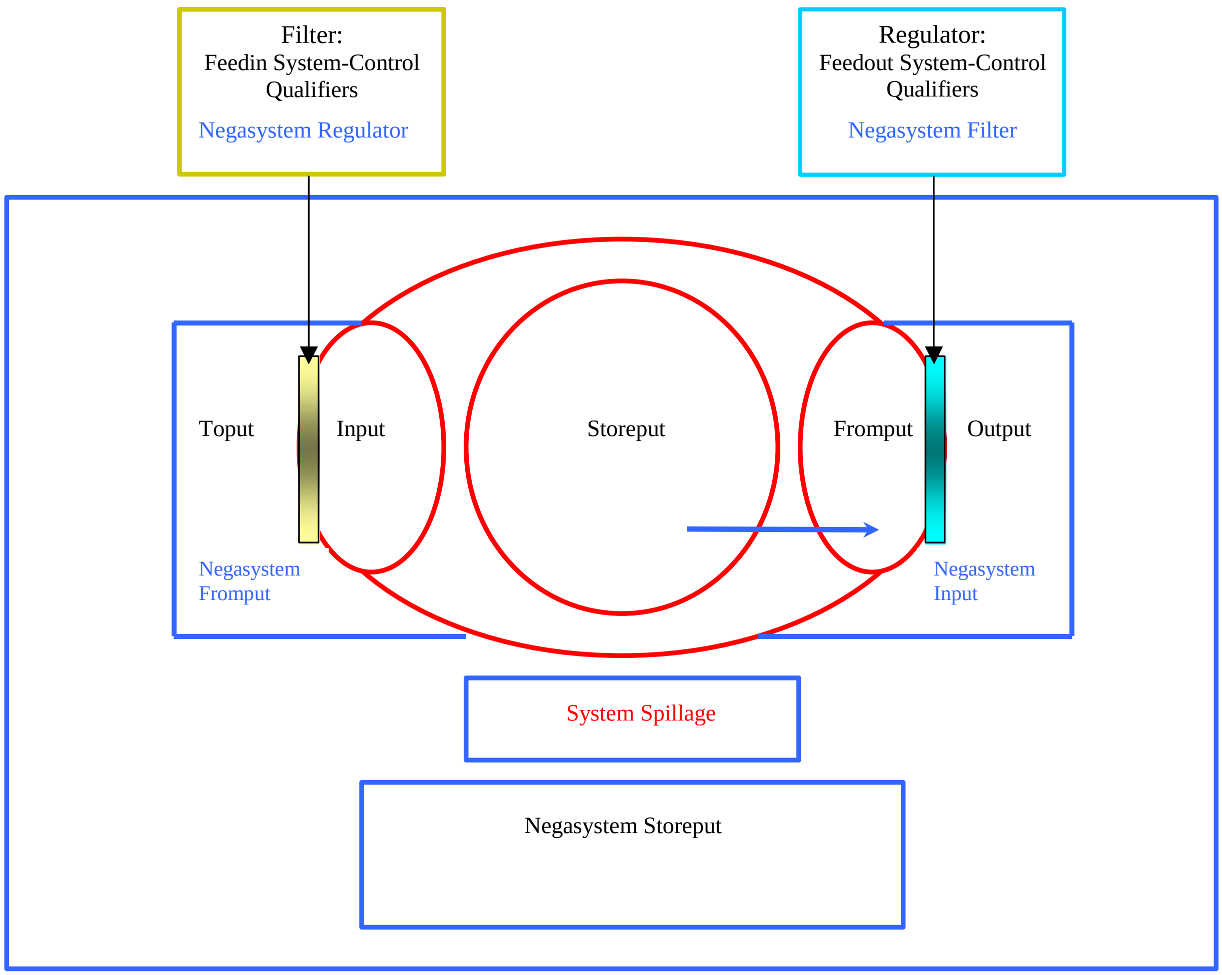
Feedstore is shown as it is initiated in *input* and then transmitted to *storeput*.

Feedfrom, $\mathfrak{f}_F(\mathbb{S}_{\varkappa})$**,** $=_{df}$ transmission of *storeput* to *fromput*.

$$\mathfrak{f}_F(\mathbb{S}_{\varkappa}) =_{df} \sigma(\mathbb{S}_{\varkappa}) \mid (\sigma : S_{\mathcal{P}} \times {}_{S\mathcal{P}}\mathscr{L}_C \to F_{\mathcal{P}}); \text{ that is, } \sigma(\varkappa_{S\mathcal{P}}) = \varkappa_{F\mathcal{P}}$$

Feedfrom is a *system state-transition function*; such that, the state transition is defined from the product of *storeput* and the *storeput-control qualifiers* to *fromput*.

Feedfrom



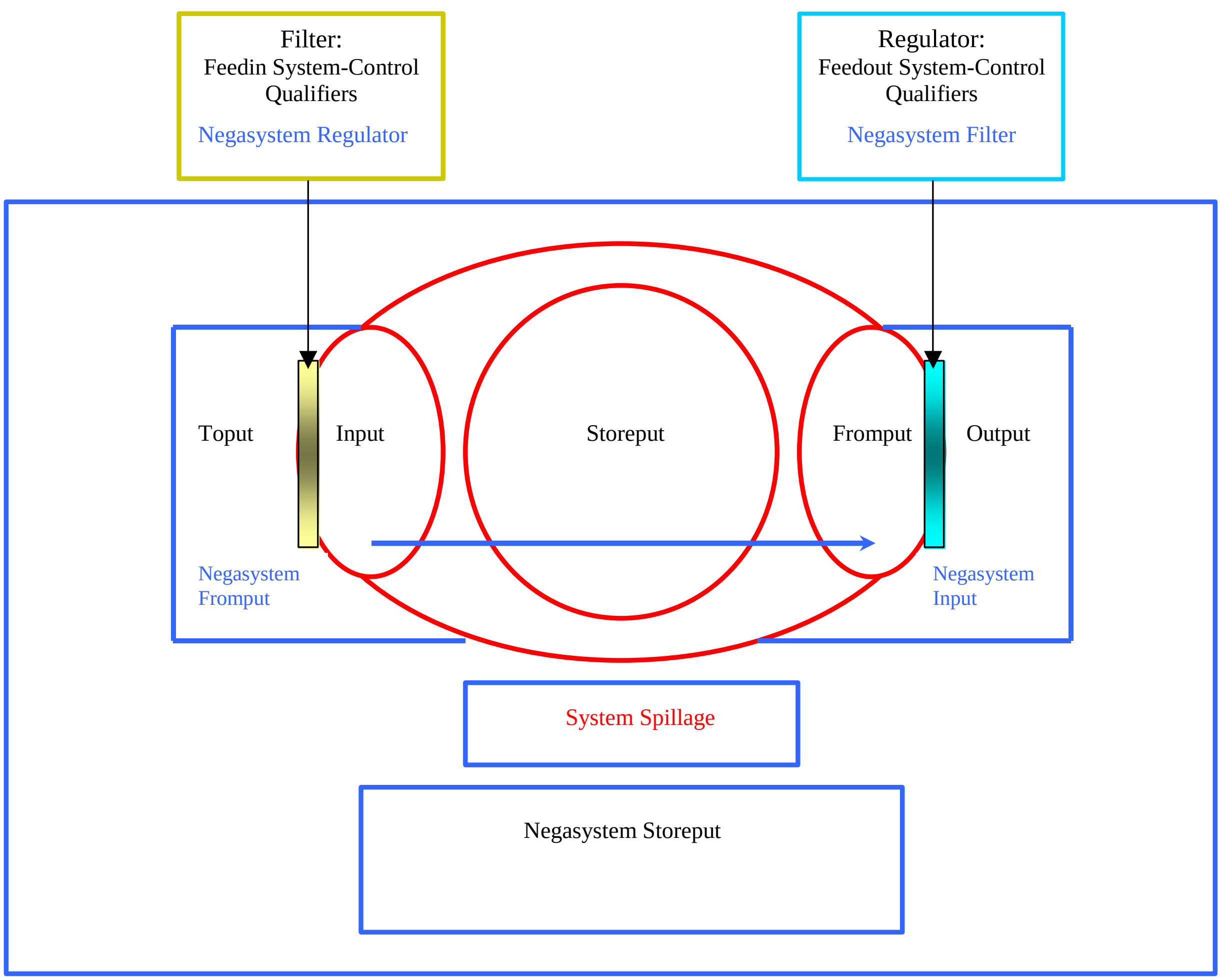
Feedfrom is shown as it is initiated in *storeput* and then transmitted to *fromput*. This is the transmission that moves the *derived production* of the system to *fromput* where it is made ready to be received by the *negasystem* in the *output*; that is, the *negasystem input* (see *derived production output*).

