# media—interaction—cybernetics

paul pangaro, ph.d. pan@pangaro.com

# media—interaction—cybernetics

intro video

skyear—usman haque—2004
*http://www.haque.co.uk/skyear*

# media—interaction—cybernetics

outline

cybernetics—point-of-view—models
machines—interaction—conversation
cybernetic models—3 projects—interaction design
discussion

cybernetics—point-of-view—models

# CYBERNETICS

# CYBERNETICS

## OR CONTROL AND COMMUNICATION IN THE ANIMAL AND THE MACHINE

Norbert Wiener

PROFESSOR OF MATHEMATICS
THE MASSACHUSETTS INSTITUTE
OF TECHNOLOGY

THE TECHNOLOGY PRESS

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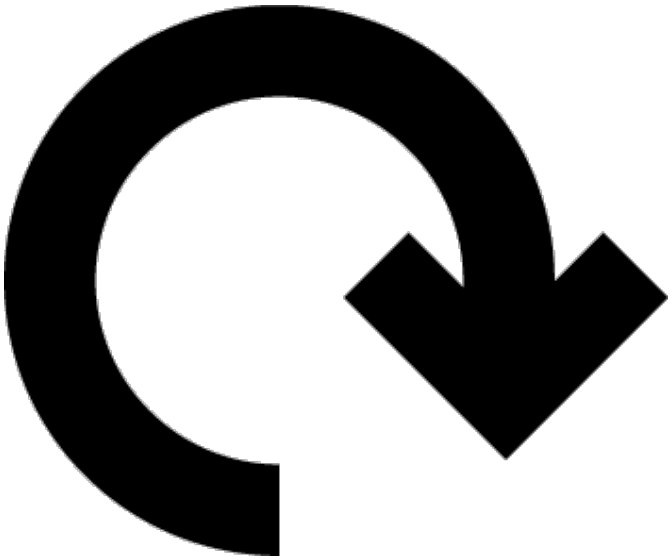
feedback—science—cybernetics

CYBERNETICS



feedback—science—cybernetics

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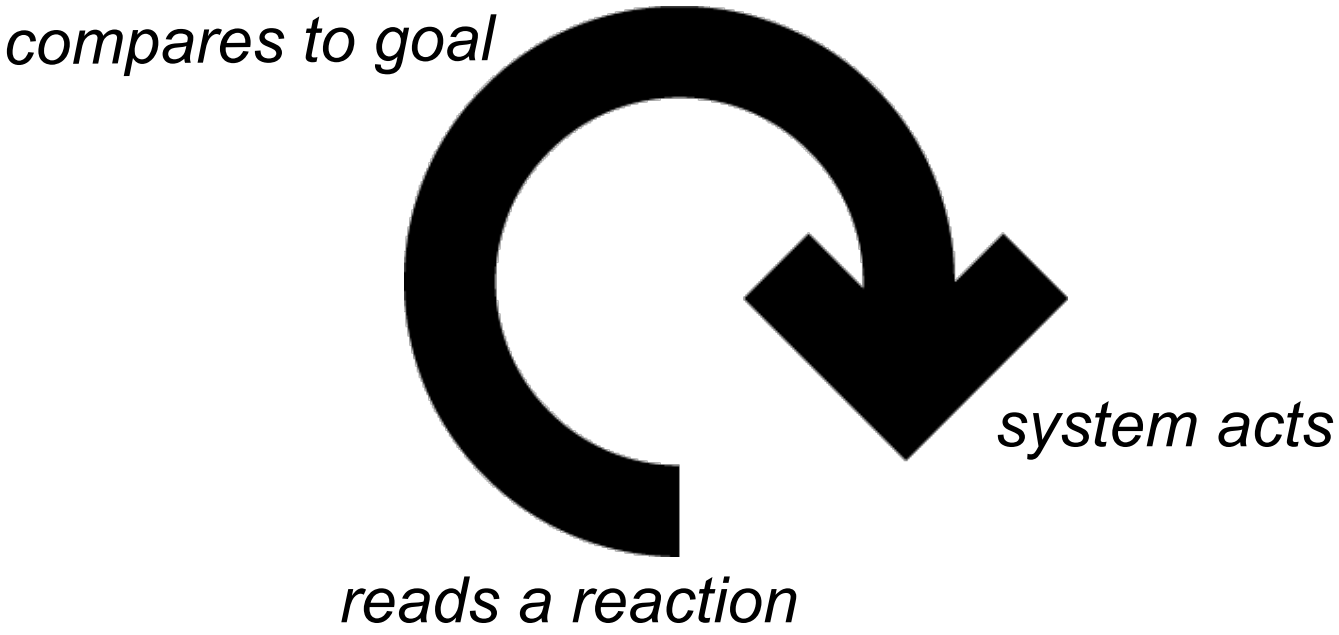
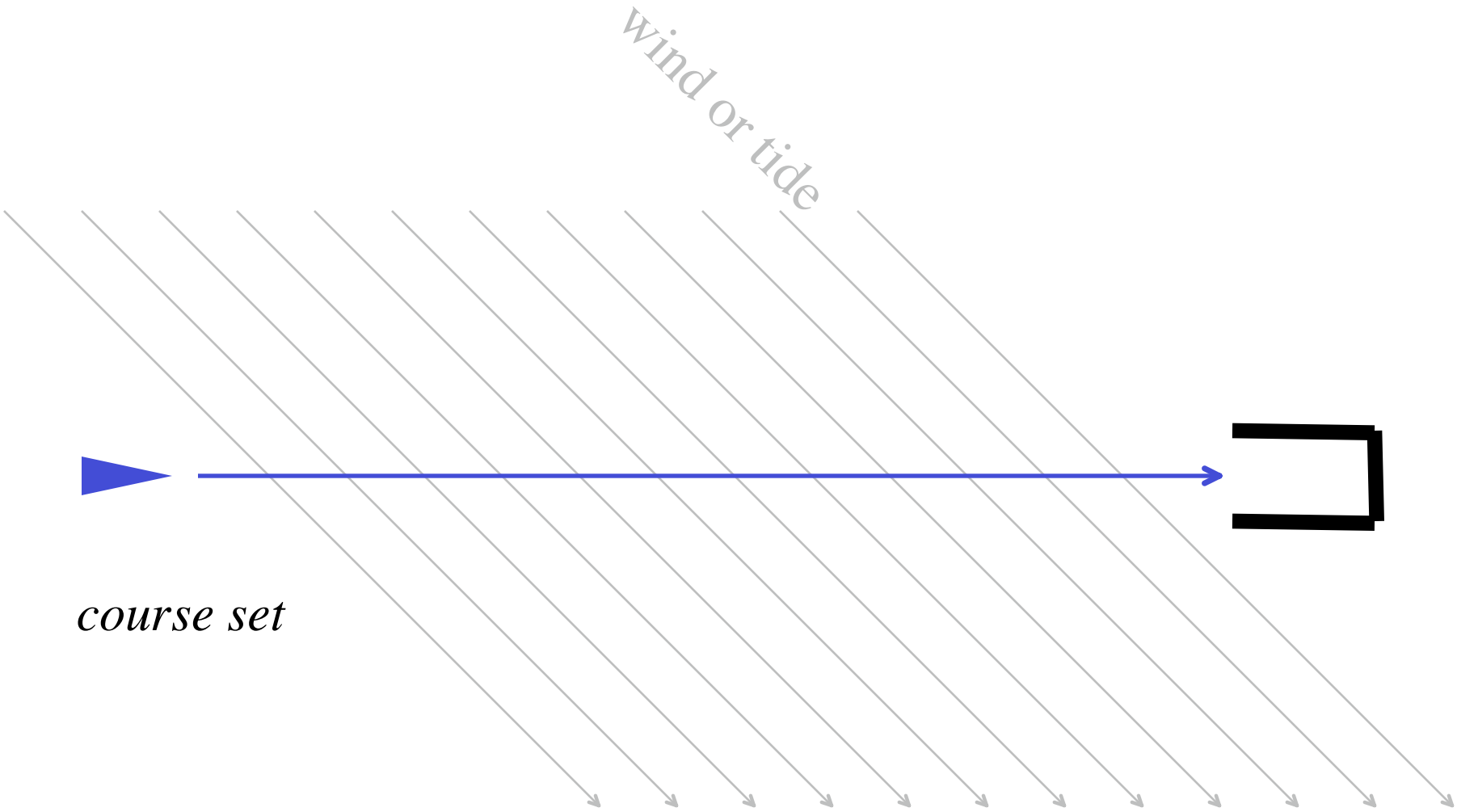


origins—neologism—steering


from Greek ‘kybernetes’

—the art of steering

# origins—neologism—steering



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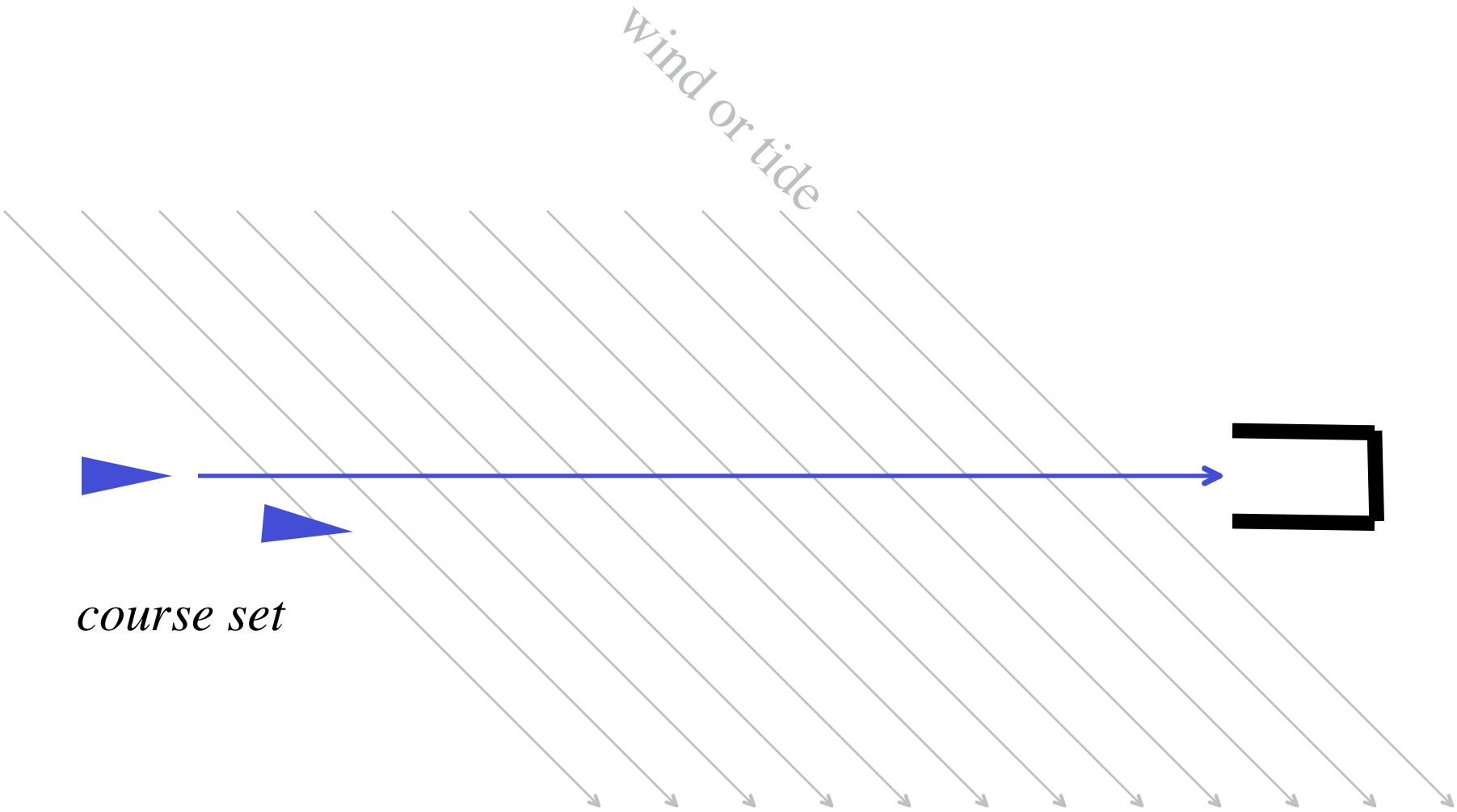

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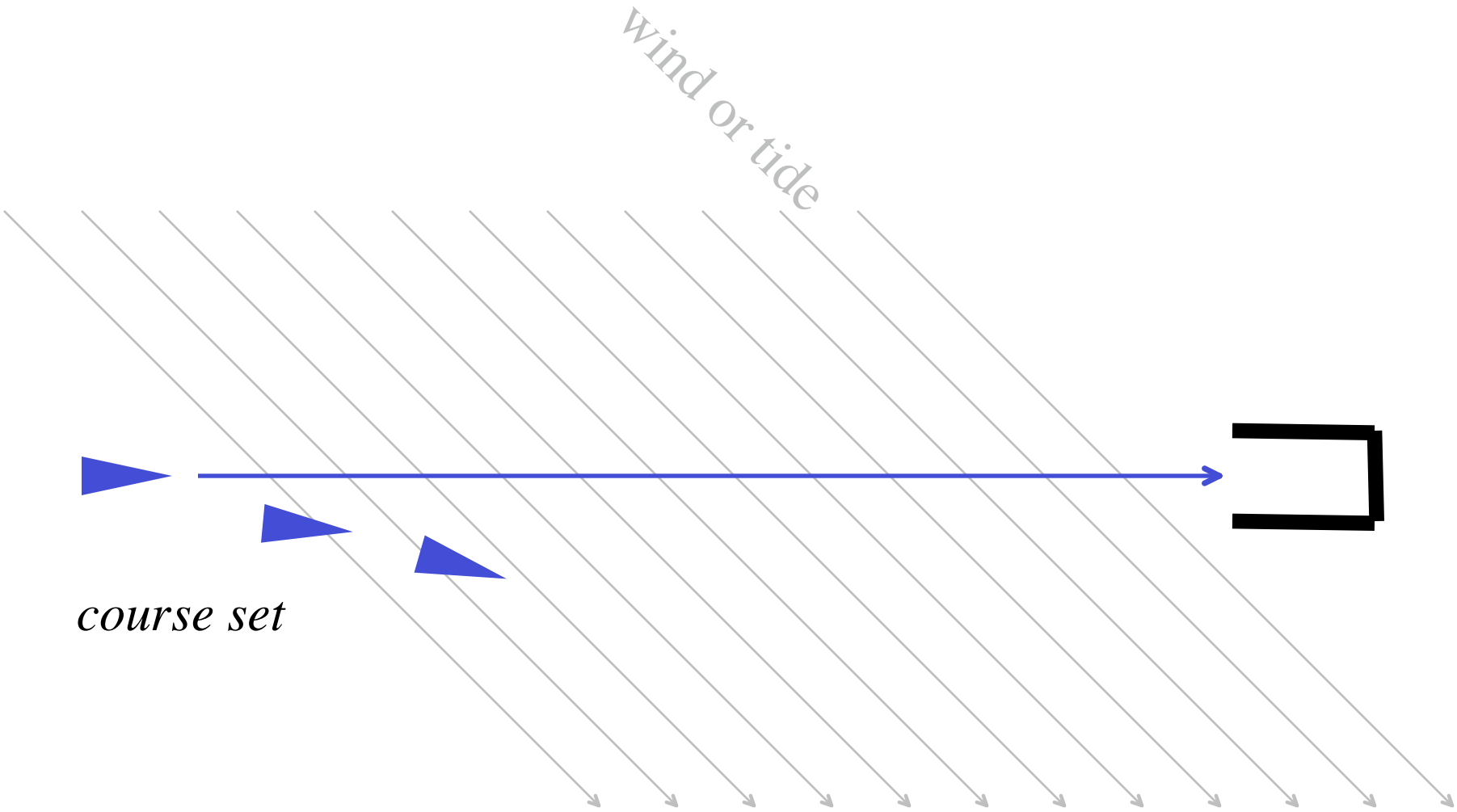

