

# Outtakes



**Understand yourself**  
 —  
**You are a purposeful controller**

Approaches to introductions to  
**Perceptual Control Theory (PCT)**

**A new foundation for the sciences of life**

**Dag Forssell, MSME, MBA**

I created a succession of five presentations, late 2016 through mid 2019.

First: *The Rubber Band Experiment in action.*

Well received, but time-consuming; not enough context to tell the story.

Page 3 provides a highly condensed illustration, with references.

Second: *Spelling out the scientific basis of PCT*

Critique: Too long! Too theoretical! What is in it for me? Tell your own story!

Pages 4–15 represent this presentation.

Third: *Story with focus on psychology*

Critique: No criticism [of psych], please! Make it interesting for everyone.

Pages 16–18 deal with criticism of psychological science. (Restored in 2019)

Fourth: *Know Yourself—Understand how you function*

The revolutionary insight of PCT is relevant throughout the life sciences. Story of interest to everyone. Clarity about descriptive vs generative theories and progress in coming decades and centuries.

Fifth: Understand yourself—*You are a purposeful controller*

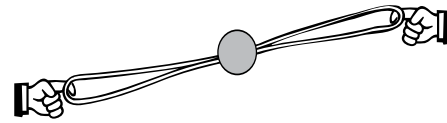
Now much more emphasis on scientific revolutions because otherwise PCT is preposterous. Control is the explanation for purpose, and purpose is much more acceptable, so I make that connection repeatedly. Interpretation sci method moved.

Dag Forssell, June 2019

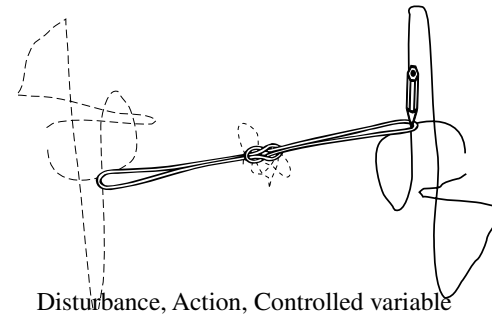
For the current presentation, see <http://www.livingcontrolsystems.com/intro>

# The Rubber Band Experiment

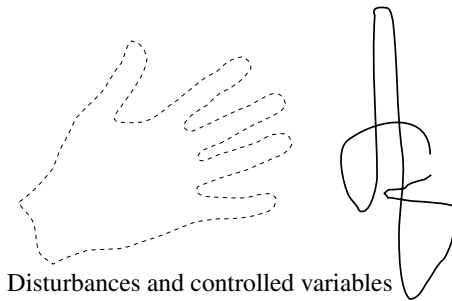
*Take two rubber bands, knot them together, and experiment with a partner...*



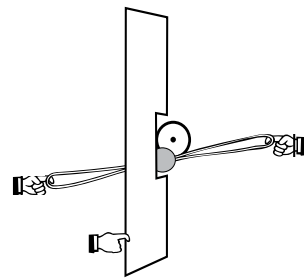
*The scientific method, correctly considering four elements of a control system: Disturbance, Reference, Action, and controlled Variable becomes the Test for the Controlled Variable (TCV).*



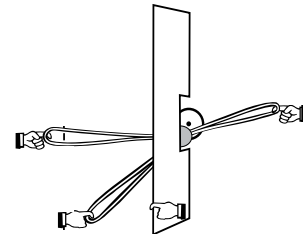
Disturbance, Action, Controlled variable



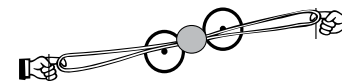
Disturbances and controlled variables are normally hidden from view



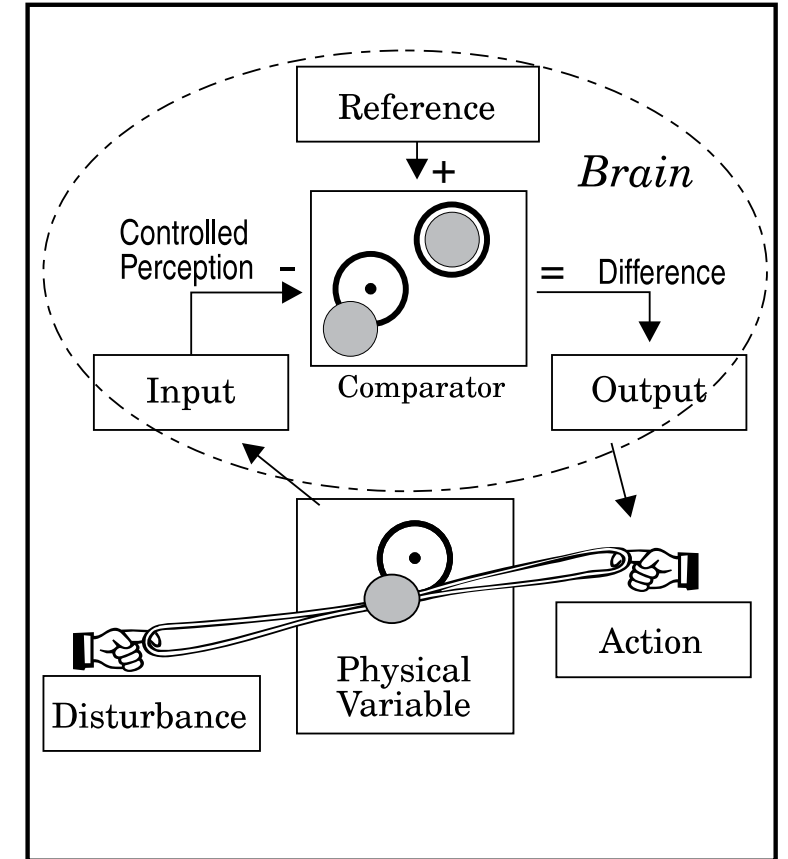
Disturbance hidden



Multiple disturbances



Conflict gets exhausting



Images excerpted from illustrated script: <http://www.livingcontrolsystems.com/RubberBand/RubberBand.pdf>

See also page 331 ff in the *Book of Readings and Resources* <http://www.livingcontrolsystems.com/readings/readings.html>

The Rubber Band Experiment provides plenty of surprise and insight as you play with it.