Feedintra, $\oint_{N}(\mathbb{S}_{x})$**,** $=_{df}$ Transmission of *input* to *fromput*.

$$\oint_{N}(\mathbb{S}_{x}) =_{df} \sigma(\mathbb{S}_{x}) \mid \sigma(x) = (\oint_{S} \circ \oint_{F})(x); \text{ that is, } \sigma(x_{I\mathcal{P}}) = x_{F\mathcal{P}}$$

Feedintra is a *system state-transition function*; such that, it is a composition of *feedfrom* and *feedstore*.

Feedintra



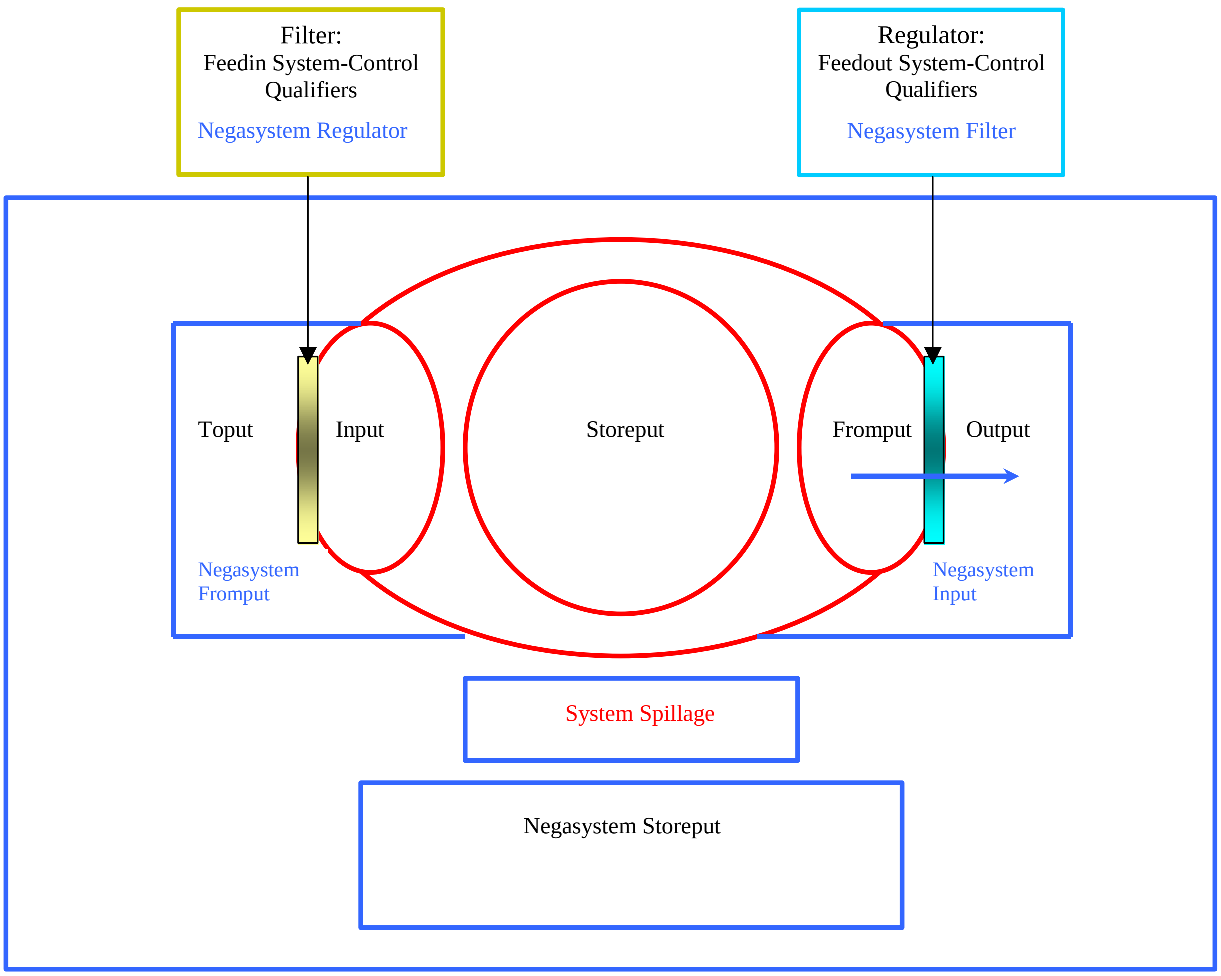
Feedin is shown as it is initiated in *toput* and transmitted to *input*. As seen here, *storeput* may influence the transmission to *fromput* by processes that produce *derived-production* (see *derived-production output*).

Feedout, $f_O(\mathbb{S}_{x})$, $=_{df}$ Transmission of system *fromput* to negasystem *output*.

$$f_O(\mathbb{S}_{x}) =_{df} \sigma(\mathbb{S}_{x}) \mid (\sigma : F_{\mathcal{P}} \times {}_{F\mathcal{P}}\mathcal{L}_{C} \rightarrow O_{\mathcal{P}})\text{; that is, } \sigma(x_{F\mathcal{P}}) = x_{O\mathcal{P}}$$

Feedout is a *system state-transition function*; such that, the state transition is defined from the product of *fromput* and the *fromput-control qualifiers* to *output*.