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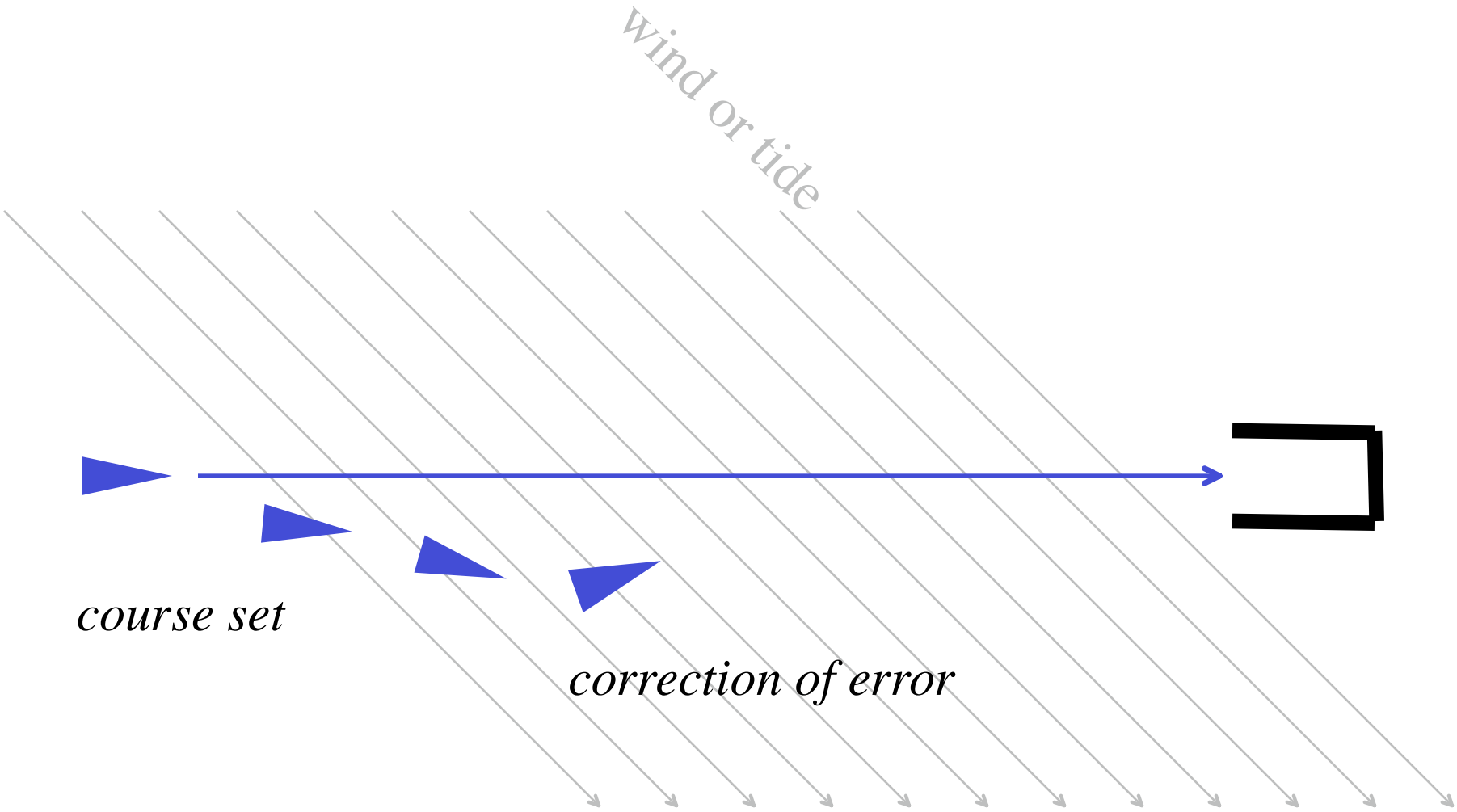

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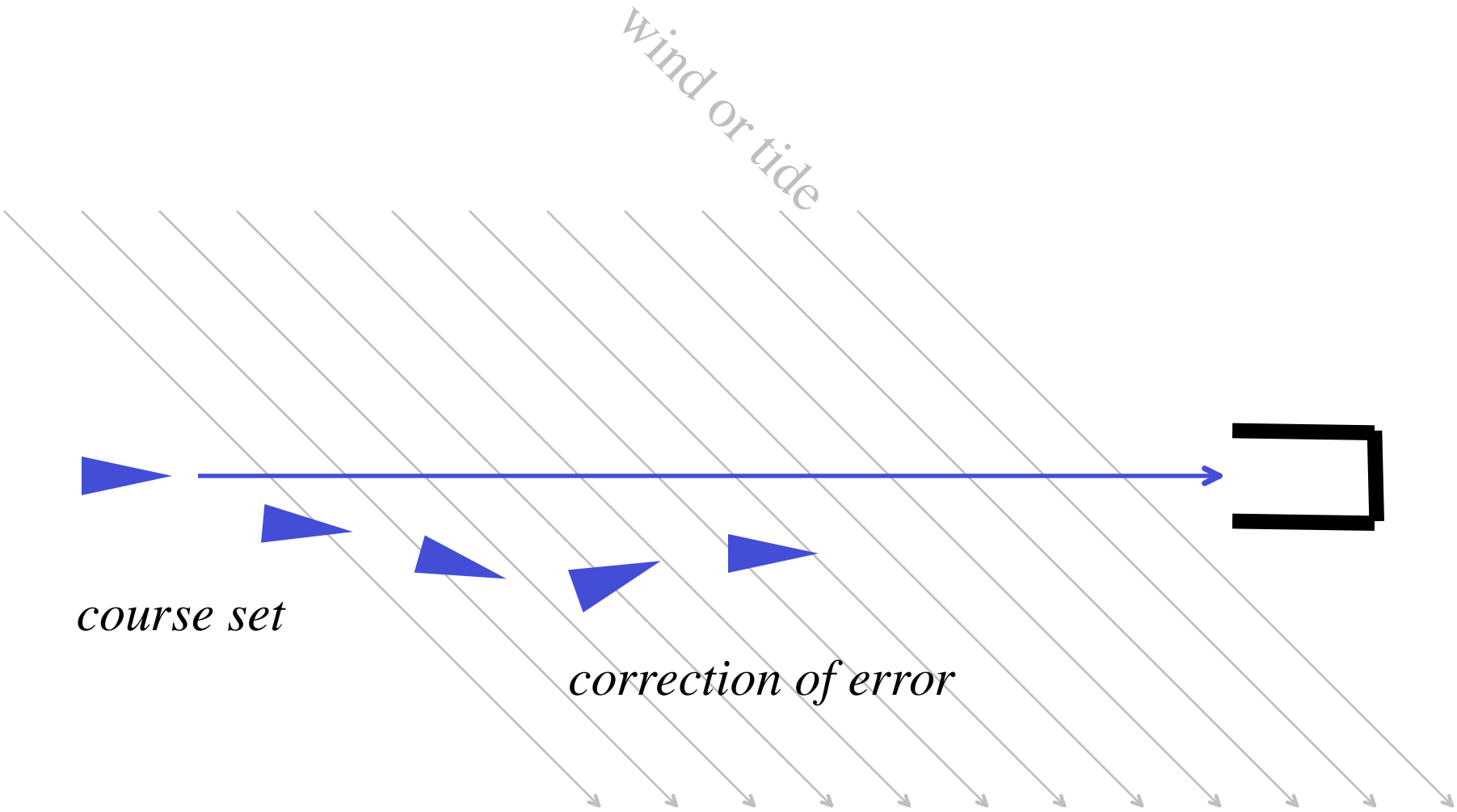

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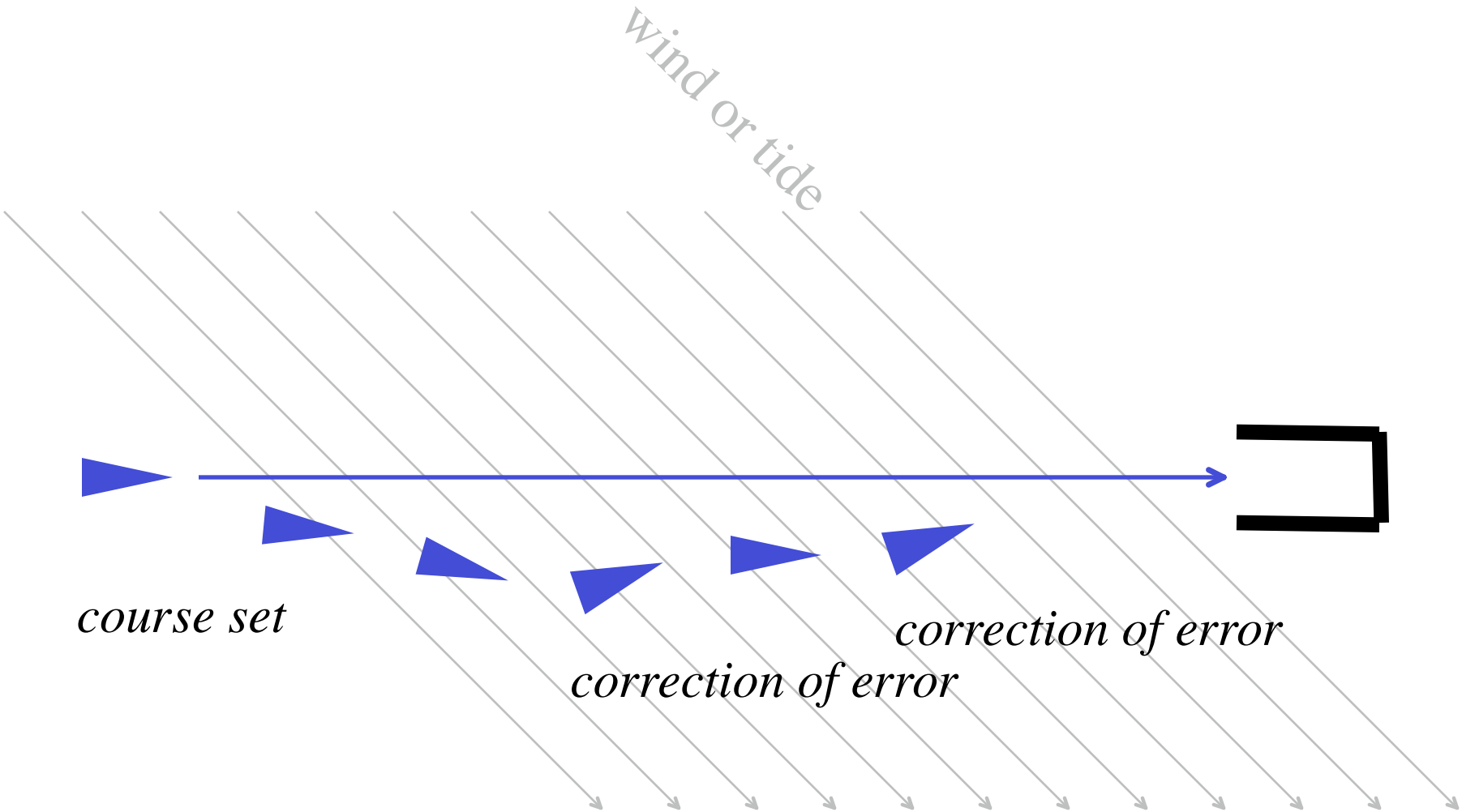

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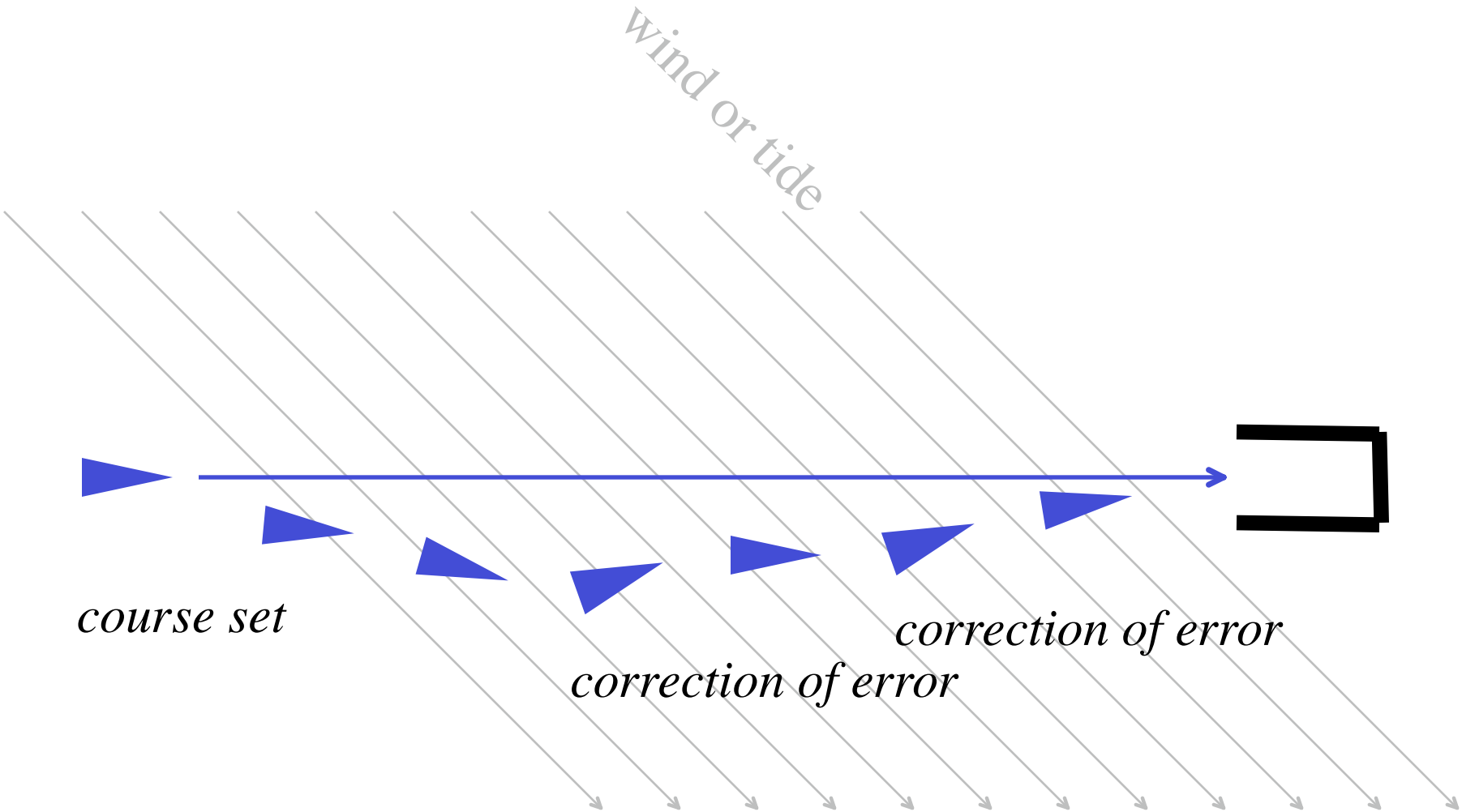

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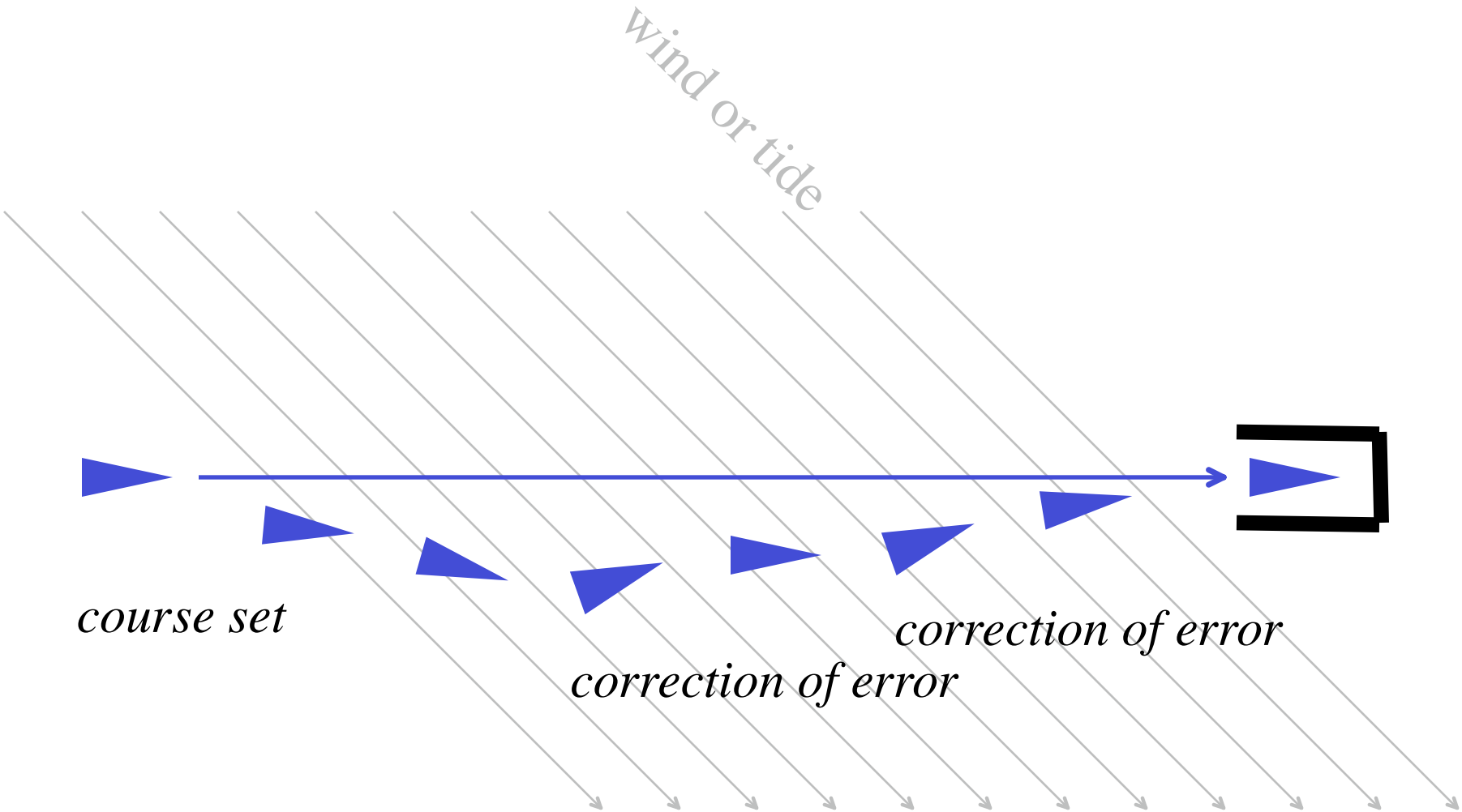


system—goal—feedback—steering


system has goal

system aims toward the goal

environment affects aim

information returns to system—'feedback'

system measures difference between state and goal
—detects 'error'

system acts to correct

system—goal—feedback—steering


from Greek ‘kybernetes’
—the art of steering

in Latin becomes ‘governing’
—regulation by law or person

# system—goal—feedback—steering

'Cybernetics saves the souls, bodies, and material possessions from the gravest dangers.'