## Notes

Bill Powers is one of the clearest and most original thinkers in the history of psychology. For decades he has explored with persistence and ingenuity the profound implications of the simple idea that biological organisms are control systems.

His background in engineering allowed him to avoid many of the traps that have victimized even the best psychologists of the past.

I believe his contributions will stand the test of time.

*Henry Yin, Ph.D. Professor of  
Psychology & Neuroscience,  
Duke University, NC*

It takes a certain genius for a person to create something about which other people say to themselves “How obvious. Why didn’t I think of that?” Once you understand it, you cannot easily go back to your previous way of seeing the world.

Perceptual Control Theory (PCT) is a creation of that kind.

However, simple exposure is not by itself sufficient for one to “see it”, as my own experience attests.

You have to explore it for yourself, and you probably will not do that unless you have some reason to believe the exercise will be worth the effort.

*Martin Taylor, Ph.D., P.Eng*

Bill Powers’ work in the 20th century will prove to be as important for the life sciences as Charles Darwin’s work in the 19th century.

*Frans X. Plooi, Ph.D.*

PCT is an innovation that destroys expertise on a massive scale

*Mats Lundqvist, Ph.D.  
Head, Chalmers University  
School of Entrepreneurship*

# Perceptual Control Theory

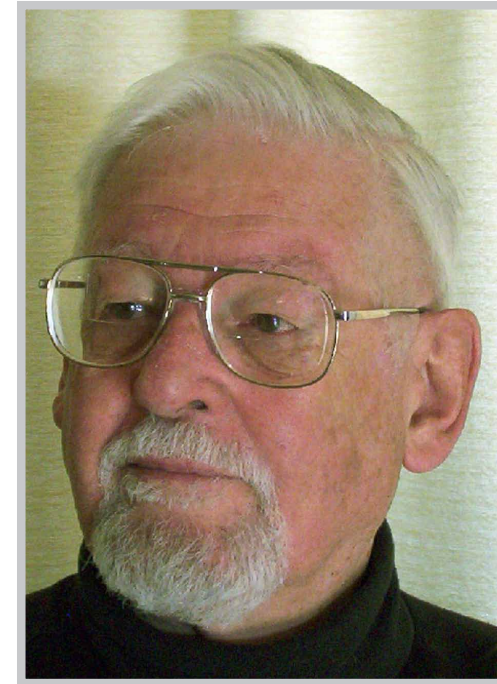
*“If I can’t swallow the basis for an argument, I just can’t see any point in hearing the whole tedious thing worked out.”*

*It is all about Fundamentals*

<http://www.iapct.org/powers.html>

[http://www.livingcontrolsystems.com/authors/about\\_powers.html](http://www.livingcontrolsystems.com/authors/about_powers.html)

[livingcontrolsystems.com](http://livingcontrolsystems.com)



William T. (Bill) Powers  
1926 – 2013  
Originator of PCT

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Student of PCT since 1989.  
Archivist & videographer,  
Control Systems Group.  
Publisher of 10 books on  
Perceptual Control Theory.  
Mechanical Engineer, MBA

*“If you want to understand  
what behavior is, how it works,  
and what it accomplishes, PCT  
is the only game in town.”*

[http://www.livingcontrolsystems.com/authors/about\\_forssell.html](http://www.livingcontrolsystems.com/authors/about_forssell.html)

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Dag C. Forssell  
1940 –

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# Life / Origin

## *The origins of purpose: the first metasystem transitions*

### ABSTRACT

This speculative essay concerns the origins of purposive behavior and **proposes that this is identically the origin of life.** Negative feedback and control offer a self-selecting mechanism that accounts for the long-term stability of replication of the genome, and a related concept of reorganization offers a rationale for the progress of evolved forms into those which exert greater and greater control over the local environment. A picture emerges in which the basic principle of control runs like a unifying thread from the first living molecules to modern complex organisms.

William T. Powers

in:

World Futures vol. 45 (special issue on The Quantum of Evolution, Heylighen F., Joslyn C. & Turchin V. (eds.)), p. 125-138 (1995)

### ABSTRACT

This speculative essay concerns the origins of purposive behavior and proposes that this is identically the origin of life. Negative feedback and control offer a self-selecting mechanism that accounts for the long-term stability of replication of the genome, and a related concept of reorganization offers a rationale for the progress of evolved forms into those which exert greater and greater control over the local environment. A picture emerges in which the basic principle of control runs like a unifying thread from the first living molecules to modern complex organisms.

### Introduction

The concept of purpose has been in disrepute among scientists since they began to substitute a universe with properties for a universe run to suit the unfathom-

### Control

In the following I will employ a concept of control that is different from, but perhaps not inconsistent with, the concepts put forth by Joslyn, Turchin, and Heylighen in this compendium. The kind of control I mean is what Joslyn calls control-sub-2—closed-loop feedback control, not control-sub-1, which is merely the attainment of an equilibrium condition or the appearance of a causal dependency. There is certainly a principle of mutual constraint at work between a system that controls and an environment that is controlled. But this mutual constraint is not symmetrical. The reason for the asymmetry lies in a property of control systems called amplification.