Feedout



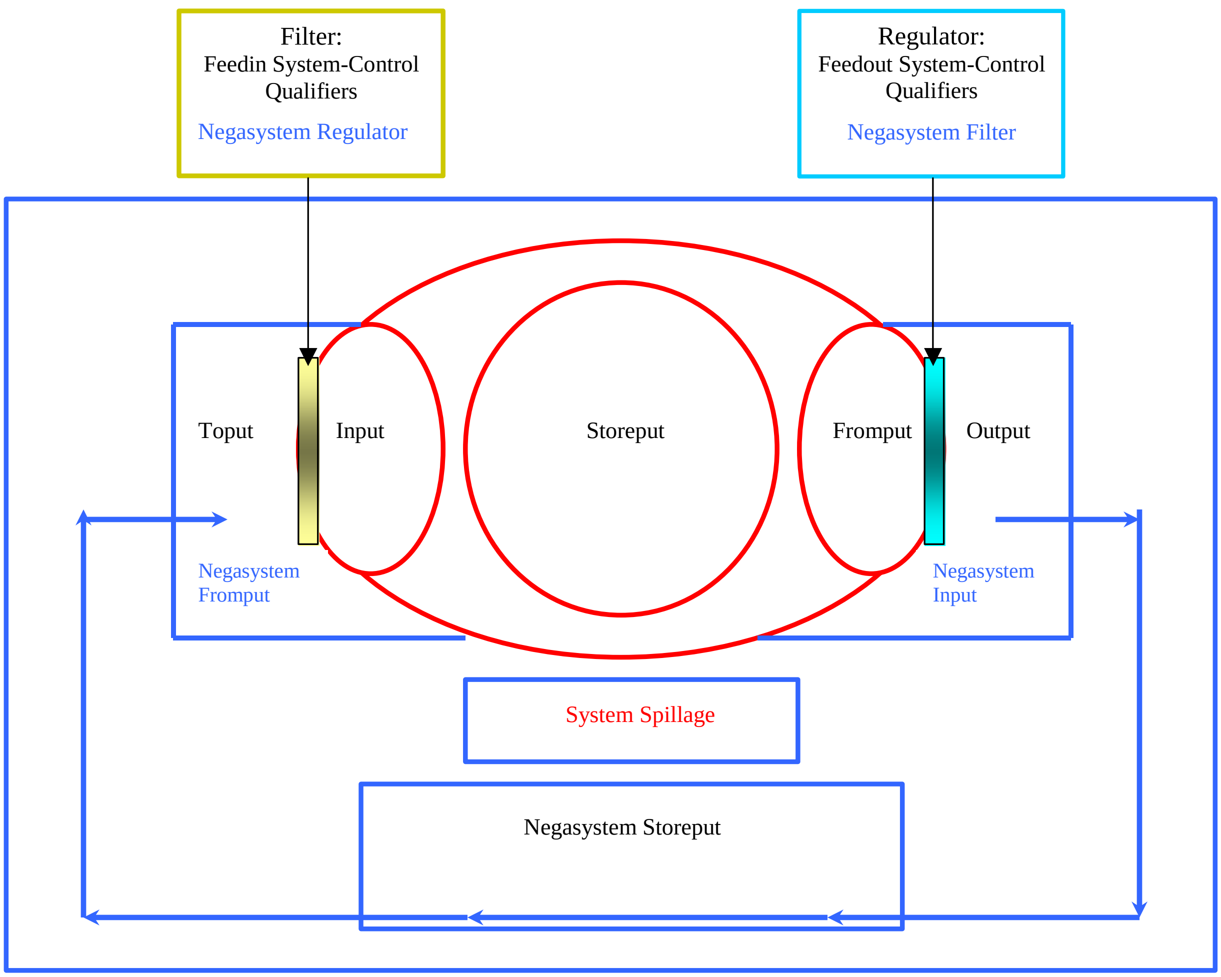
Feedout is shown as it is initiated in *fromput* and transmitted to *output*. As seen here, the *regulator* may influence *feedout* (see *regulation*).

Feedenviron, $f_E(\mathbb{S}_x)$, $=_{df}$ transmission of *output* (*negasystem input*) to *toput* (*negasystem fromput*).

$$f_E(\mathbb{S}_x) =_{df} \sigma(\mathbb{S}_x) \mid (\sigma : O_{\mathcal{P}} \times {}_{O\mathcal{P}}\mathcal{L}_{\mathcal{C}} \to T_{\mathcal{P}}); \text{ that is, } \sigma(x_{O\mathcal{P}}) = x_{T\mathcal{P}}$$

Feedenviron is a *system state-transition function*; such that, the state transition is defined from the product of *output* and the *output-control qualifiers* to *toput*.

Feedenviron



Feedenviron is shown as it is initiated in *output*, transmitted through the *negasystem* (*system environment*), and to *toput*. As seen here, *feedenviron* may be influenced by its transmission through the *negasystem* as a result of *negasystem derived production output* as it passes through the *negasystem storeput*.

Feedback, $\oint_B(\mathbb{S}_x)$**,** $=_{df}$ transmission of *fromput* through a negasystem to *input*.

$$\oint_B(\mathbb{S}_x) =_{df} \sigma(\mathbb{S}_x) \mid \sigma(x) = (\oint_I \circ \oint_E \circ \oint_O)(x)$$

Feedback is the result of a system state-transition function; such that it is a composition of feedout, feedenviron and feedin.

Positive and **negative feedback** definitions are as follows:

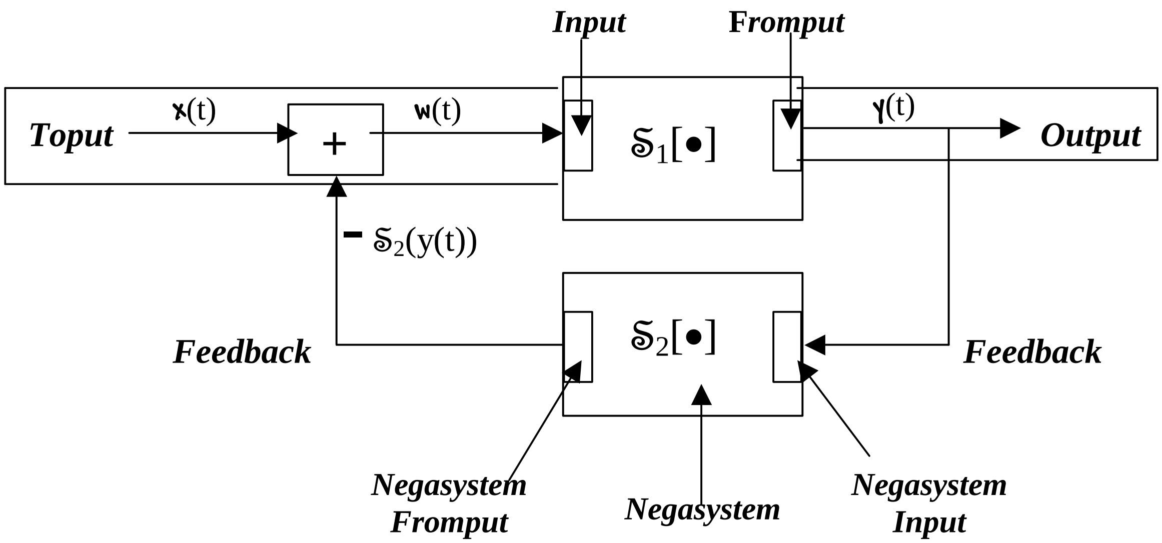
$$\oint^{+}_B =_{df} \mathcal{A}(\oint_O)_{t(1)} \prec \mathcal{A}(\oint_I)_{t(2)} \qquad \overline{\oint}_B =_{df} \mathcal{A}(\oint_O)_{t(1)} \succ \mathcal{A}(\oint_I)_{t(2)}$$