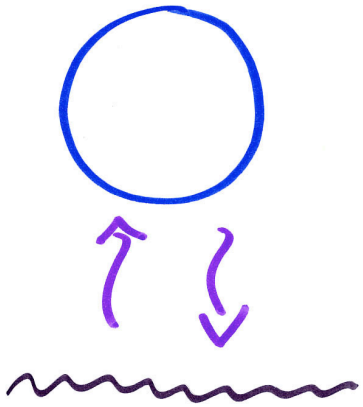
— *Socrates according to Plato, c. 400 B.C.E.*

'The future science of government should be called "la cybernetique."'

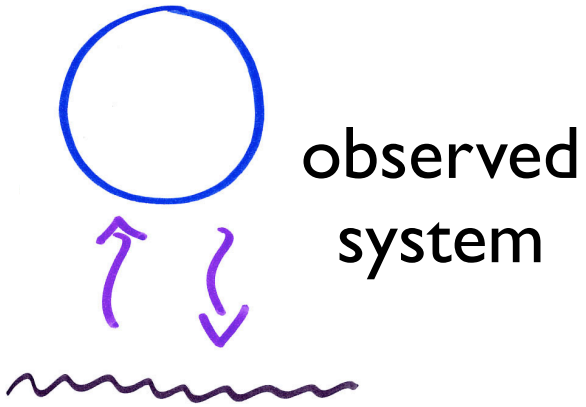
— *André-Marie Ampere, 1843*

'Until recently, there was no existing word for this complex of ideas, and…I felt constrained to invent one....'