A control system senses some aspect of its environment and produces actions bearing directly on that aspect. With only this much definition, it would seem that the environment affects the control system just as much as the control system affects the environment, and that this relationship is symmetrical.

Ref: [http://www.livingcontrolsystems.com/intro\\_papers/evolution\\_purpose.pdf](http://www.livingcontrolsystems.com/intro_papers/evolution_purpose.pdf)

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Notes

# Biochemistry / Enzymes

## BIOCHEMISTRY-LEVEL CONTROL

The requirements for making a biochemical negative feedback control system are not complicated. Consider Figure 1, from *The dynamic analysis of enzyme systems* by Hayashi and Sakamoto<sup>2</sup>. The diagram shows a biochemical system in which an enzyme catalyzes the rate of one stage of the main reaction from substrate A through X1 to X4, and in which effects of the last product in the chain are connected back to the enzyme, so that the final stage of the reaction affects a prior stage.

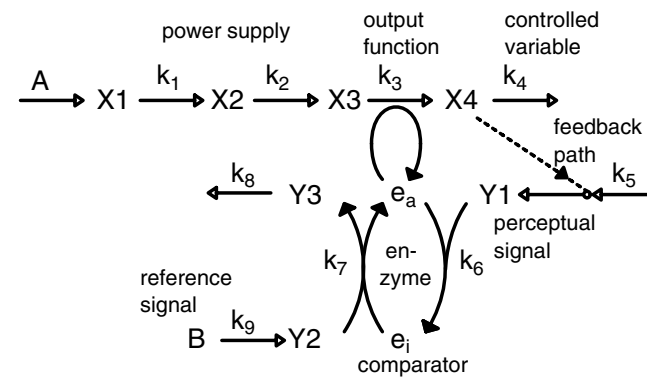


Fig. 1. Biochemical system with annotations suggesting functions in a standard negative feedback control system. X4 is the controlled variable. Redrawn from Hayashi and Sakamoto.<sup>2</sup>

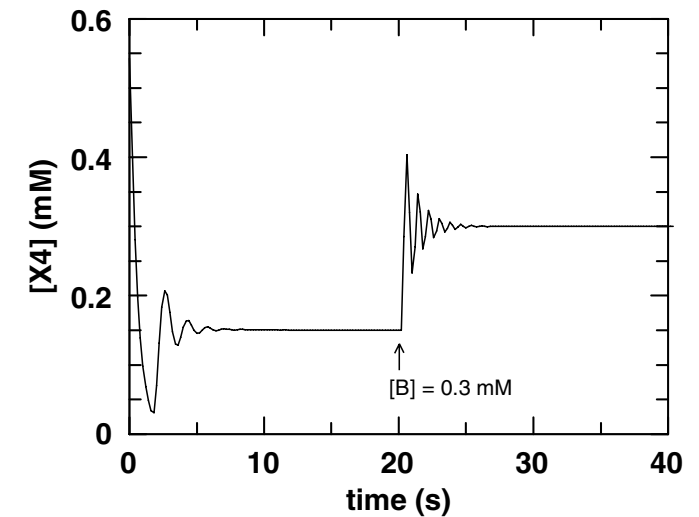


Fig. 2. Simulation of system in Fig. 1.

Ref: [http://www.livingcontrolsystems.com/intro\\_papers/neglected\\_phenomenon.pdf](http://www.livingcontrolsystems.com/intro_papers/neglected_phenomenon.pdf)

# Control within living cells



Opinion

TRENDS in Cell Biology Vol.15 No.6 June 2005

Full text provided by www.sciencedirect.com



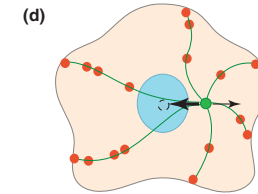
## How dynein helps the cell find its center: a servomechanical model

Richard B. Vallee and Stephanie A. Stehman

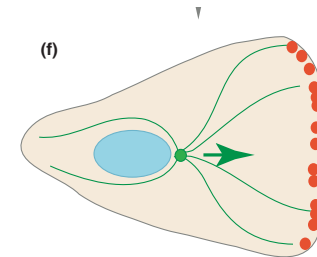
Departments of Pathology & Anatomy and Cell Biology, Columbia University College of Physicians and Surgeons, P&S 15-409, 630 W 168th St, New York, NY 10032, USA

Cytoplasmic dynein is the major minus-end-directed microtubule motor protein in interphase cells. In addition to its well-established roles in vesicular transport and chromosome dynamics, cytoplasmic dynein also associates with the cell cortex. From this site, it appears to pull on the cytoplasmic microtubule network, influencing mitotic spindle orientation, nuclear position and other aspects of cell polarity and organization. Recent evidence indicates that the cell has the remarkable ability to calculate its geometric center, and, with the help of dynein, to position the centrosome at this central site. Here, we outline models to account for this behavior.

“...cortically exerted forces would balance when the centrosome is at the cell center... and serve as a mechanical calculator of centroid position”



“A surprising outcome of this model is its implications for understanding the role of dynein at the leading edge of migrating cells.”



Source: <https://www.ncbi.nlm.nih.gov/pubmed/15953546>

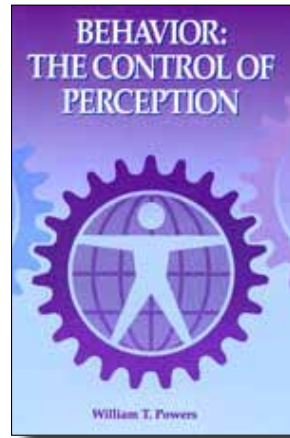
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These researchers understand control and recognize that it operates inside living cells.