APT&C (Analysis of Patterns in Time), $\mathcal{A}$, analyses measure *positive* and *negative feedback*. APT&C analyses determine measures of *system state*, and a comparison of these measures before and after feedback determines positive or negative feedback.

Feedback was initially conceived as a process by which information is produced by a system that is then reintroduced into the system in a manner that helps the system self-regulate. *Feedback* in the physical sciences has been used to control various types of systems—temperature, fuel flow, electrical surges, float valves for water/liquid levels, and biological regulators. These types of feedback are quite basic; that is, they are measures provided to a system that induces the system to adjust its relation-set so as to re-establish its *set point*; that is, the initial desired system parameters.

If *feedback* produces no change, then it is a *Feedback Identity System*. If there were substantial modification of the *fromput* so that the *feedback* is not recognizable, then we would have a *Feedback Zero-Neutralized System*. Any modification of the initial *feedout* is the result of the negasystem's *derived production output*. For most, if not all, social systems, any initial *feedout* will be modified in some way, resulting in a *derived production input* that is distinctly different from the *fromput*. To understand this process, consider the *feedback diagram* shown below.

Feedback Diagram



Feedback is transmitted from *fromput* through *output* where it may be modified by the *negasystem* (system environment), $\mathbb{S}_2$, before being transmitted to *toput*, where it may modify other *toput* components, and then be transmitted into the system as *input*. The system, $\mathbb{S}_1$, responds to the feedback-modified-input by adjusting its system state parameters accordingly to maintain the initial *set point*.

Consider, for example, an *Identity Feedback System* characterized by an airplane autopilot. The *set point* is 270 knots, 10,000-foot altitude, and a heading of 175°. The airplane instrumentation provides the actual airspeed, altitude and heading as output.

For autopilot control we have the following: $\mathbf{x}(t) = (270, 10{,}000, 175°)$,
$\mathbf{y}(t) = \mathbb{S}_1(\mathbf{w}(t)) = (270, 10{,}000, 175°)$ — the airplane instrumentation readings,
$\mathbf{w}(t) = \mathbf{x}(t) - \mathbb{S}_2(y(t)) = (270, 10{,}000, 175°) - (270, 10{,}000, 175°) = (0, 0, 0)$; therefore,
$\mathbf{x}(t) - \mathbf{w}(t) = (270, 10{,}000, 175°)$. For an *Identity Feedback System*, where *output* equals *input*, no system adjustment is required.

However, if there is a change in *output* for any of these parameters, then we might have:
$\mathbf{y}(t) = \mathbb{S}_1(\mathbf{w}(t)) = (268, 9{,}500, 177°)$,
$\mathbf{w}(t) = \mathbf{x}(t) - \mathbb{S}_2(\mathbf{y}(t)) = (270, 10{,}000, 175°) - (268, 9{,}500, 177°) = (2, 500, -2)$;
therefore, $\mathbf{x}(t) - \mathbf{w}(t) = (268, 9{,}500, 177°)$. In this case, $\mathbb{S}_1(\mathbf{w}(t))$ must compensate for the 2 knots to bring it back up to 270 knots, the 500 feet to bring it back to 10,000 feet, and the -2° to bring it back to 175° which is the *set point*; that is, the controlling parameters.

In physical applications similar to that shown above, the *feedback* is the *output* determined by the system instrumentation and there are no additional modifications except that which may be required due to problems relating to the transmission of the data.