— *Norbert Wiener, 1954*

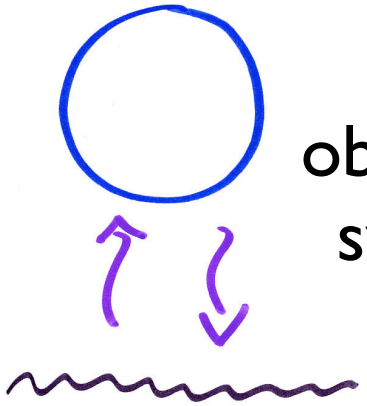


*after Maturana*




*after Maturana*

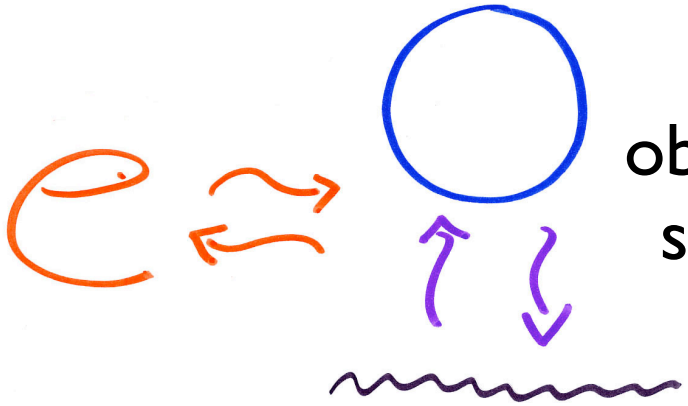
## first-order cybernetics



observed system

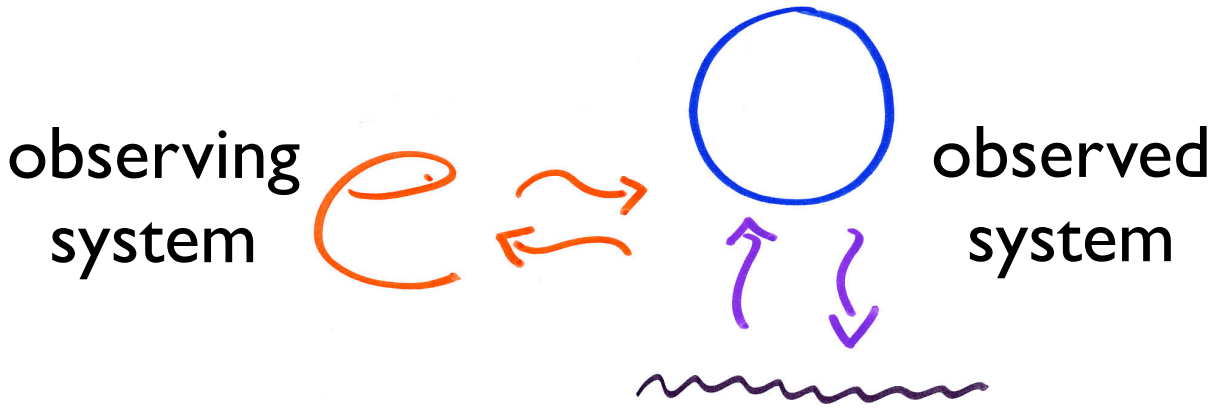
*after Maturana*

## first-order cybernetics



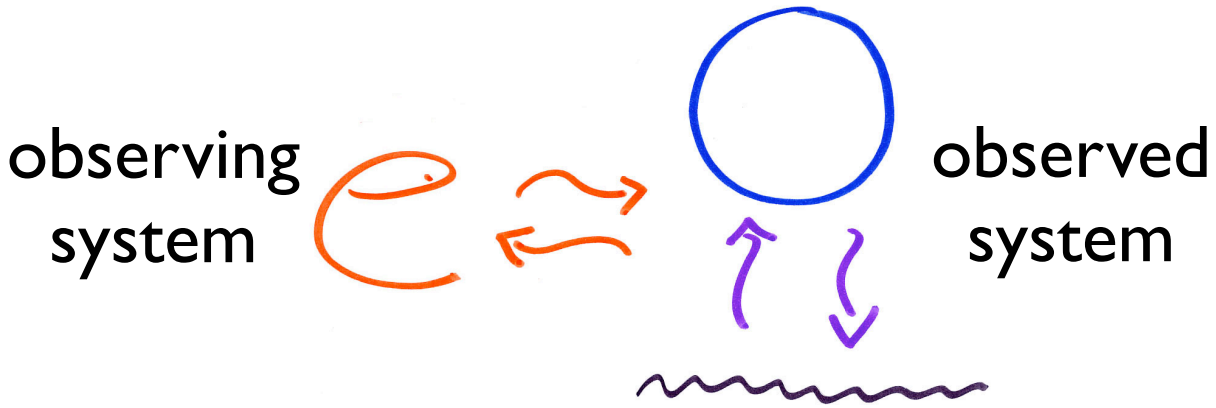
observed system

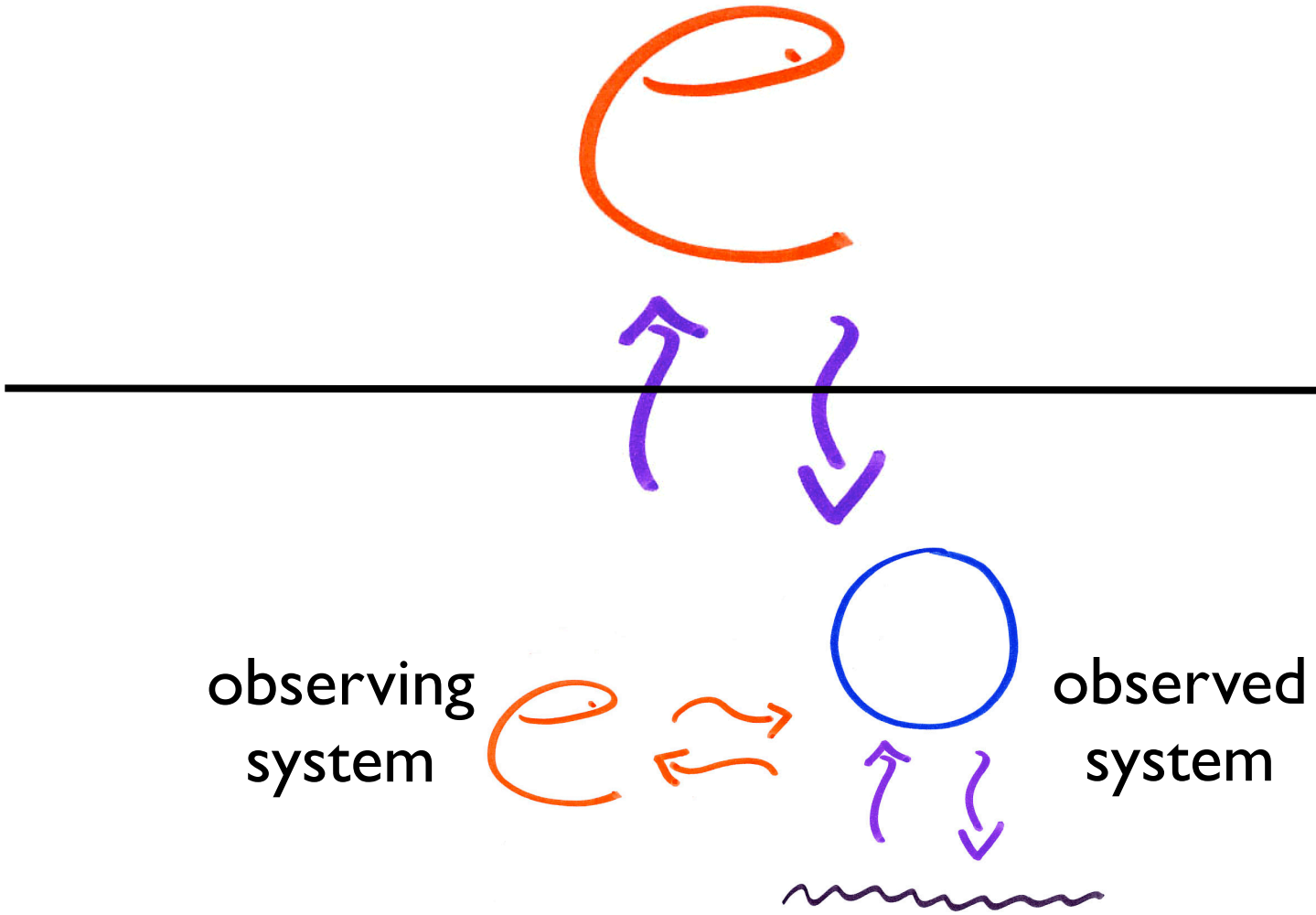
## first-order cybernetics

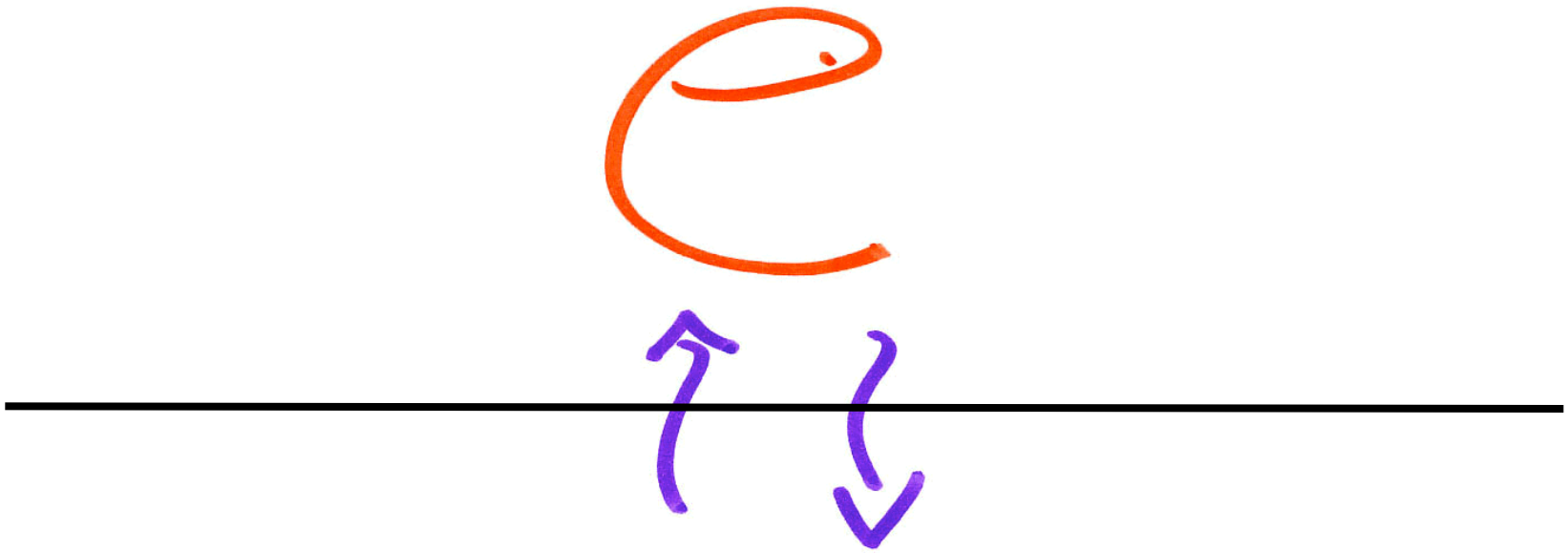


second-order cybernetics

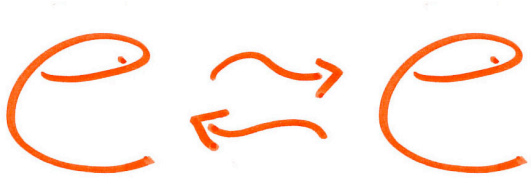
first-order cybernetics



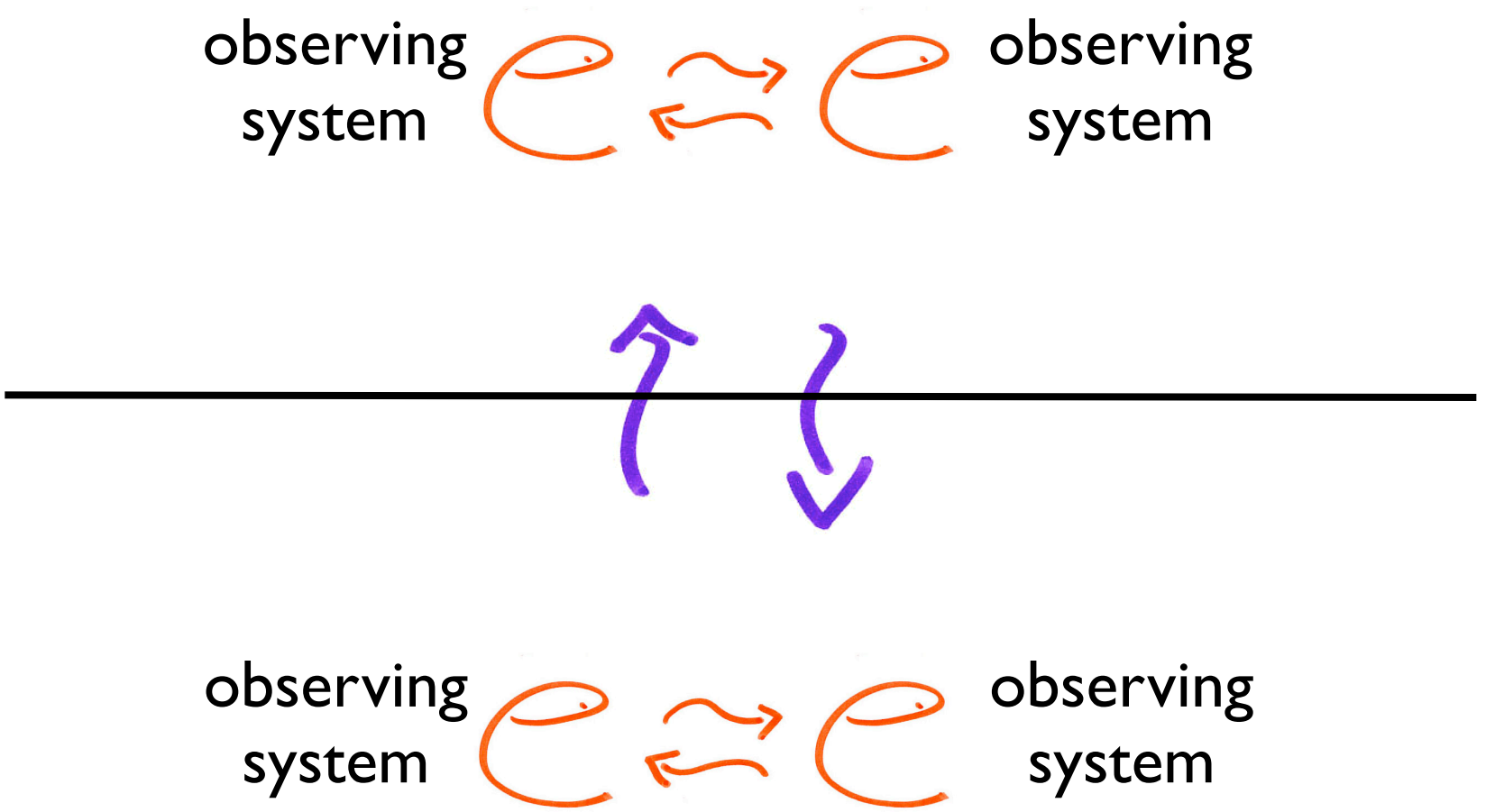

observing
system
observed
system



observing system



observing system


observing system
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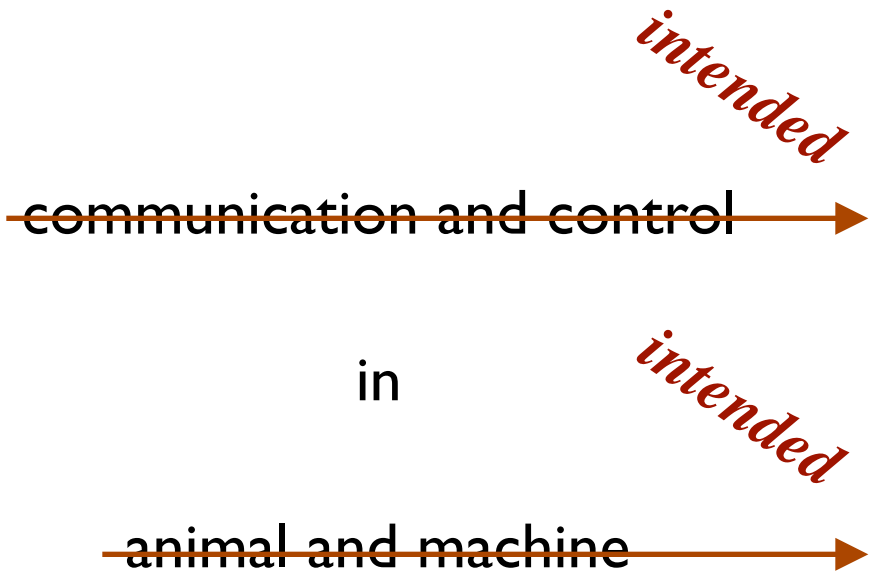
# wiener's subtitle—early intentions—first-order

communication and control

in

animal and machine

# wiener's subtitle—early intentions—first-order



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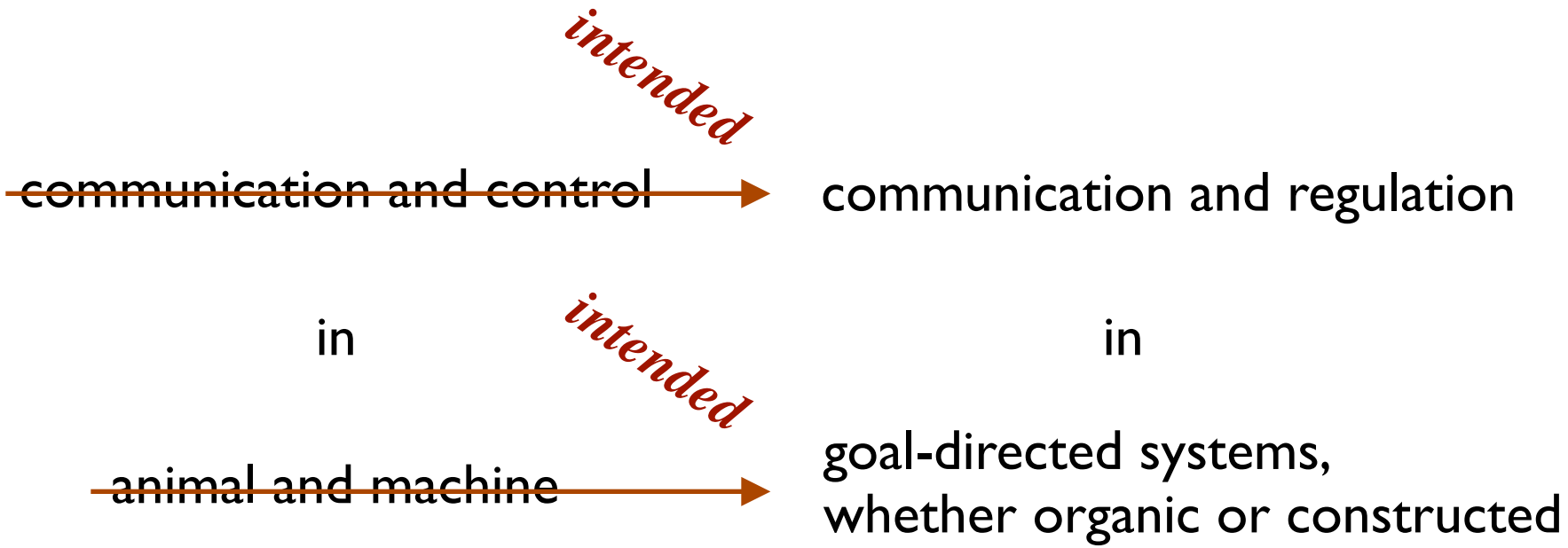

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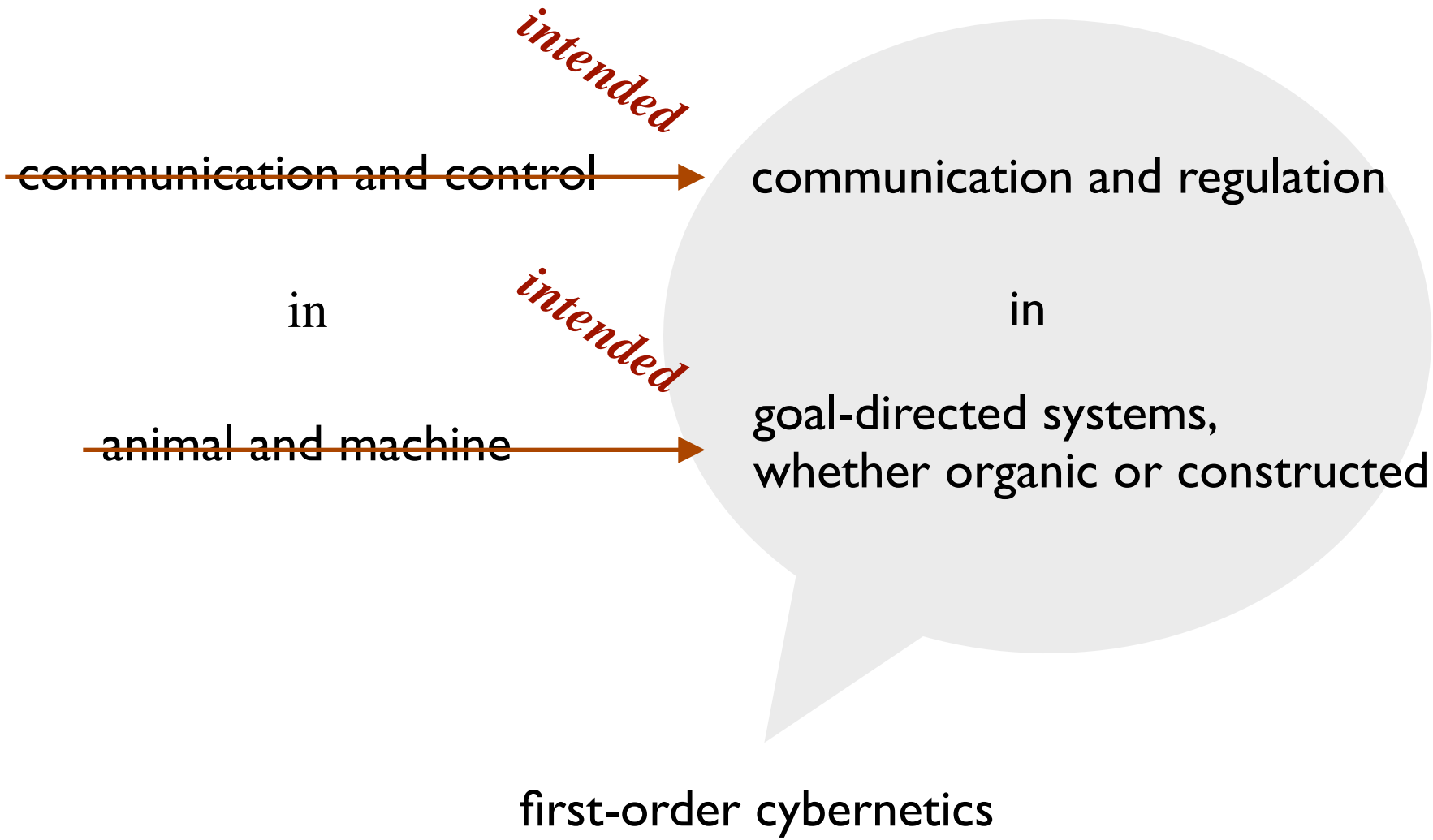



first-order cybernetics

# wiener's subtitle—early intentions—first-order

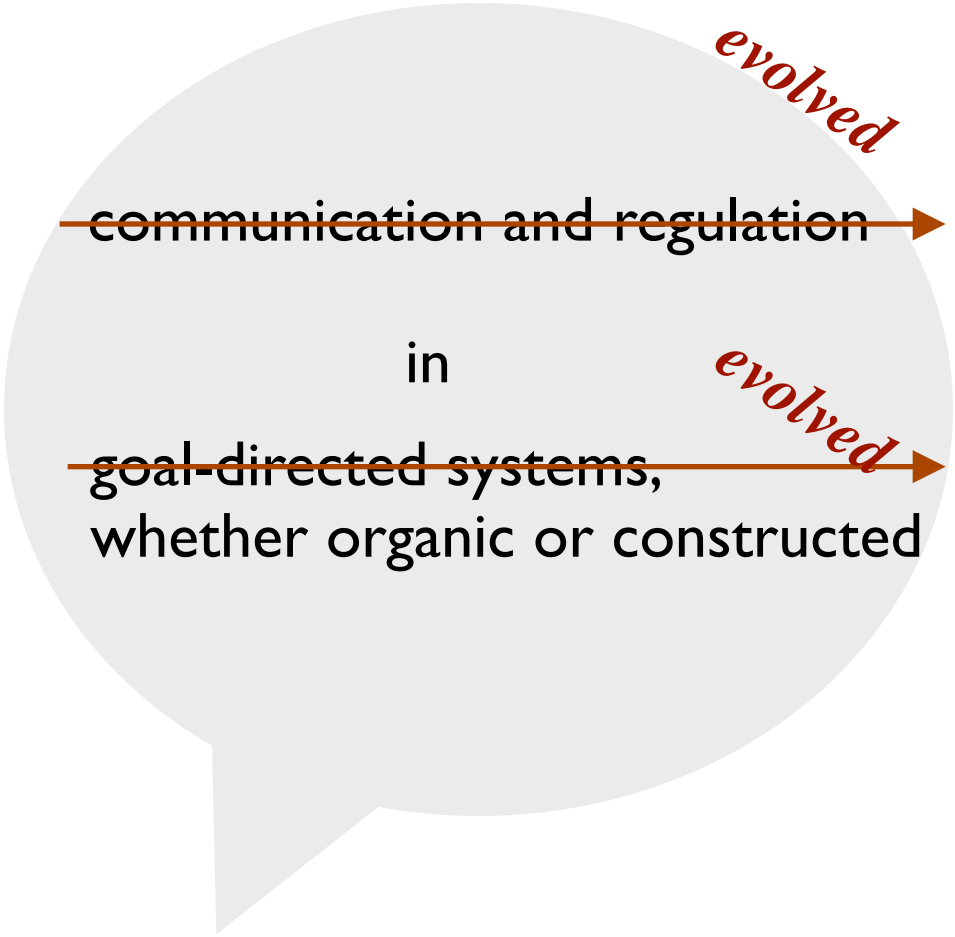
communication and regulation

in

goal-directed systems,
whether organic or constructed

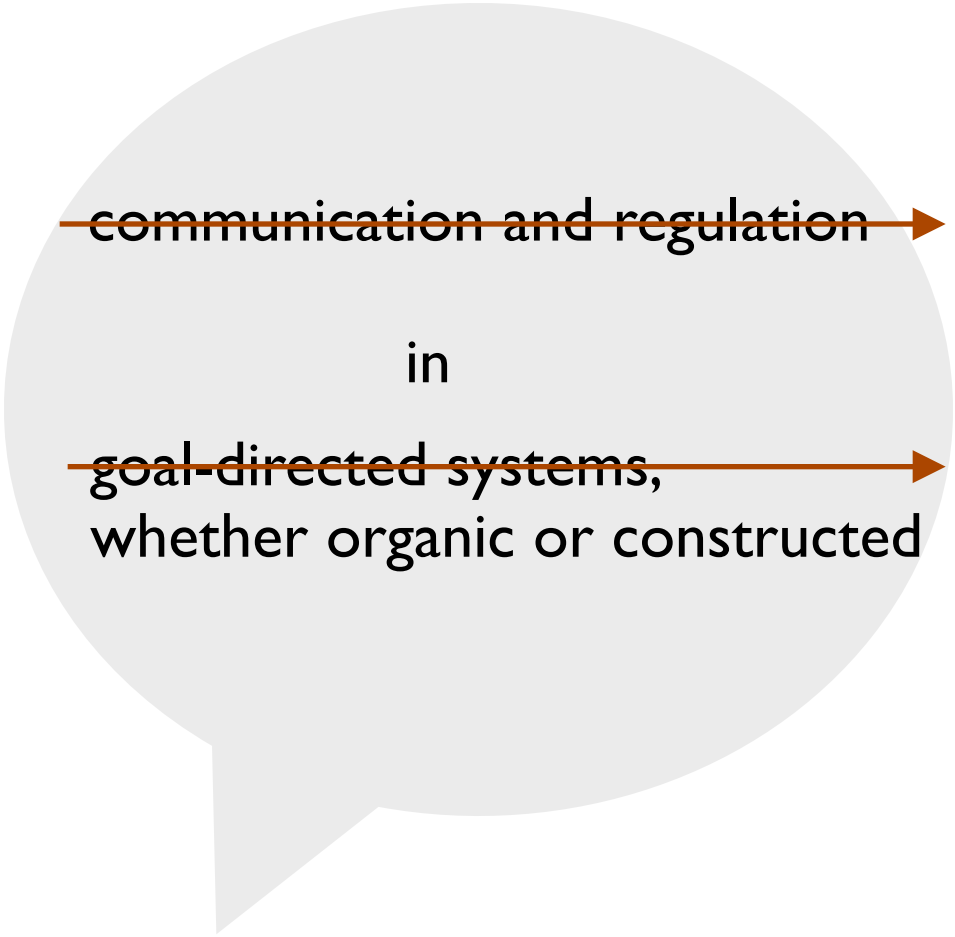
first-order cybernetics

# evolution—conversation-focused—second-order




first-order cybernetics

# evolution—conversation-focused—second-order



~~communication and regulation~~ → language and agreement

in → in

~~goal-directed systems,~~ → linguistic, goal-directed systems
~~whether organic or constructed~~ → whether organic or constructed

first-order cybernetics

# evolution—conversation-focused—second-order

~~communication and regulation~~ → language and agreement

in

in

~~goal-directed systems,~~ → linguistic, goal-directed systems
whether organic or constructed whether organic or constructed

second-order cybernetics

# evolution—conversation-focused—second-order

communication and regulation

in

goal-directed systems,
whether organic or constructed

language and agreement

in

linguistic, goal-directed systems
whether organic or constructed

science of
observed systems

science of
observing systems

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## CIRCULAR CAUSAL AND FEEDBACK MECHANISMS IN BIOLOGICAL AND SOCIAL SYSTEMS

*Transactions of the Tenth Conference*
*April 22, 23, and 24, 1953, Princeton, N. J.*


*Edited by*

HEINZ VON FOERSTER

DEPARTMENT OF ELECTRICAL ENGINEERING
UNIVERSITY OF ILLINOIS
CHAMPAIGN, ILL.