# Neural currents perform



## Chapter 3 Premises

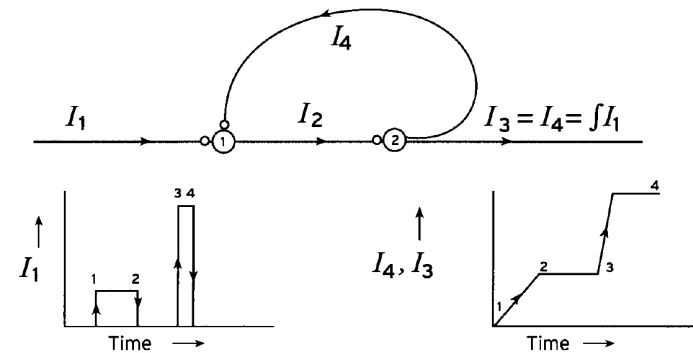


Figure 3.7. Time-integrator

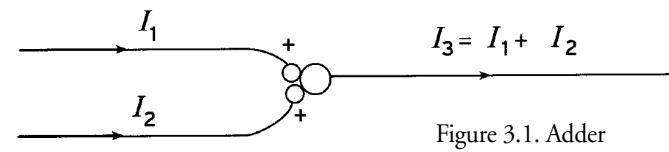


Figure 3.1. Adder

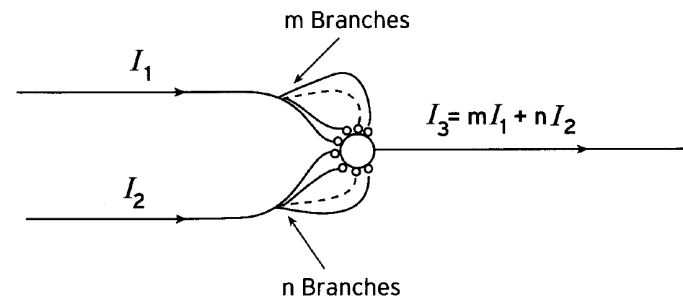


Figure 3.5. Weighted summation

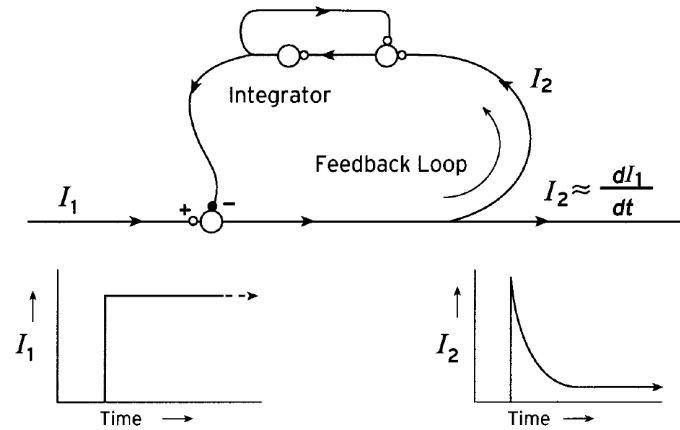
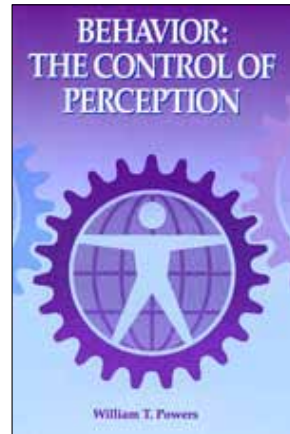


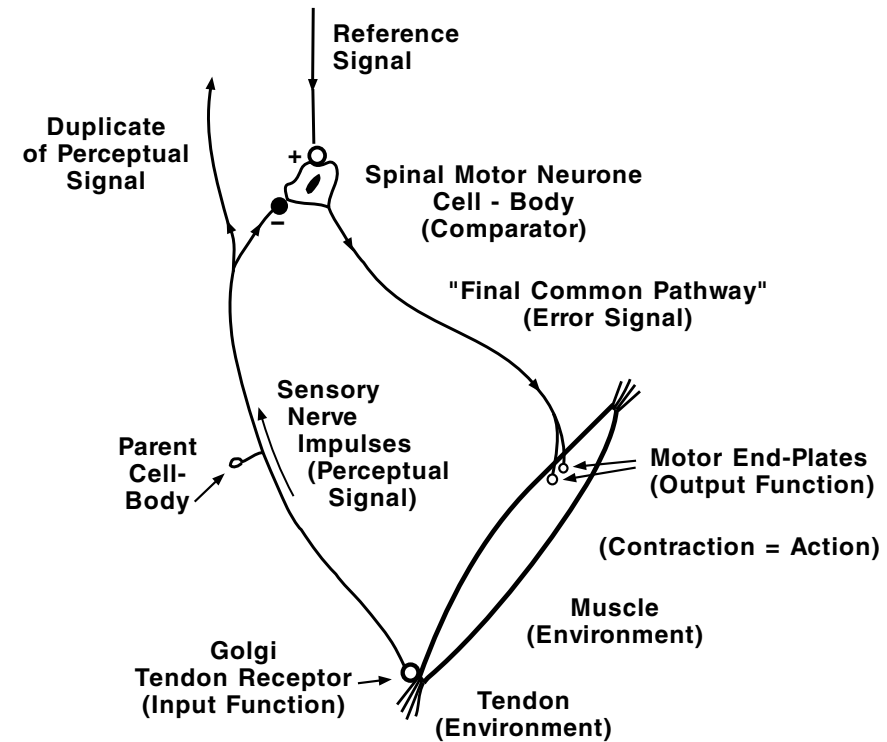
Figure 3.9. Differentiator: Using integrator in feedback loop

Chapter reproduced in the *Book of Readings and Resources* <http://www.livingcontrolsystems.com/readings/readings.html>



Chapter 7  
First-Order Control Systems:  
Intensity Control

# Control Loop



The basic first-order control system;  
the tendon reflex loop. (Powers, 1973, 2005).