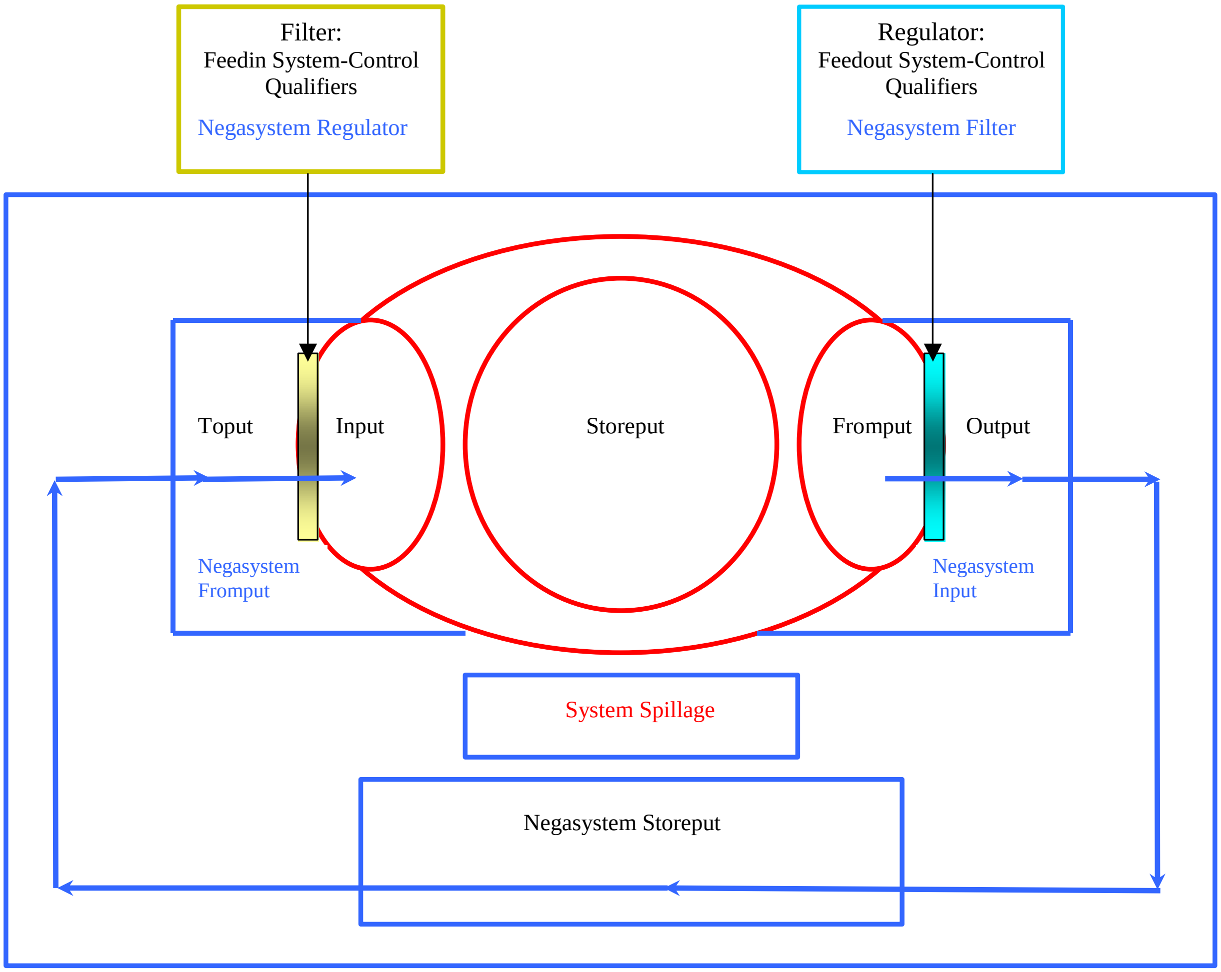
This is not the case when considering the intentional systems of the social sciences. For these intentional systems there may be substantial modification of the *output* before it is transmitted to the *toput* of the system. For example, the problems encountered by the founder of Cybernetics, the science of *feedback*, Norbert Weiner, is a classic example of disinformation that caused his own personal implosion that terminated what should have been a much more recognized scientific development. His own wife undermined his professional relations with his colleagues by providing him with the disinformation that his daughter had slept with those colleagues. He believed her and cut off all communications with them, thus destroying the very collaborations that had been promoting his scientific discoveries. In this case, the *output* from the system, which was benign, was grossly distorted and reintroduced into the "Norbert Weiner System" as *toput* that was internalized as *input*. With this internalization, the "Norbert Weiner System" responded to that disinformation as though it were true and acted on it, producing an *output* that destroyed the collaborative system that he had with his colleagues. In this case, the purported *feedback* could not actually be traced to the *output*, since the compatibility of the *output* and *toput* would essentially be zero. This is an example of a *Feedback Zero-Neutralized System*. If this type of feedback had been provided to the autopilot in the previous example, the airplane would have "adjusted" by climbing rapidly to 20,000-feet, while turning almost 180° in the opposite direction while attempting to obtain 536 knots, possibly outside the range of the engine. Under these conditions, the airplane as a system would be destroyed—as was the "Norbert Weiner System."

From the applications in the physical sciences considered above, it is seen that we have essentially ignored the impact of the *negasystem* (environment) on the system *output*. The reason is that the *negasystem* has had minimal impact on the *toput* that resulted from the *feedback*. This is not the case with *Intentional Systems*. In these cases the *negasystem* must be treated as a system with all of the possible affect relations that may be established. This is especially the case when considering the *negasystem* property for *derived production output*. *Derived-production output* is defined as follows:

Derived-production output, $_{DP}\mathcal{f}_{T}$, $=_{df}$ Feedthrough with a high dissimilarity of toput and output in which output is significantly more complex.

The greater complexity of *intentional system feedback* is shown in the diagram below.

Feedback



Feedback is shown as it is initiated in *fromput*, transmitted to *output*, then through the *negasystem* (*system environment*), to the system *toput*, and finally transmitted to *input*. As seen here, *feedback* may be influenced by its transmission through the *negasystem*. While many representations of *feedback* show only the loop exiting the system, curving around in the environment, and then re-entering the system, for *ATIS*-type systems; that is, those concerned with *intentional systems* and especially social systems, the *environment* will practically always have a substantial influence on the *feedback*. For that reason, the partitions of the *negasystem* are shown as the *feedback* is transmitted through each partition. From this transmission, it is seen that the *regulator* may influence *feedback*, as also will the *negasystem derived production output* as it passes through the *negasystem storeput*, and then by the *filter* as it re-enters the system (see *regulation* and *filtration*).

In the case of *feedback* with respect to the system, $\mathbb{S}_1$, the *output* is the *input* for the negasystem, $\mathbb{S}_2$. For *Intentional Systems*, this *input* can undergo significant changes as a result of $\mathbb{S}_2$ action. $\mathbb{S}_2$ action can produce *derived-production output* that is significantly different from the *input*. When it does so, that is the *feedback* that is transmitted to $\mathbb{S}_1$ for *input*; that is, $\mathbb{S}_2$ produces *derived-production input* for $\mathbb{S}_1$.

For example, the empirical evidence confirms that human activity is insignificant in terms of any contribution to the phenomena of *global warming*. However, the *Intentional System* represented by the Atmospheric Scientists has a goal of raising money for atmospheric research. Hence, the *feedback* to the *General Public System* is that there is a problem with human activity relating to global warming that needs to be funded so the Atmospheric Scientists can continue to obtain research income. In this case, the *negasystem* has created *derived production output* that is substantially different and more complex than the research results that were used to produce the *output*. (It should be noted that any manipulation, revision, construction, etc. of *input* will result in an *output* that is more complex by the very nature of such activity.)

Another example is the initiation of the Viet-Nam War. The Gulf of Tonkin Incident never occurred, and yet it was used as the basis to initiate the war. Again, there was *derived-production output* created to achieve a goal of an *Intentional System*, the American Government, which was significantly different from the *output* of the *Viet-Nam System* from which the input to the *American General Public System* was derived.

For school systems, one must always be alert for *derived-production output* being submitted as *toput* for a system. Frequently, these come in the form of promoting various "agendas." Such agendas may relate to efforts to preclude the closing of a school, the hiring of new teachers who may embellish their résumés, the claims made by new instructional programs or the promotion of text books, the financial needs of a school system demanding increased taxes, etc. Students may graduate who wish to support or harm the efforts of the school system. Such efforts are compromised by whatever *derived production output* these students wish to present to support the goals of their own *Intentional Systems*. Are they trying to redefine science so that mathematics is no longer a filter for students to take physics? Are they trying to redefine science so that intelligent design can "compete" with evolution? Whatever the goal is of an *Intentional System*, one must be careful to critically analyze the *derived-production output* of such systems.

To a great extent, and more so than in the physical sciences, the *derived-production output* of the *negasystem* of *Intentional Systems* is responsible for the *positive* and *negative feedback* obtained by the *Intentional System*.