*Assistant Editors*

MARGARET MEAD

AMERICAN MUSEUM OF NATURAL HISTORY
NEW YORK, N. Y.

HANS LUKAS TEUBER

DEPARTMENT OF PSYCHIATRY AND NEUROLOGY
NEW YORK UNIVERSITY COLLEGE OF MEDICINE
NEW YORK, N. Y.



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# PARTICIPANTS

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## *MEMBERS*

WARREN S. McCULLOCH, *Chairman*
Research Laboratory of Electronics, Massachusetts Institute of Technology
Cambridge, Mass.

HEINZ VON FOERSTER, *Secretary*
Department of Electrical Engineering, University of Illinois
Champaign, Ill.

GREGORY BATESON
Veterans Administration Hospital
Palo Alto, Cal.

ALEX BAVELAS†
Department of Economics and Social Science, Massachusetts Institute of Technology
Cambridge, Mass.

JULIAN H. BIGELOW
Department of Mathematics, Institute for Advanced Study
Princeton, N. J.

HENRY W. BROSIN
Department of Psychiatry, University of Pittsburgh School of Medicine
Pittsburgh, Pa.

LAWRENCE K. FRANK
72 Perry St., New York, N. Y.

RALPH W. GERARD†
Departments of Psychiatry and Physiology, University of Illinois College of Medicine
Chicago, Ill.

GEORGE EVELYN HUTCHINSON
Department of Zoology, Yale University
New Haven, Conn.

HEINRICH KLÜVER
Division of the Biological Sciences, University of Chicago
Chicago, Ill.

LAWRENCE S. KUBIE
Department of Psychiatry and Mental Hygiene, Yale University School of Medicine
New Haven, Conn.

RAFAEL LORENTE de NÓ†
Rockefeller Institute for Medical Research
New York, N. Y.

DONALD G. MARQUIS
Department of Psychology, University of Michigan
Ann Arbor, Mich.

MARGARET MEAD
American Museum of Natural History
New York, N. Y.

F. S. C. NORTHROP
Department of Philosophy, Yale University
New Haven, Conn.

* This is the final conference.
† Absent.

WALTER PITTS
Research Laboratory of Electronics, Massachusetts Institute of Technology
Cambridge, Mass.

ARTURO S. ROSENBLUETH†
Department of Physiology, Instituto Nacional de Cardiologia
Mexico City, D. F., Mexico

LEONARD J. SAVAGE
Committee on Statistics, University of Chicago
Chicago, Ill.

T. C. SCHNEIRLA
American Museum of Natural History
New York, N. Y.

HANS LUKAS TEUBER
Department of Psychiatry and Neurology, New York University College of Medicine
New York, N. Y.

GERHARDT VON BONIN
Department of Anatomy, University of Illinois College of Medicine
Chicago, Ill.

## *GUESTS*

VAHE E. AMASSIAN
Department of Physiology and Biophysics, University of Washington
School of Medicine
Seattle, Wash.

Y. BAR-HILLEL
Department of Philosophy, Hebrew University
Jerusalem, Israel

JOHN R. BOWMAN
Department of Physical Chemistry
Mellon Institute of Industrial Research, University of Pittsburgh
Pittsburgh, Pa.

YUEN REN CHAO
Department of Oriental Languages, University of California
Berkeley, Cal.

JAN DROOGLEEVER-FORTUYN
Department of Neurology, University of Groningen
Groningen, Holland

W. GREY-WALTER
Burden Neurological Institute
Stapleton, Bristol, England

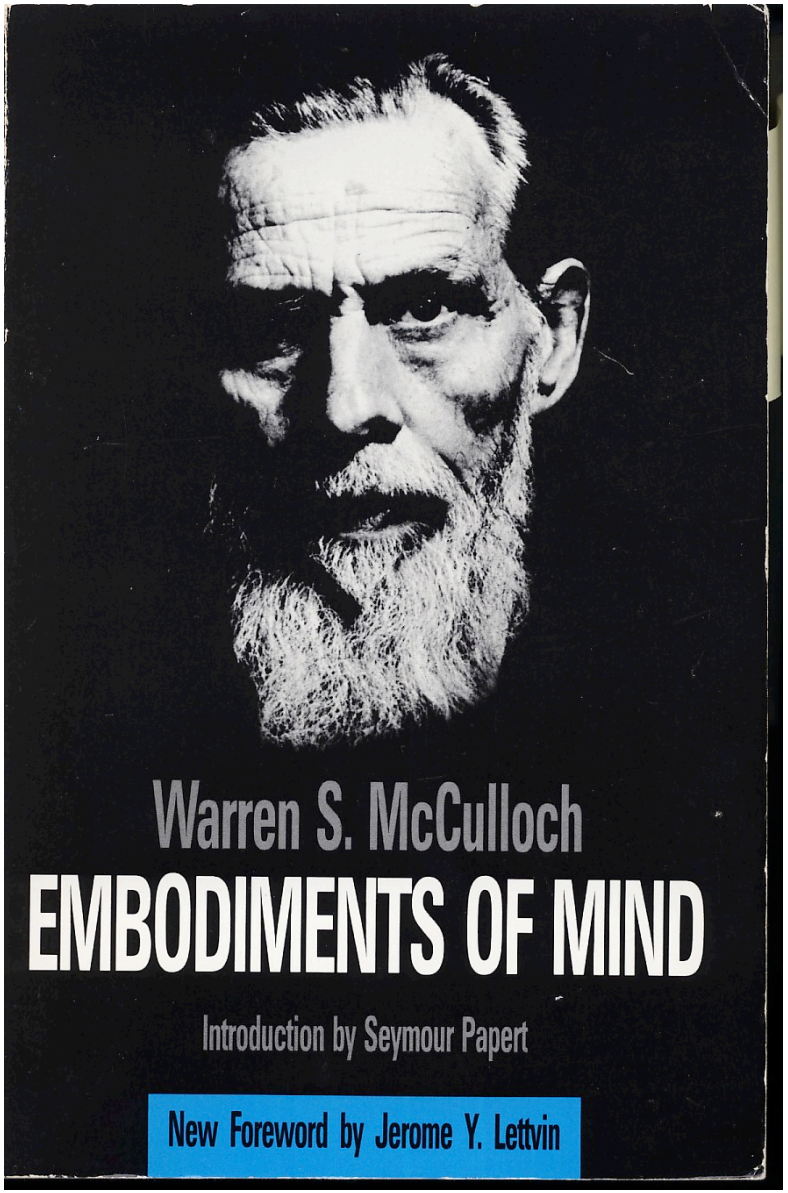
HENRY QUASTLER
Control Systems Laboratory, University of Illinois
Urbana, Ill.

CLAUDE SHANNON
Bell Telephone Laboratories, Inc., Murray Hill Laboratory
Murray Hill, N. J.

THE JOSIAH MACY, JR. FOUNDATION
FRANK FREMONT-SMITH, *Medical Director*
JANET FREED LYNCH, *Assistant for the Conference Program*

† Absent.

# warren mcculloch—rise of AI—intelligent confusions



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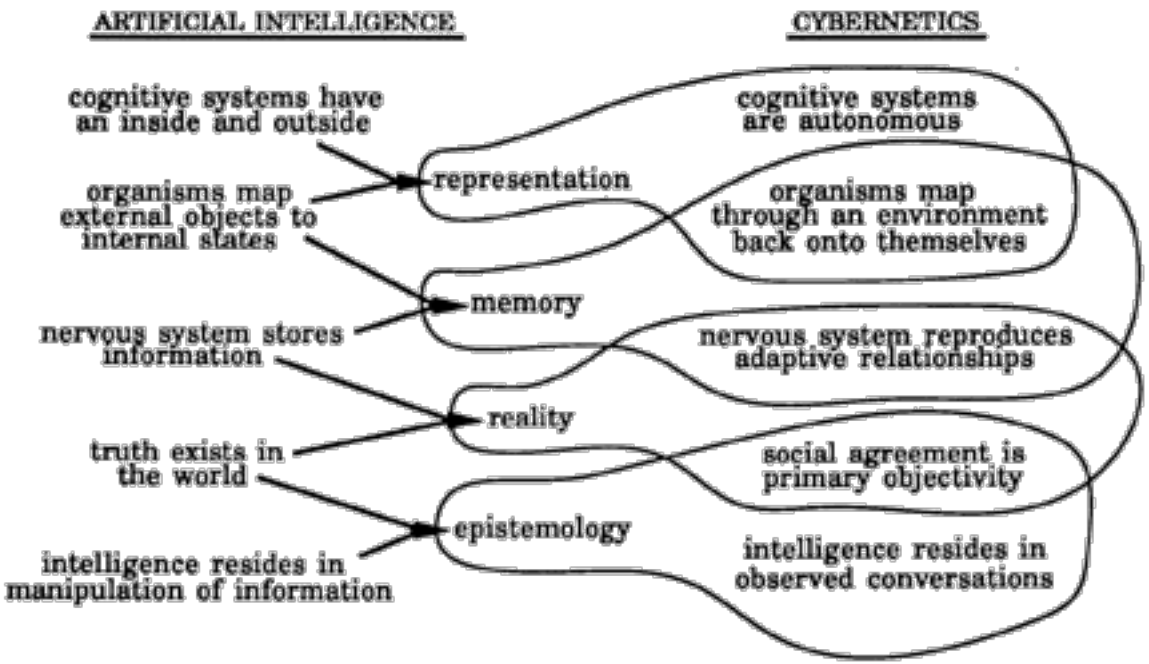
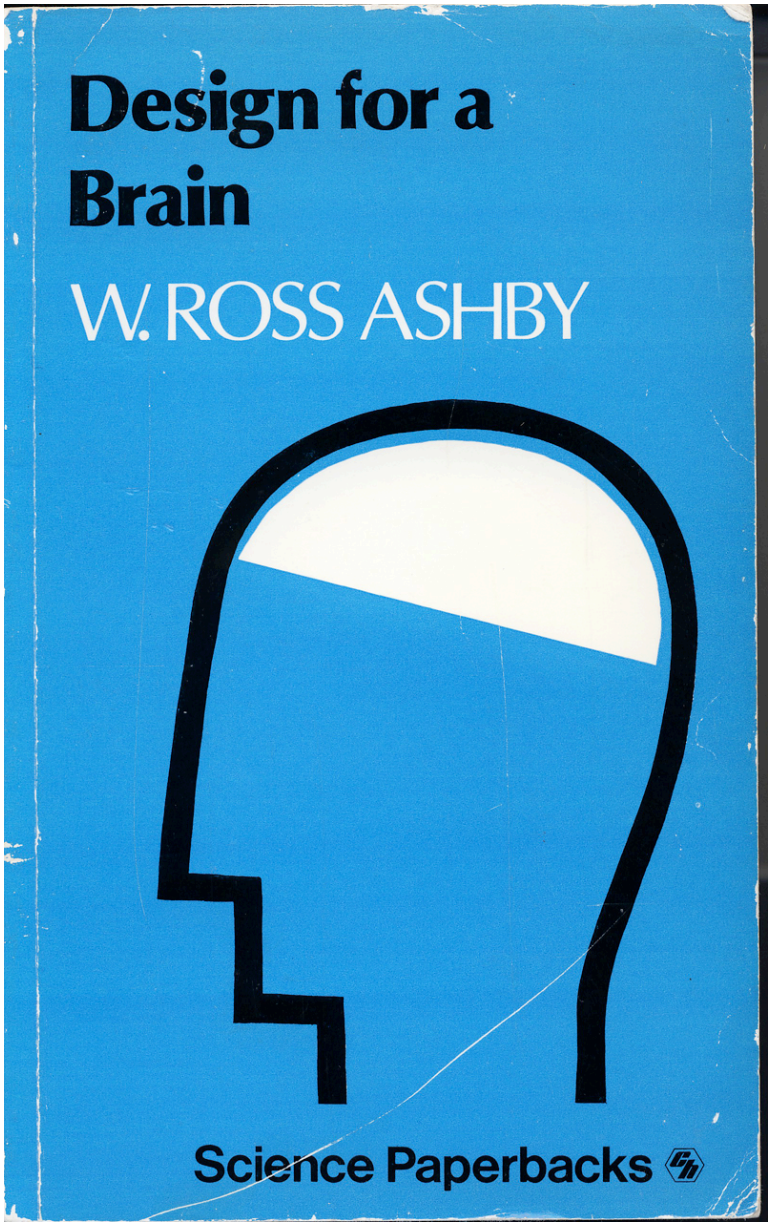