# Inverted pendulum

PCT makes it so simple!  
(We are inverted pendulums  
when we stand and walk about.)



Figure 1: An inverted pendulum

[http://www.livingcontrolsystems.com/demos/tutor\\_pct.html](http://www.livingcontrolsystems.com/demos/tutor_pct.html)  
scroll down to  
*Inverted Pendulum — DOS and Windows* by Bill Powers  
for both program and documentation

[www.livingcontrolsystems.com](http://www.livingcontrolsystems.com)

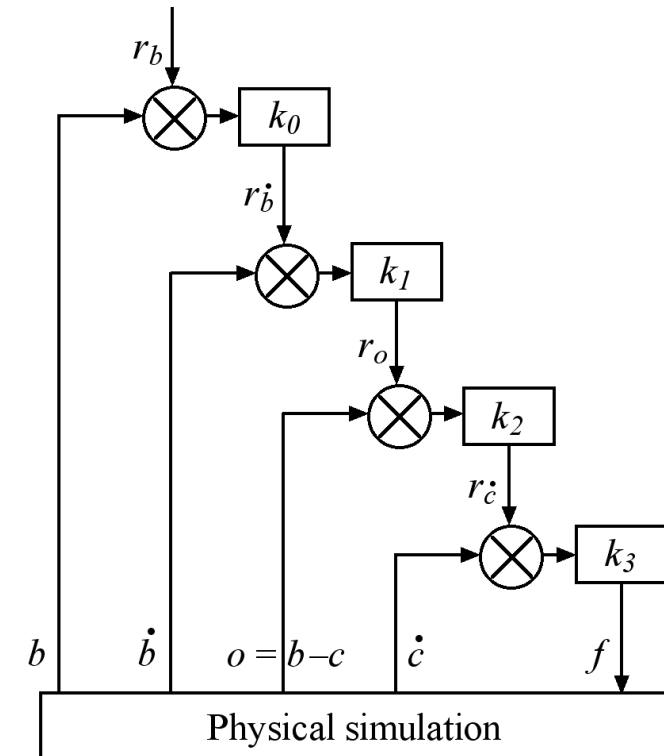
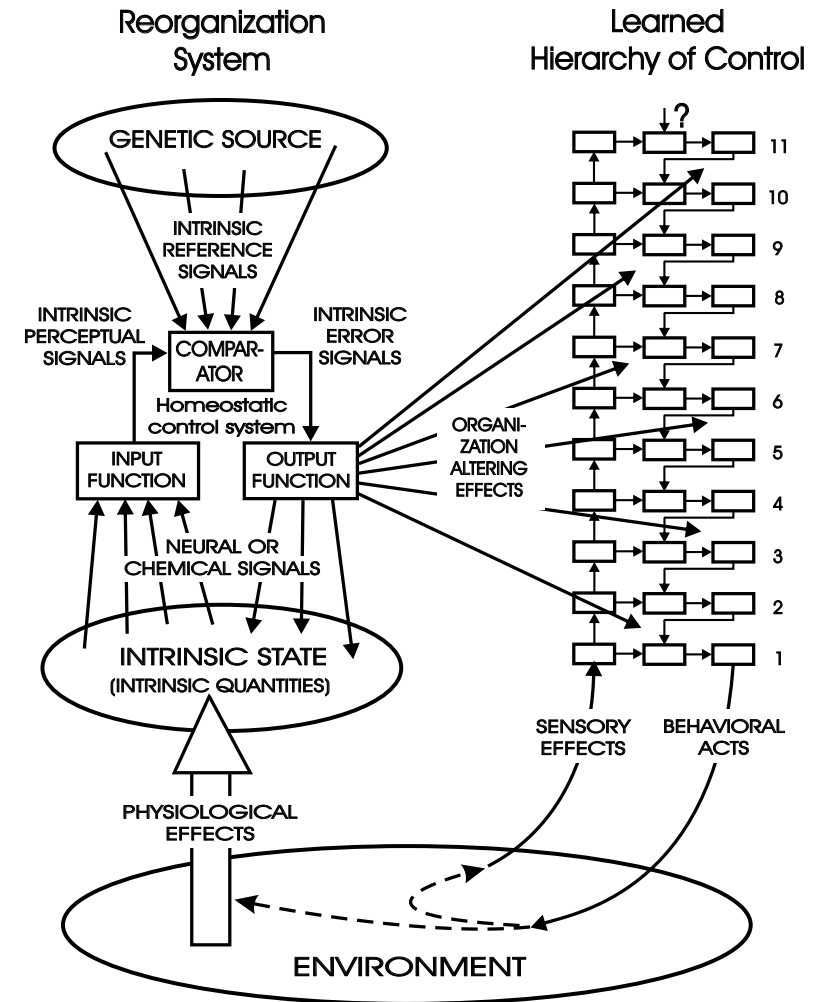


Figure 2: Control hierarchy for inverted pendulum

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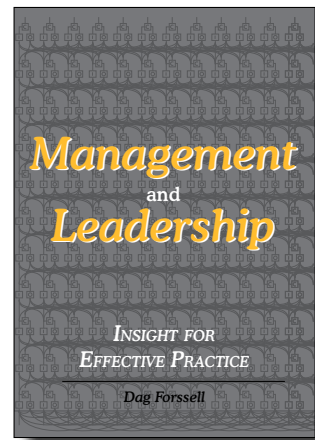
This interactive computer demo  
shows uncanny live action.