Feedthrough, $\oint_T(\mathbb{S}_x)$, $=_{df}$ transmission of negasystem *toput* through a system to negasystem *output*.

$$\oint_T(\mathbb{S}_x) =_{df} \sigma(\mathbb{S}_x) \mid \sigma(x) = (\oint_O \circ \oint_N \circ \oint_I)(x);\ \text{that is, } \sigma(x_{T\mathcal{P}}) = x_{O\mathcal{P}}$$

Feedthrough is defined as a *system state-transition function*; such that it is a composition of *feedin*, *feedintra* and *feedout*.

Positive and **negative feedthrough** definitions are as follows:

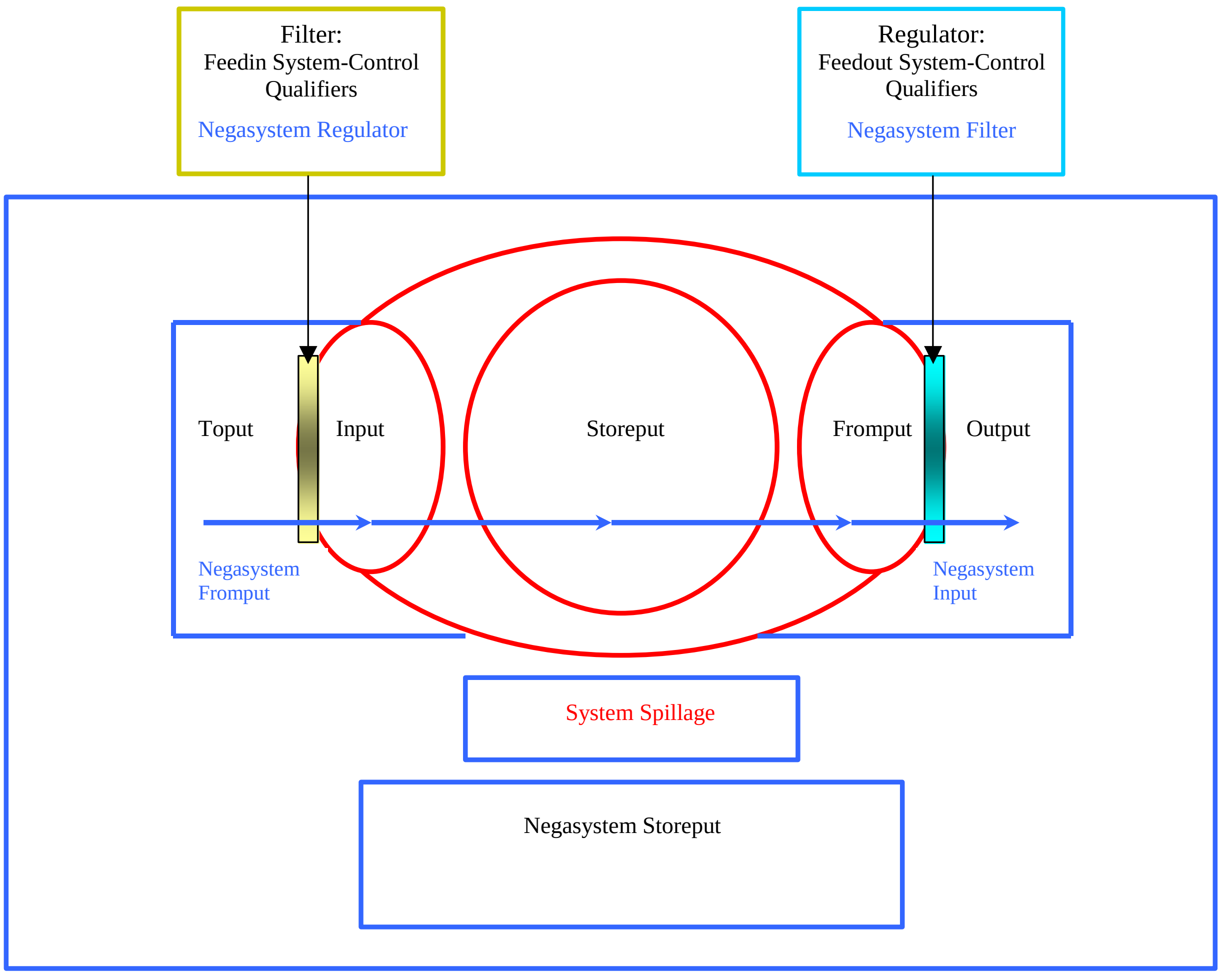
$$\oint^+_T =_{df} \mathcal{A}(\oint_I)_{t(1)} \prec \mathcal{A}(\oint_O)_{t(2)} \qquad \bar{\oint}_T =_{df} \mathcal{A}(\oint_I)_{t(1)} \succ \mathcal{A}(\oint_O)_{t(2)}$$

APT&C (Analysis of Patterns in Time and Configuration), $\mathcal{A}$, analyses measure *positive* and *negative feedthrough*. These analyses determine measures of *system state* and a comparison of these measures before and after feedthrough determines positive or negative feedthrough.

Feedthrough is *feedback* with respect to the *negasystem*. As such, the report provided for *feedback* also applies for *feedthrough*. For *feedthrough*, however, there are products on the market that are called 'feedthroughs'. One such *feedthrough* is shown below. As the name indicates, the object is to "feedthrough" something from one side to the other, through the connecting "system." As with *feedback*, if there is no change as a result of the *feedthrough*, then it is a *Feedthrough Identity System*. If, there were substantial modification of the *input* so that the *feedthrough* is not recognizable, then we have a *Feedthrough Zero-Neutralized System*. Any modification of the initial *feedin* is the result of the system's *derived production output*. For most, if not all, social systems, any initial *feedthrough* will be modified in some way, resulting in a *derived production output* that is distinctly different from the *toput*. As a result, *feedthrough* will be modified so that there is a reduced commonality of *toput* and *output*.

The FC-VFT vacuum feedthroughs are designed for use of fiber optics in vacuum chambers, such as for plasma monitoring. The vacuum feedthrough consists of an M12 housing with Viton® O-ring and 2 SMA fiber optic interconnects to allow easily coupling to fiber optic cables and probes. The vacuum feedthrough can be delivered for all fiber diameters, such as 50 µm up to 1000 µm for UV/VIS as well as for VIS/NIR. (This is a product of Avantes, Inc., 9769 W. 119th Dr., STE 4, Broomfield, CO 80021. http://www.avantes.com/)

Feedthrough



Feedthrough is shown as it is initiated in *toput*, transmitted to *input*, then to *storeput*, then to *fromput*, and then transmitted to *output*. As seen here, both the *filter* and *regulator* may influence *feedthrough*, as well as the *production process* of *storeput* (see *filtration*, *regulation*, and *derived production output*).