ross ashby—system limits—requisite variety—learning



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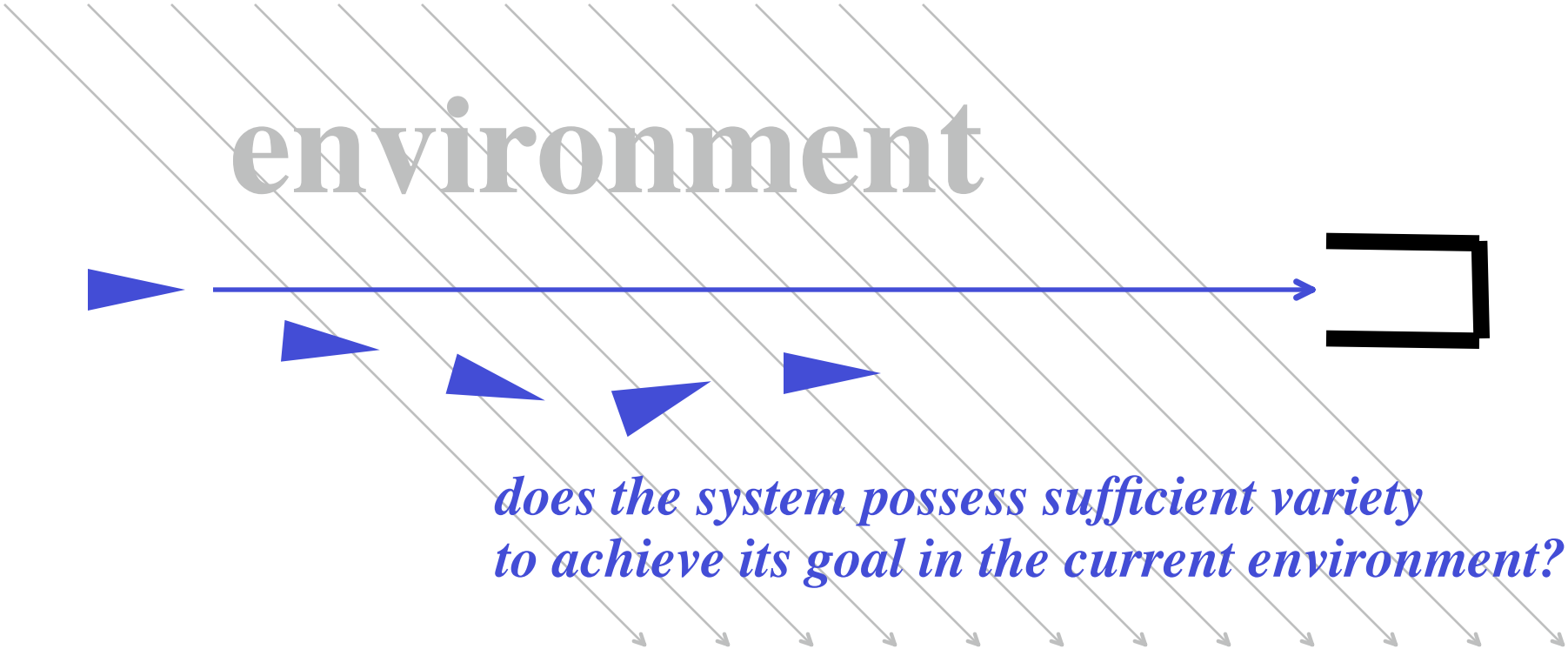
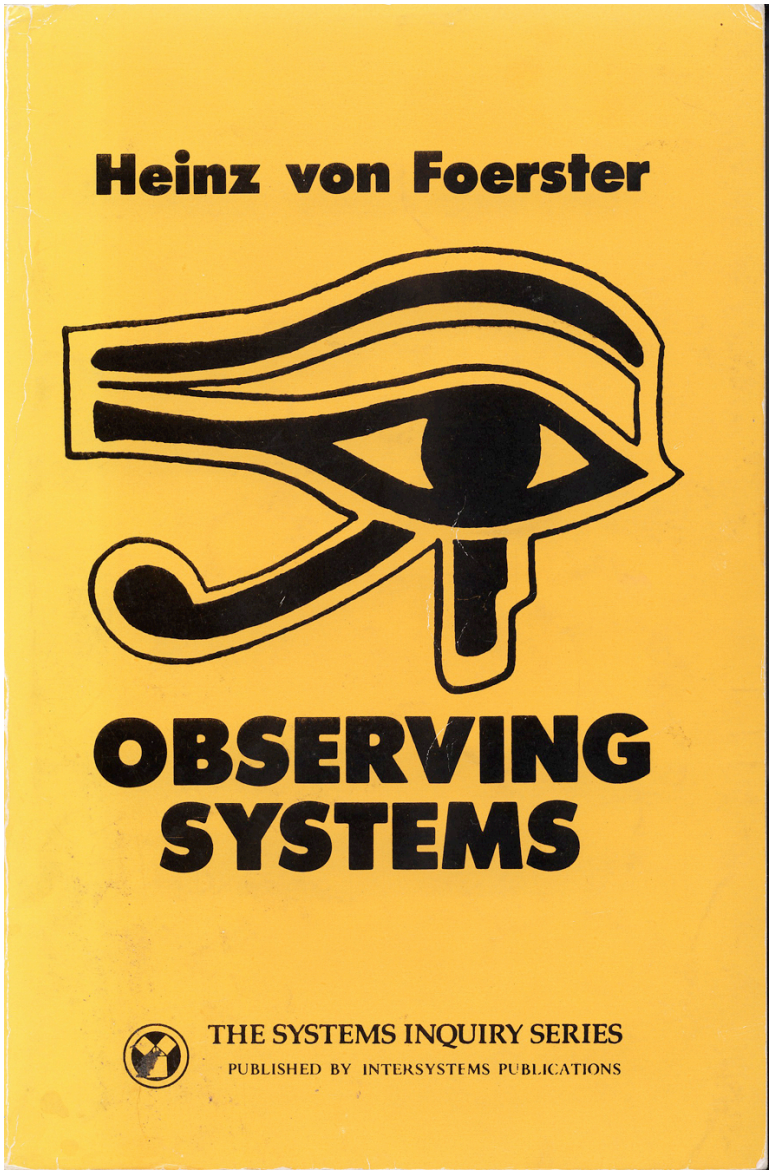
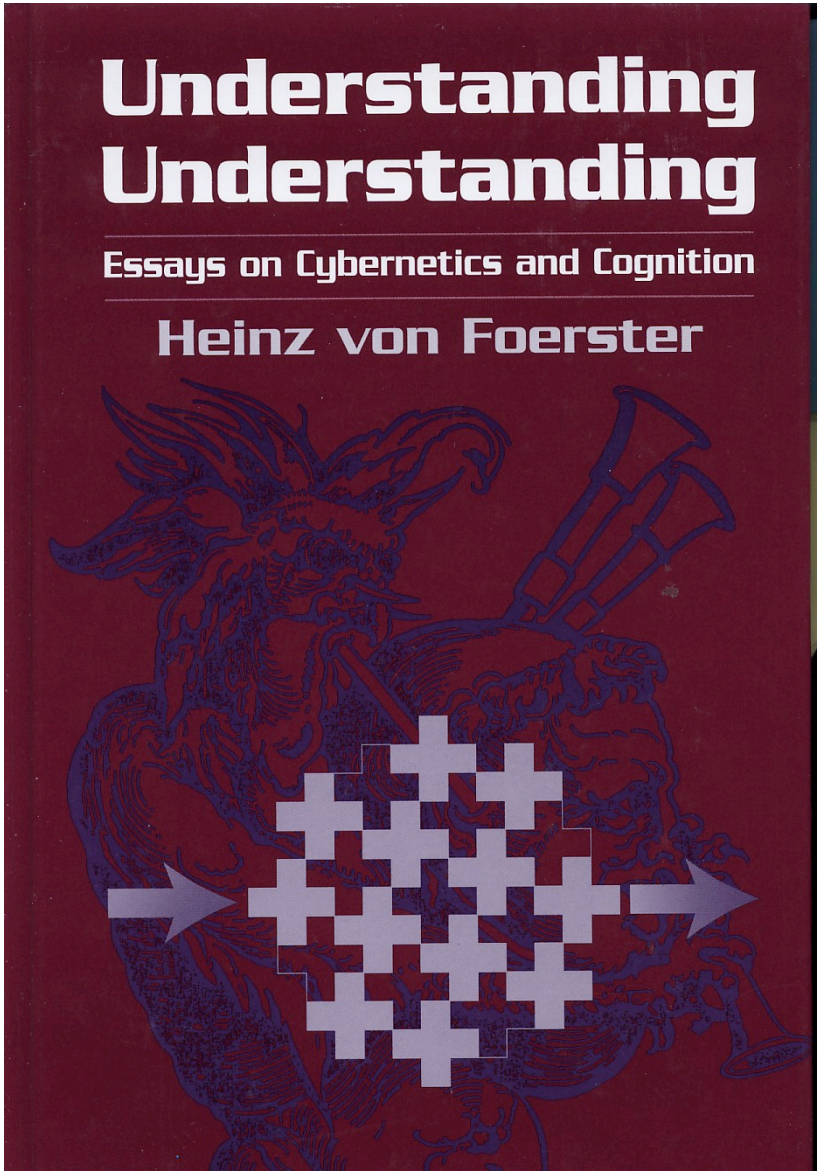


# von forester—circularity—understanding understanding

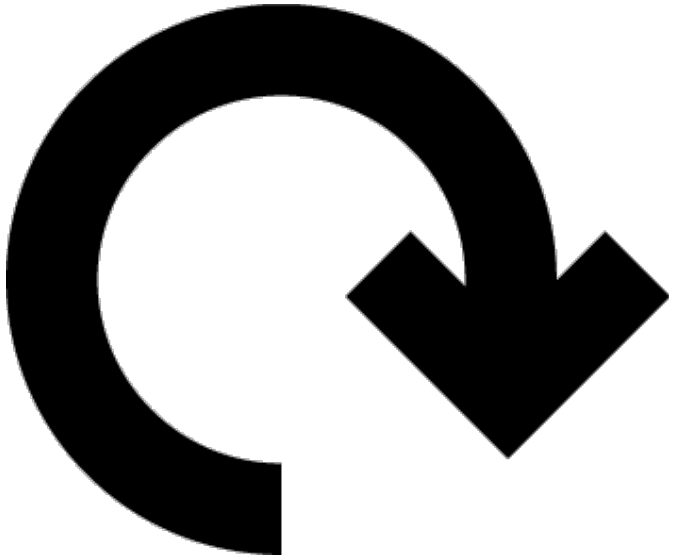


cybernetics—circularity—causality

‘Cybernetics introduces for the first time —
and not only by saying it, but methodologically —
the notion of circularity, circular causal systems.’

— *Heinz von Foerster*



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outline

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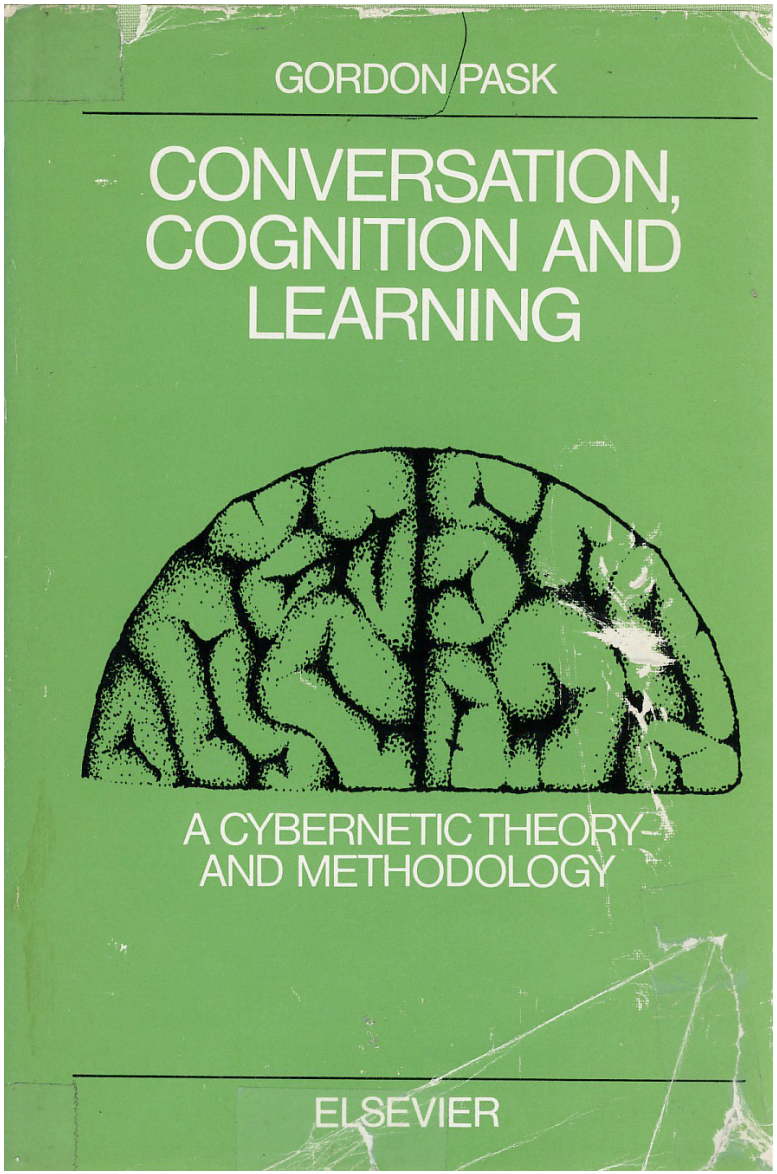
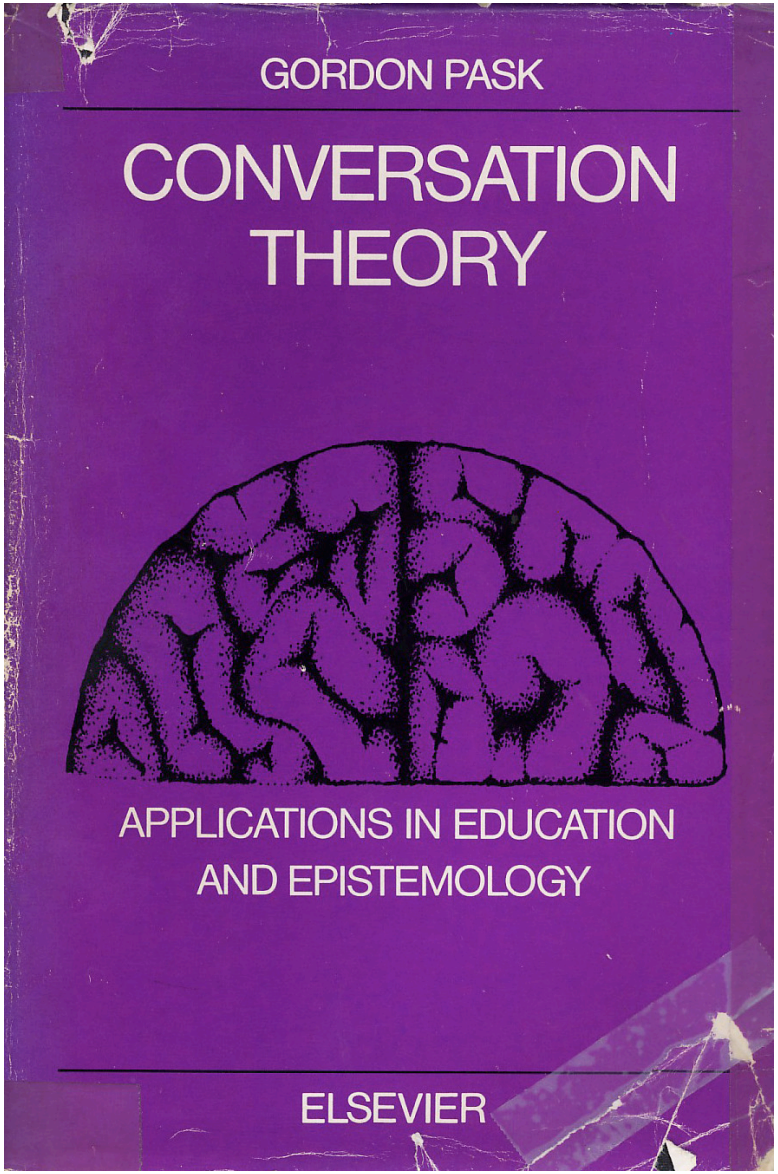
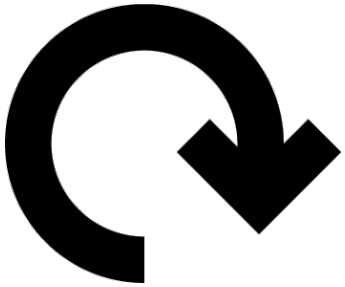
machines—interaction—conversation
cybernetic models—3 projects—interaction design
discussion

# machines—interaction—conversation



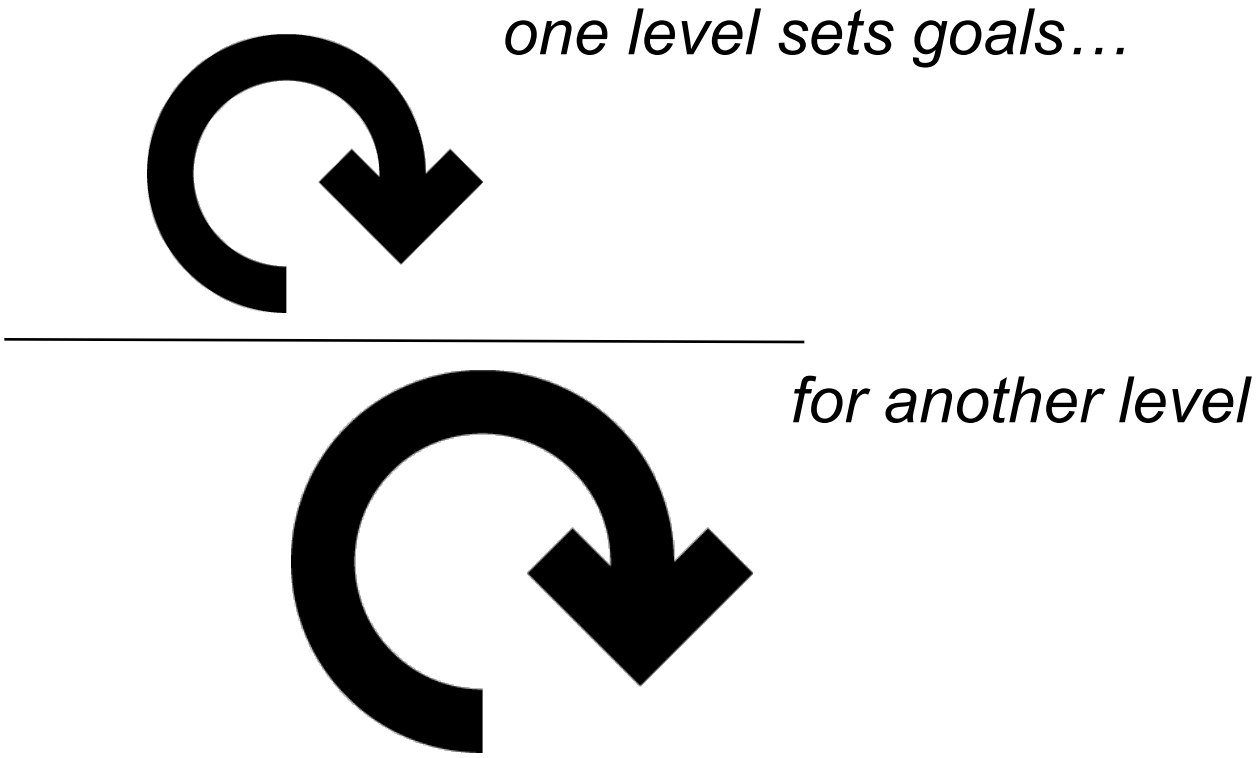



# machines—interaction—conversation

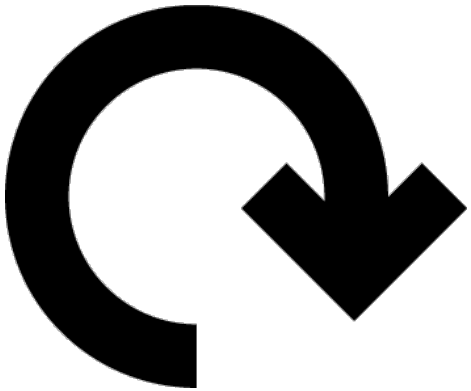


*one level sets goals…*

machines—interaction—conversation



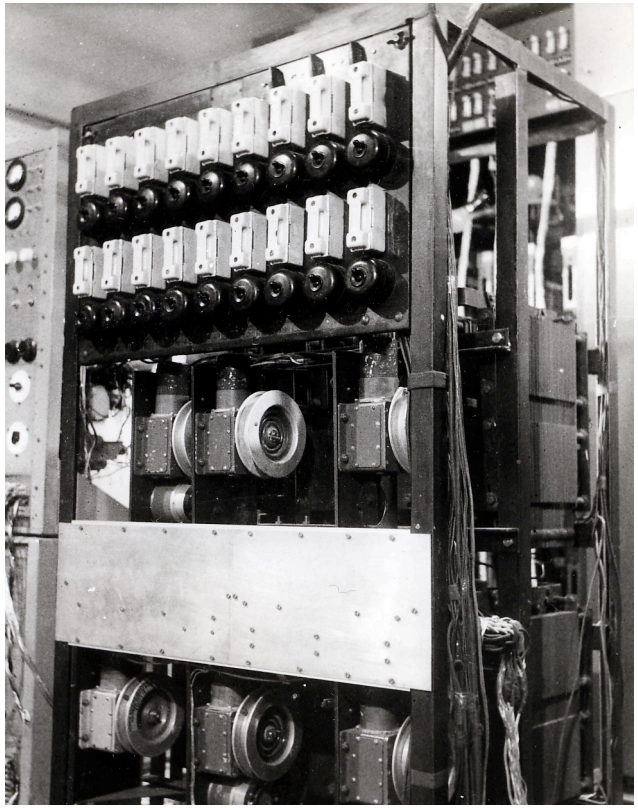
# gordon pask—circular interactions—musicolour