# Reorganization



See *Reorganization and MOL*, pp 26-29  
 and *From Reorganization to Evolution and Back*, pp 100-106  
 in the *Book of Readings and Resources*  
[www.livingcontrolsystems.com/readings/readings.html](http://www.livingcontrolsystems.com/readings/readings.html)

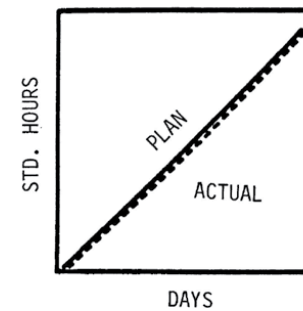
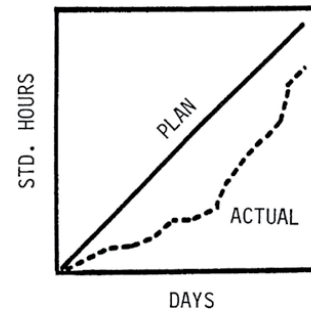
# Management and Leadership



- Understand and resolve conflict.
- Performance coaching reviews.
- Develop team spirit and caring relationships.
- Vision and Mission statements.
- Total Quality Management.

Effective  
Personnel Management  
by Jim Soldani

	COMPARISON OF PERFORMANCE		BENEFITS
	BEFORE PROGRAM	AFTER PROGRAM	
PERFORMANCE TO SCHEDULE	23%	98%	customer satisfaction
VOL. % TO F.G.	82%	101%	customer satisfaction more sales
OVERTIME	12%	3%	\$17,000 / mo. saved
DAYS OF INV.	75 days	52 days	\$2,100,000 reduction
MTL. SHORTS	4%	1,5%	productivity plus 21%
QUALITY	1.26 dpu	0.25 dpu	
LINEARITY	avg - 7.0 days	avg ± .1 day	



"CONFLICTS HAVE BEEN REDUCED ... CREDIBILITY AND TRUST HAVE BEEN IMPROVED SUBSTANTIALLY"  
*the plant manager*

Papers on pages 80-94 in the *Book of Readings and Resources* <http://www.livingcontrolsystems.com/readings/readings.html>

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# Why study PCT?

PCT provides insight for all life sciences and enables psychology to develop into a natural science.

Each demonstration/experiment works 100%, just like those in the natural sciences. No fuzzy statistics here.

PCT provides in-depth understanding. No prescriptions.

You can reason from first principles in any situation.

You gain insight into the structure of the minds of your fellow man—not individual content, but structure. As a manager, associate, or friend, this insight helps you ask questions to “get into the other person’s world” and helps you develop mutually satisfying, productive relationships.

PCT shows how we function, always have, always will.

Paper on page 16 in the *Book of Readings and Resources* <http://www.livingcontrolsystems.com/readings/readings.html>

# Lessons Learned

Don't focus on behavior. Do focus on understanding.

When you see strange behavior, don't ask: "What are you doing?"  
Instead ask: "What are you trying to achieve?"

Don't micromanage. Align Understanding.

Focus on ends, not means. Specify top-level goals and let others figure out the details of how to achieve them (lower-level goals).

Intervene only when a conflict of lower-level goals emerges. The intervention is to focus on the higher-level end that the two conflicting lower-level means are trying to satisfy, so that the process of figuring out those details can resume (MoL).

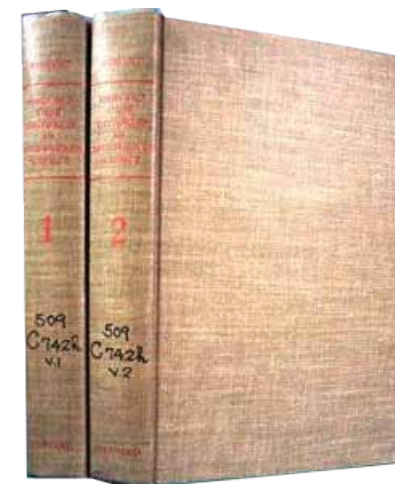
*Contents*

**VOLUME I**

INTRODUCTION, BY JAMES BRYANT CONANT	VII
1. ROBERT BOYLE'S EXPERIMENTS IN PNEUMATICS, EDITED BY JAMES BRYANT CONANT	1
2. THE OVERTHROW OF THE PHLOGISTON THEORY: THE CHEMICAL REVOLUTION OF 1775-1789, EDITED BY JAMES BRYANT CONANT	65
3. THE EARLY DEVELOPMENT OF THE CONCEPTS OF TEMPERATURE AND HEAT: THE RISE AND DECLINE OF THE CALORIC THEORY, PREPARED BY DUANE ROLLER	117
4. THE ATOMIC-MOLECULAR THEORY, EDITED BY LEONARD K. NASH	215

**VOLUME 2**

5. PLANTS AND THE ATMOSPHERE, EDITED BY LEONARD K. NASH	323
6. PASTEUR'S STUDY OF FERMENTATION, EDITED BY JAMES BRYANT CONANT	437
7. PASTEUR'S AND TYNDALL'S STUDY OF SPONTANEOUS GENERATION, EDITED BY JAMES BRYANT CONANT	487
8. THE DEVELOPMENT OF THE CONCEPT OF ELECTRIC CHARGE: ELECTRICITY FROM THE GREEKS TO COULOMB, BY DUANE ROLLER AND DUANE H. D. ROLLER	541



James Bryant Conant was the 23rd President of Harvard University, 1933–1953

Wikipedia: “In his later years at Harvard, Conant taught undergraduate courses on the history and philosophy of science, and wrote books explaining the scientific method to laymen.”