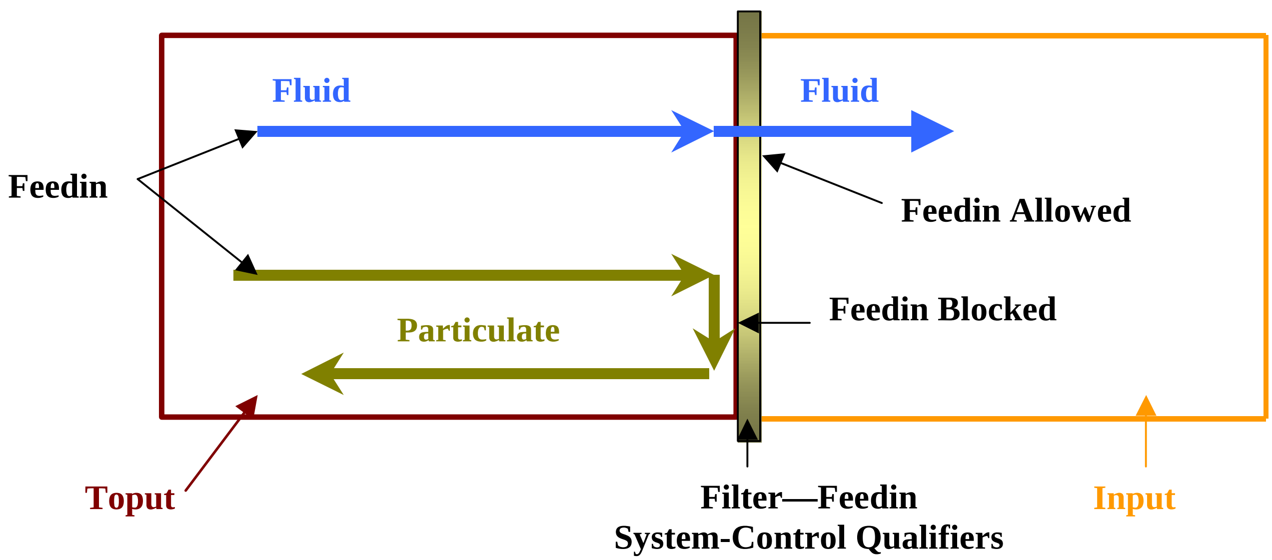
Dynamic Behavior-Controlling Properties

Filtration, $\mathscr{F}(\mathbb{S})$**,** $=_{df}$ the set of *toput system-control qualifiers* that control *feedin* of *toput*.

$$\mathscr{F}(\mathbb{S}) =_{df} \{P(\varkappa) \mid P(\varkappa) \in T\mathcal{P}\mathcal{LC} \wedge A^{\mathcal{F}iltration}\sigma_{\varkappa}\, (\sigma_{\varkappa}: T_{\mathcal{P}} \times T\mathcal{P}\mathcal{LC} \to (T_{\mathcal{P}}, I_{\mathcal{P}}))$$

Filtration, is a set of predicates, $P(\varkappa)$; such that, $P(\varkappa)$ is an element of the *toput system-control qualifier*, and the *ATIS—Filtration Quantification* with respect to the *system transition function* is such that, the *transition function* maps *toput* to itself or to *input*.

Filtration



Filtration is a separation process by which certain *toput* is blocked from entering the system. *Filtration* is the result of *System-Control Qualifiers* allowing certain *toput* to enter the system while blocking other *toput*; for example, a fluid is presented as *toput* and is allowed to enter while precluding the entry of other *toput* components; for example, particulates that happened to have commingled with the fluid. In this case, the *filter* could be a membrane. In the case of education systems that control the *input* of students, the filter is, first, the rules that allow student entry, and possibly physical barriers that physically preclude certain individuals from entering a school building.

Filtration is the control of *toput* by the blocking of feedin and not the selection of toput. For example, in the above example, the particulates were "selected" for toput when the fluid was "selected," even though not intended. Filtration blocked the unintended toput. Filtration is the active blocking of unacceptable or unintended toput that is attempting to enter the system.

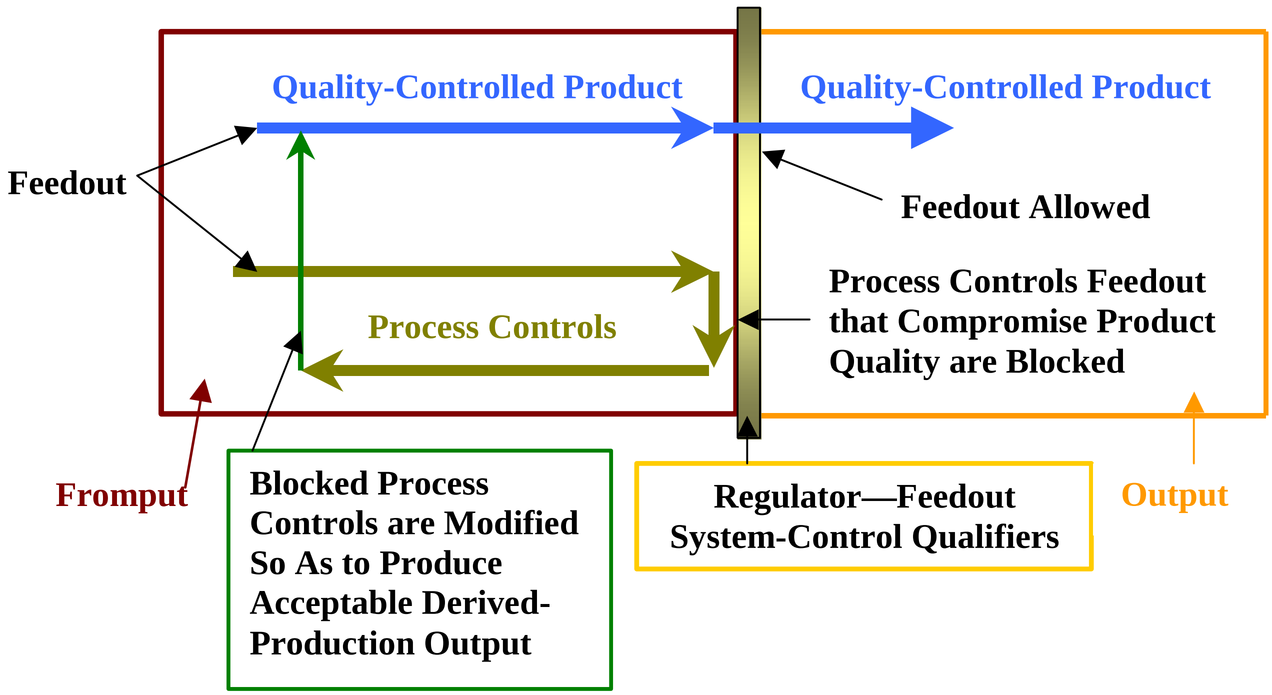
Regulation, $\mathcal{R}(\mathbb{S})$**,** $=_{df}$ the set of fromput system-control qualifiers that control *feedout* and adjust *fromput process controls* to within acceptable limits.

$$\mathcal{R}(\mathbb{S}) =_{df} \{P(x) \mid P(x) \in \mathcal{L}_{\mathcal{C}} \wedge [\Delta\mathcal{B}(\mathbb{S}')_{t(1) \to t(2)} \Vdash \mathcal{S}_{t(1)} \equiv \mathcal{S}_{t(2)}]\}$$

Regulation, is a set of predicates, $P(x)$; such that, $P(x)$ is an element of the *control qualifier set*, and a change in negasystem behavior yields an equivalence of system state at time t_1 and t_2.