*respond to sound*
*with light show*

gordon pask—circular interactions—musicolour

*c. 1955*



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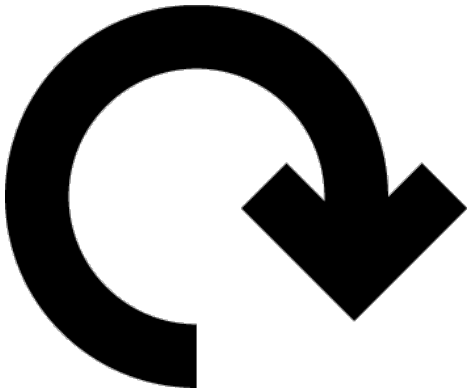
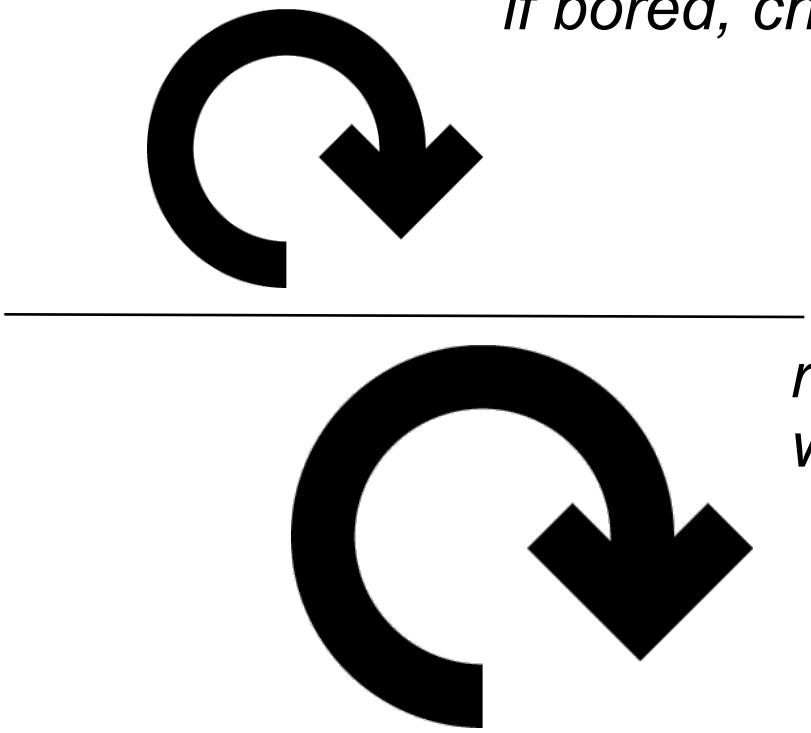


*respond to sound*
*with light show*

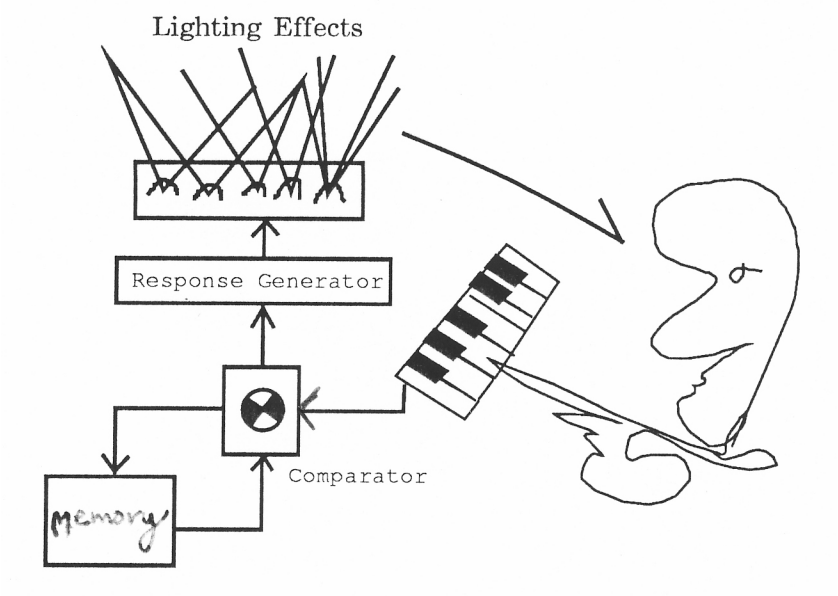
# gordon pask—circular interactions—musicolour



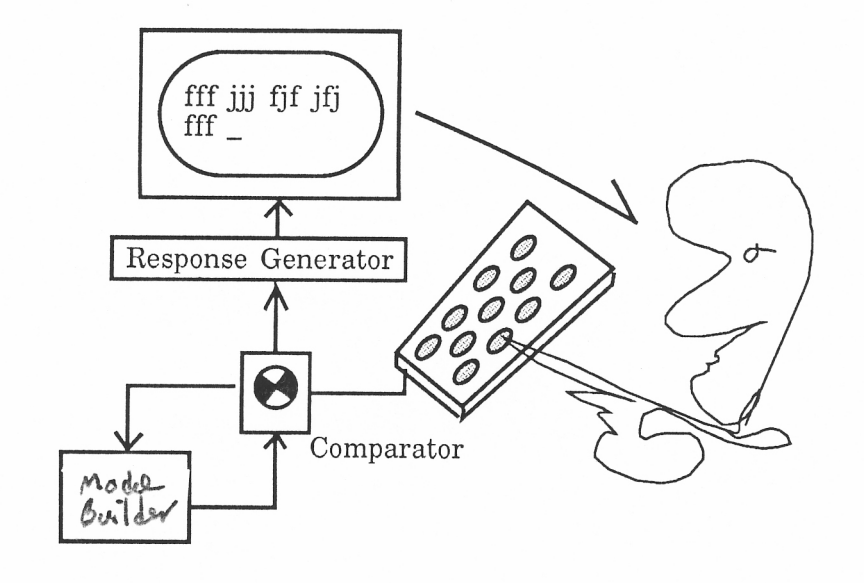
*if bored, change nature of response*

*respond to sound with light show*

# gordon pask—circular interactions—musicolour



# gordon pask—circular interactions—typing

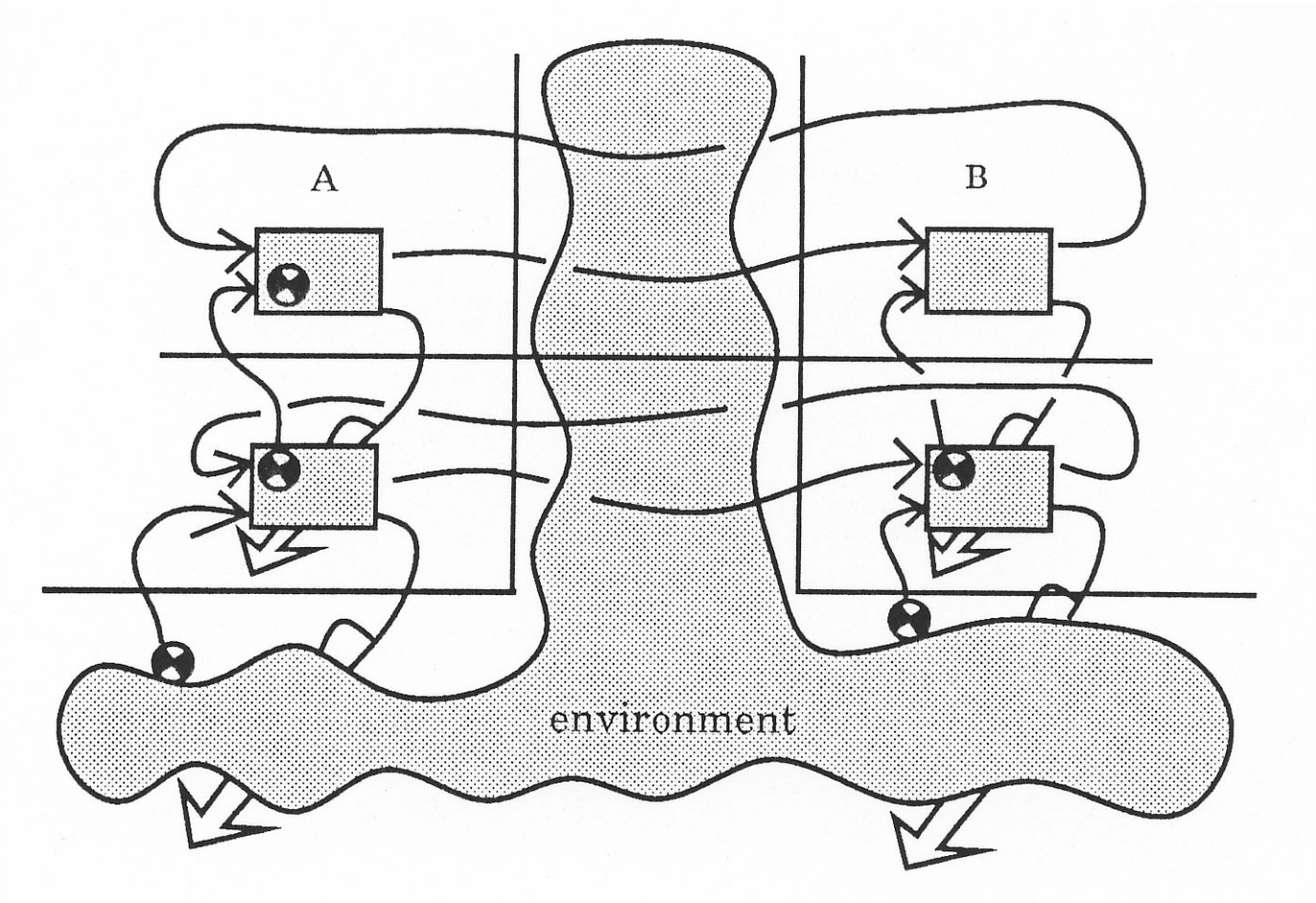


gordon pask—circular interactions—art installation

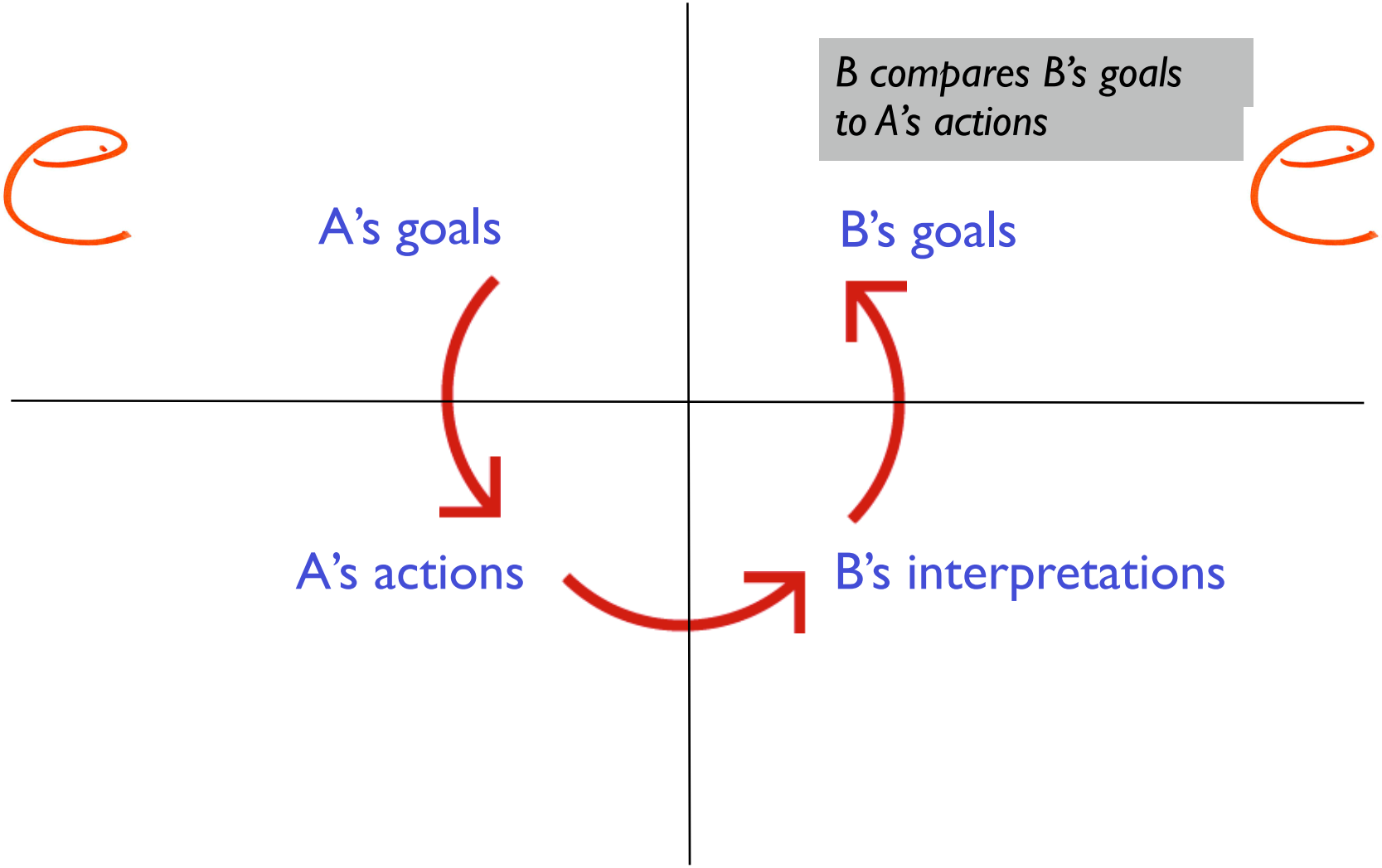
video

colloquy of mobiles—gordon pask—1968
*cyberneticians.com*

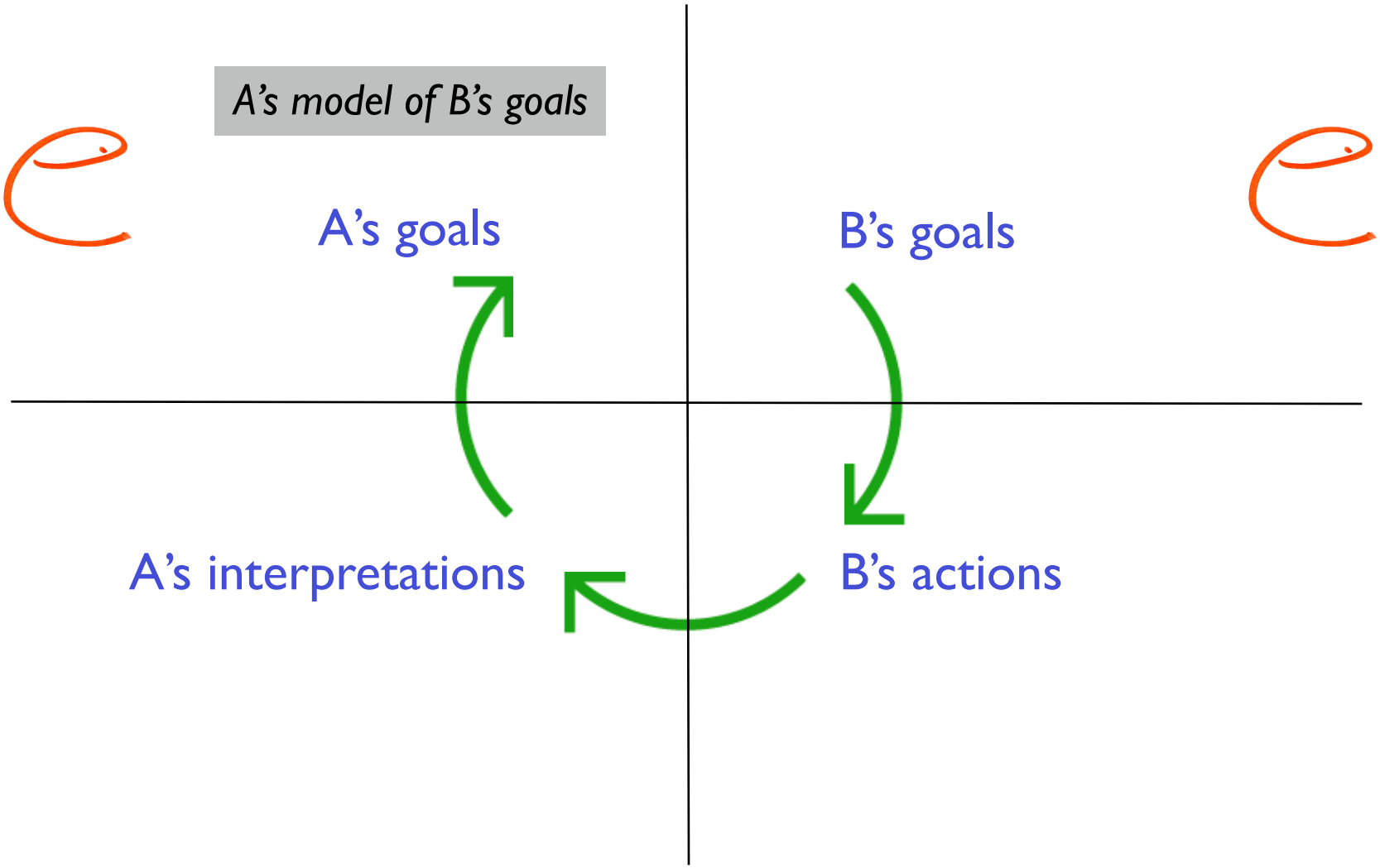
# gordon pask—circular interactions—modeling