*Introduction*

The Harvard Case Histories in Experimental Science were designed primarily for students majoring in the humanities or the social sciences. Such students require an understanding of science that will help them to relate developments in the natural sciences to those in the other fields of human activity. To do so demands an understanding both of the methods of experimental science and of the growth of scientific research as an organized activity of society.

Experience shows that a man who has been a successful investigator in any field of experimental science approaches a problem in pure or applied science, even in an area in which he is quite ignorant, with a special point of view. One may designate this point of view “understanding science”; it is independent of a knowledge of the scientific facts or techniques in the new area. . . .

For free pdf downloads of the two volumes, see [www.pctresources.com/Public](http://www.pctresources.com/Public)  
[www.livingcontrolsystems.com](http://www.livingcontrolsystems.com)

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For an overview of past scientific revolutions, I recommend the *Harvard Case Histories In Experimental Science*, designed primarily for students majoring in the humanities or the social sciences.

This work was first published in 1948 and was an inspiration for Kuhn when he wrote his book, published in 1962.



Now that we have some understanding of control, we can take a look at the scientific method used by psychologists today.

Not understanding that they were looking at control in action, scientists called the disturbance a Stimulus, and the output a Response, with the presumption that the Stimulus (the Independent Variable) causes the Response (the Dependent Variable).

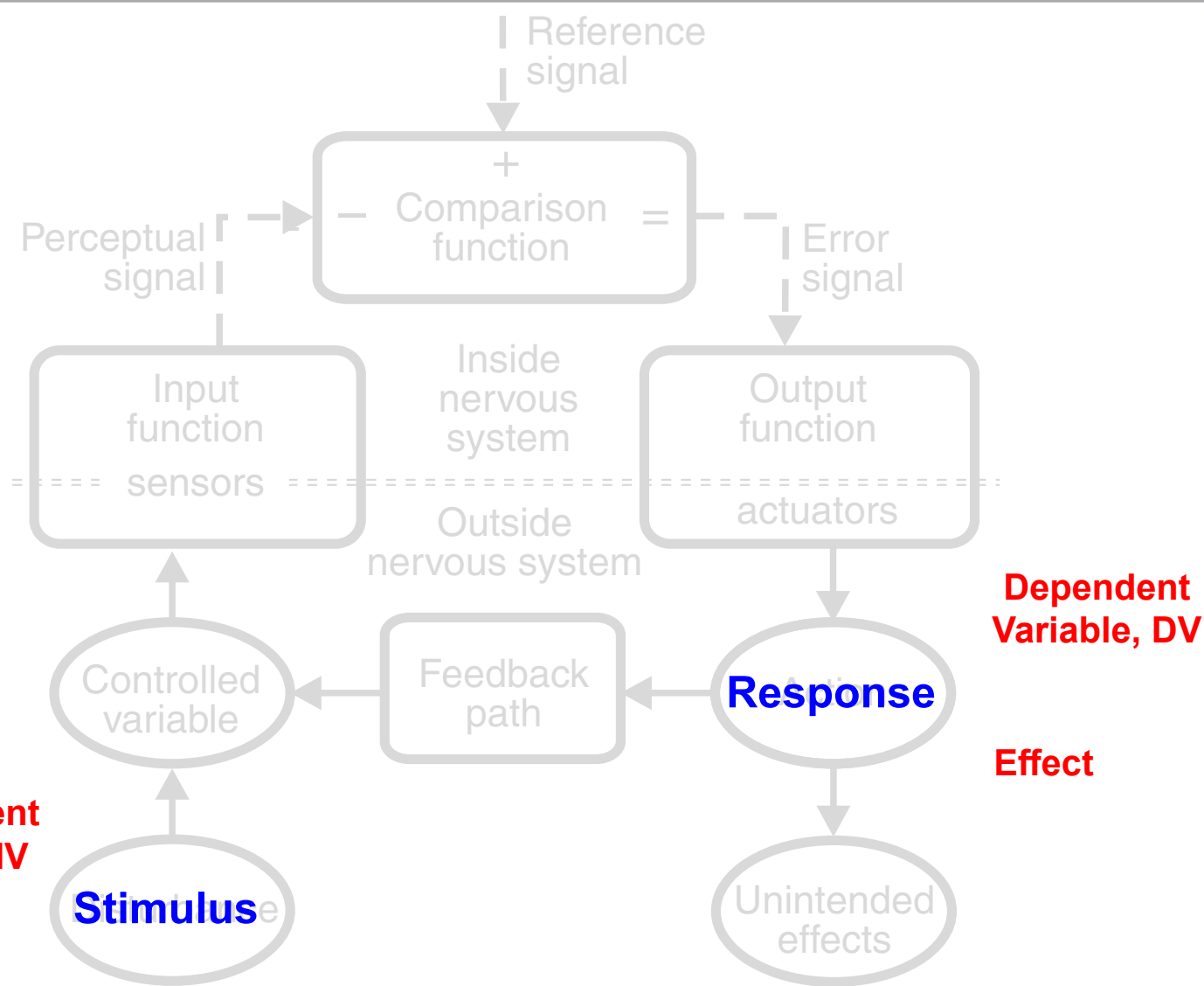
This leads to the First Grand Theory of Psychology: Behaviorism, which says that the environment makes us behave.

*The language and teachings of Behaviorism pervade our culture.*

Note that if control is good, the correlation between Stimulus and Response (Disturbance and Action, as in “you push me, I push back”) will be high. Precisely what scientific psychologists are looking for, But...