A chart explaining **regulation** is shown on the next page.

Regulation



Regulation is a separation process by which certain *frompu t* is blocked from leaving the system. *Regulation* is the result of *Negasystem-Control Qualifiers* allowing certain *frompu t* to leave the system while blocking other *frompu t*; for example, government regulations, retail store quality standards, or delivered goods returned to the manufacturer. In the case of education systems the *No Child Left Behind Act*, *State Proficiency Tests*, *Teacher Qualifying Exams* and other regulations are instituted to control product quality; that is, the graduating credentials of the students.

Regulation is the control of *frompu t* by the blocking of *frompu t* and not the selection of *frompu t*. For example, in schools, students are automatically presumed to be frompu t when they near their graduation date, but regulation may block the actual graduation due to not fulfilling course requirements, leaving school, etc. *Regulation* is the active blocking of unacceptable or unintended *frompu t* that is attempting to leave the system.

Regulation is the control of derived-production output with respect to both the products themselves as well as the standards and production processes by which the products are made.

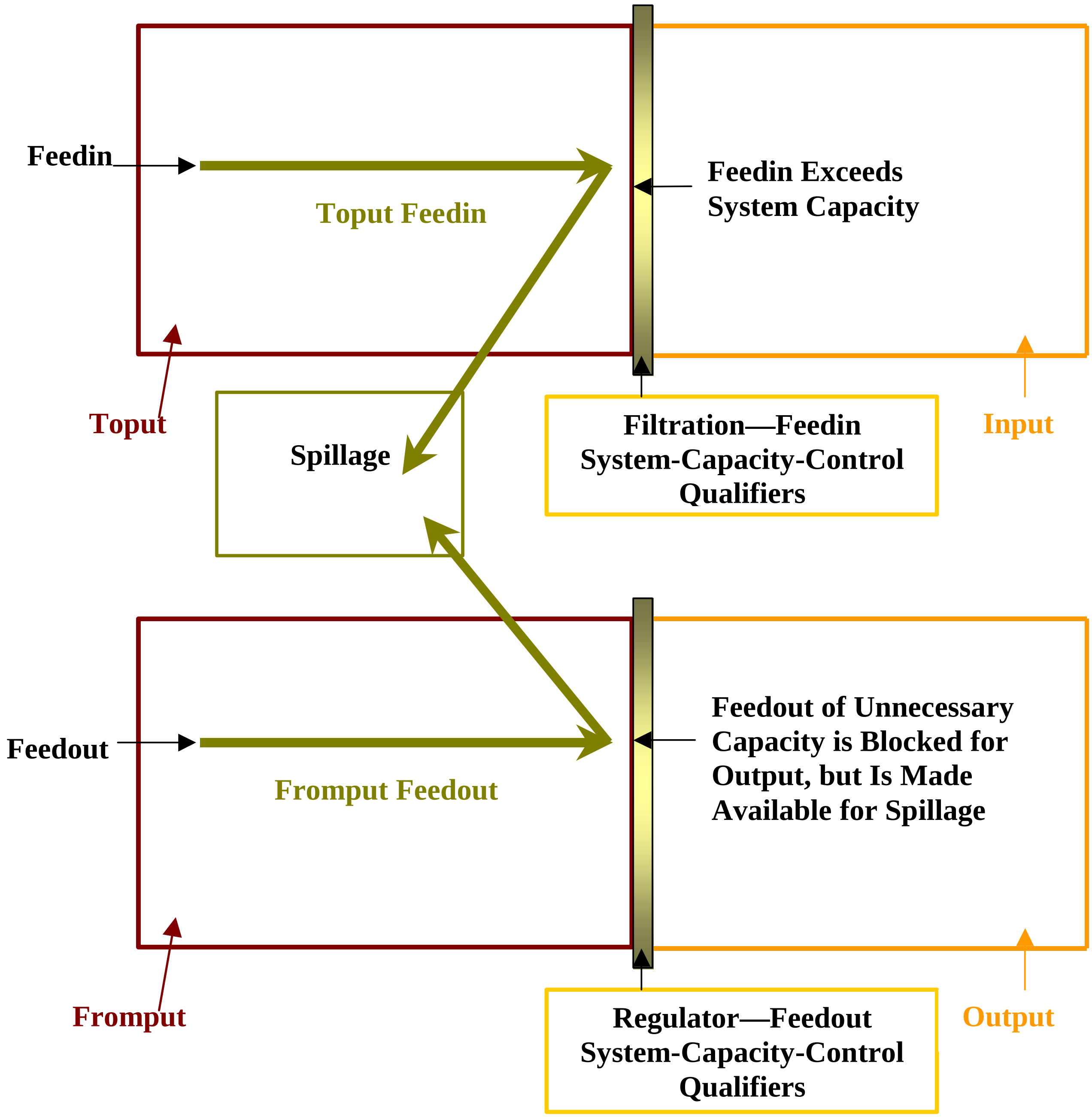
Spillage, $\mathscr{S}(\mathbb{S})$**,** $=_{df}$ feedin that is blocked by the feedin system-capacity-control qualifier of filtration or feedout system-capacity-control qualifier of regulation.

$$\mathscr{S}(\mathbb{S}) =_{df} \{x \mid {}^{capacity}\mathscr{L}_{\mathcal{C}}\langle \mathscr{F}_x(\mathbb{S})\rangle = \top \vee {}^{capacity}\mathscr{L}_{\mathcal{C}}\langle \mathscr{R}_x(\mathbb{S})\rangle = \top\}$$

Spillage is defined as a set of components such that; x satisfies the predicate that defines the system-capacity-control qualifier of filtration or the system-capacity-control qualifier of regulation.

A chart explaining **spillage** is shown on the next page.

Spillage



Spillage is the result of *System-Capacity-Control Qualifiers* not allowing *feedin* to exceed system capacity, and allowing *feedout* to place in *spillage* that which is not provided for *feedout*. (1) In the first instance, it is as though a person is drinking too fast for the capacity of intake and spills what cannot be consumed. Maximum-capacity is exceeded. (2) In the second instance, it is the nutrients in the intestine that are not required for sustenance, but are made available to the commensal bacteria for their benefit. The nutrients are not available for expulsion from the system, but are made available in spillage as nutrients not required for the system. Minimal-capacity requirements are maintained. Another example of *spillage* is pilfering by company employees. The taking of pens, supplies, etc. generally does not affect the company operation, and is not *output* of the company. This pilfering is the acquisition by employees of *spillage*.