This mistaken use of the scientific

**Independent Variable, IV**  
**Cause**



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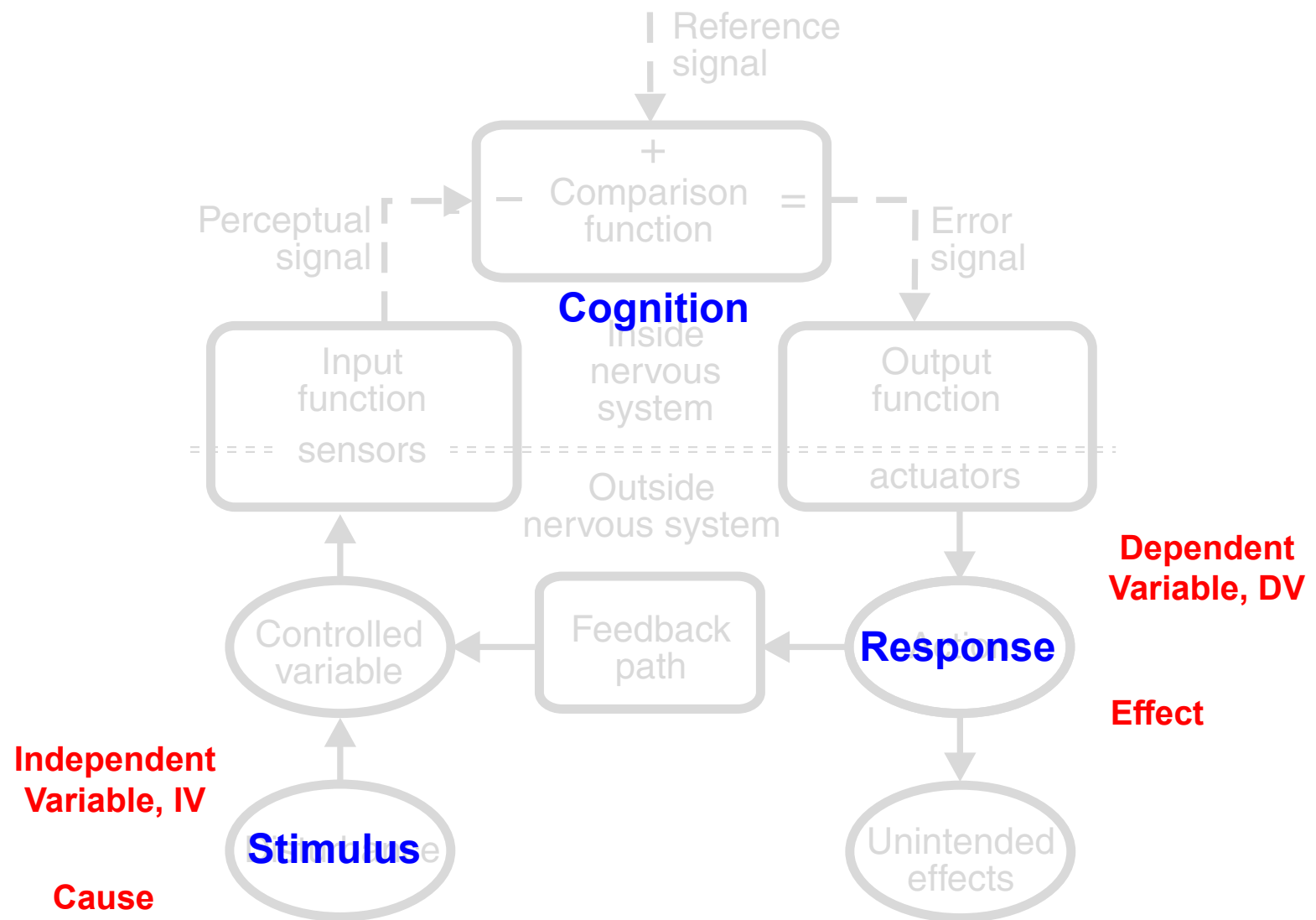
method will tell you nothing about the inner workings of the organism.

Bill Powers wrote:

“There is one clear message that we have to send to the life sciences

concerned with behavior, which in one way or another means all of them. It is that all the behavioral sciences have been pursuing an illusion during their whole history, the behavioral illusion.

They have been misled by the actions that organisms use for generating effects that are of importance to them into thinking that those actions are the effects of importance.”



With Cognition as an intermediary, somehow, between Stimulus and Response, you get the Second Grand Theory of Psychology.

Cognitive psychology is not a single theory but rather an all-inclusive term that serves as an umbrella for any psychological theory that recognizes cognition. There are many.

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Some cognitive psychologists suggest that our brains perform elaborate calculations of the physical properties of the environment, makes predictions, and issues commands to our muscles.

This is not possible in the real world of random disturbances and tiring muscles.

Actually, it requires information about the environment that the brain just does not have. It requires a generous dose of magic.

Note that the scientific method continues to be applied as if living control systems are inanimate objects.

For a discussion of the state of psychiatry, see

<http://www.nybooks.com/articles/2011/07/14/illusions-of-psychiatry/>

and

<http://www.nybooks.com/articles/2011/06/23/epidemic-mental-illness-why/>

followed by

<http://www.nybooks.com/articles/2011/08/18/illusions-psychiatry-exchange/>

**Also of interest**

DSM — Unfit for purpose by Tim Carey: <http://dxsummit.org/archives/550>

***To learn more...***

**iapct.org**

**International Association for PCT**

**be sure to check out Websites**

**livingcontrolsystems.com**

**Book of Readings and Resources**