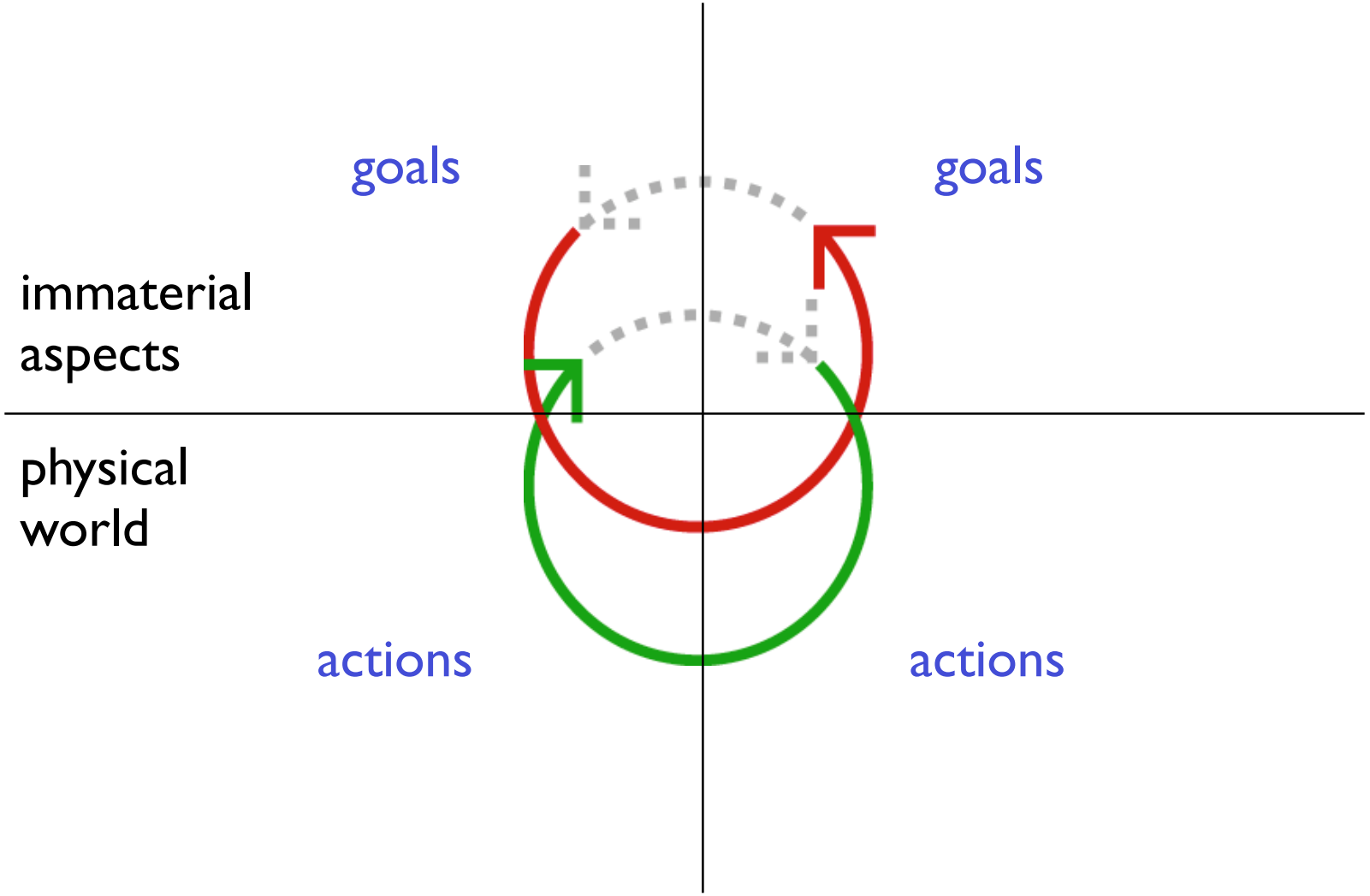
# architecture—participants—'interaction'



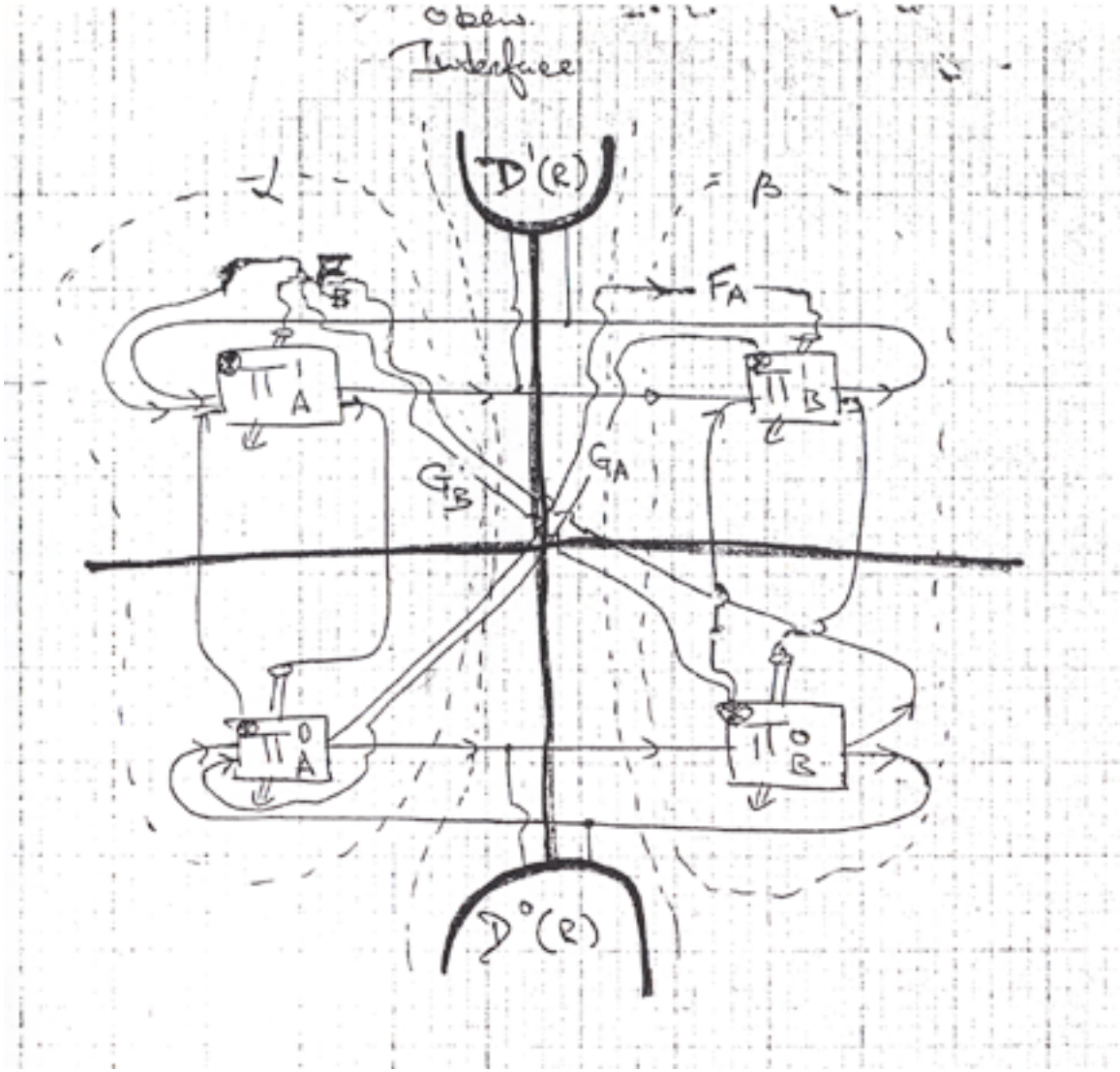
# history—cooperation—'relationship'



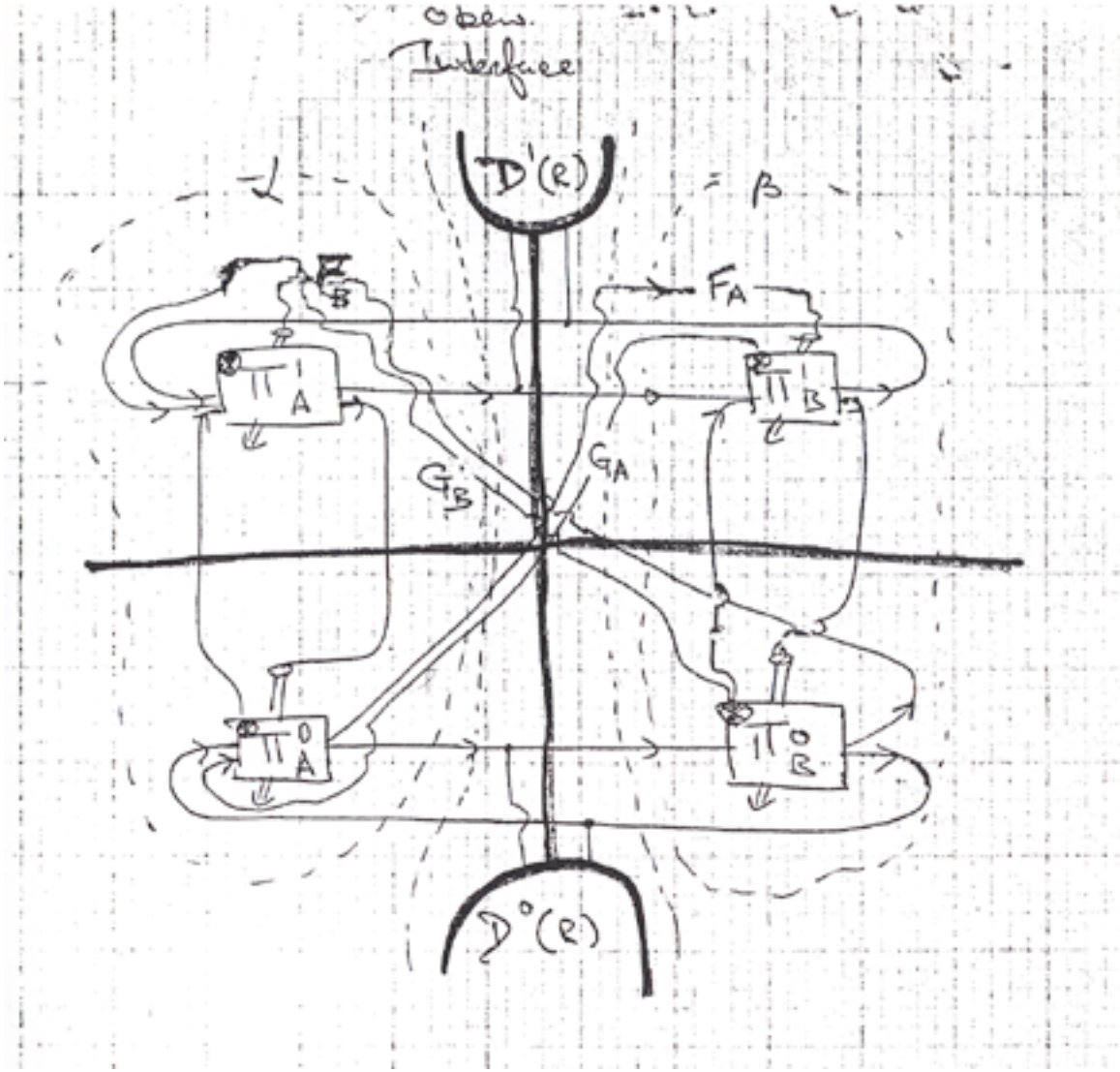
# shared models—immateriality—'conversation'



# dance—contention—shared outcomes



# subjectivity—synchronization—coherence



# media—interaction—cybernetics

outline

cybernetics—point-of-view—models
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—interaction modeling
—entailment-based user experience

# clicking—action—intent

what does it mean to click on a hyperlink?

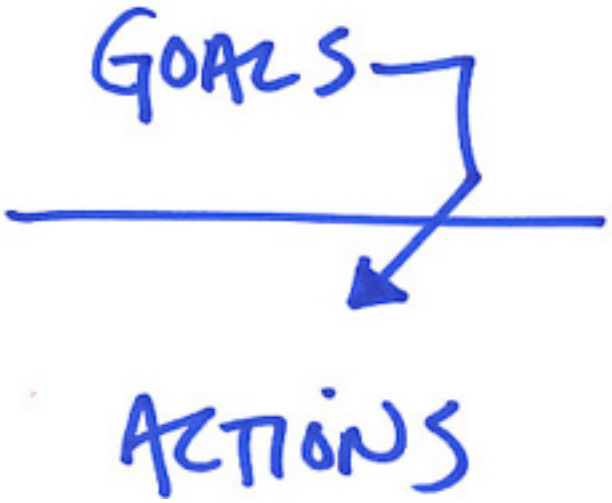
hot on the trail of something in my browser, and…

- I have no clue what it means to click here, so I just try it…
- I suspect the current page is totally irrelevant, so I'm hoping the next page is more what I want…
- I'm totally distracted by this interesting link, it having nothing to do with what I was just doing…
- I forget what my goal is, maybe I'll remember if I click here…

# clicking—action—intent


*after Pask*

# clicking—action—intent




*after Pask*

whose goal is it anyway?

‘P-Individual’ = psychological individual

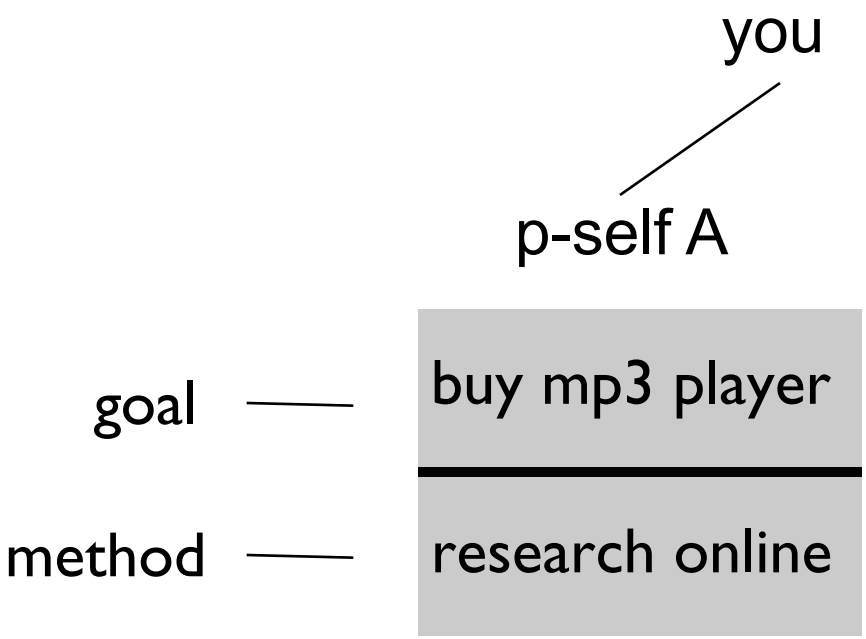
- a perspective, point-of-view, or goal
- a repertoire of consistent processes, all in service of the goal

‘User’ = collection of P-Individuals (a.k.a ‘p-selves’)

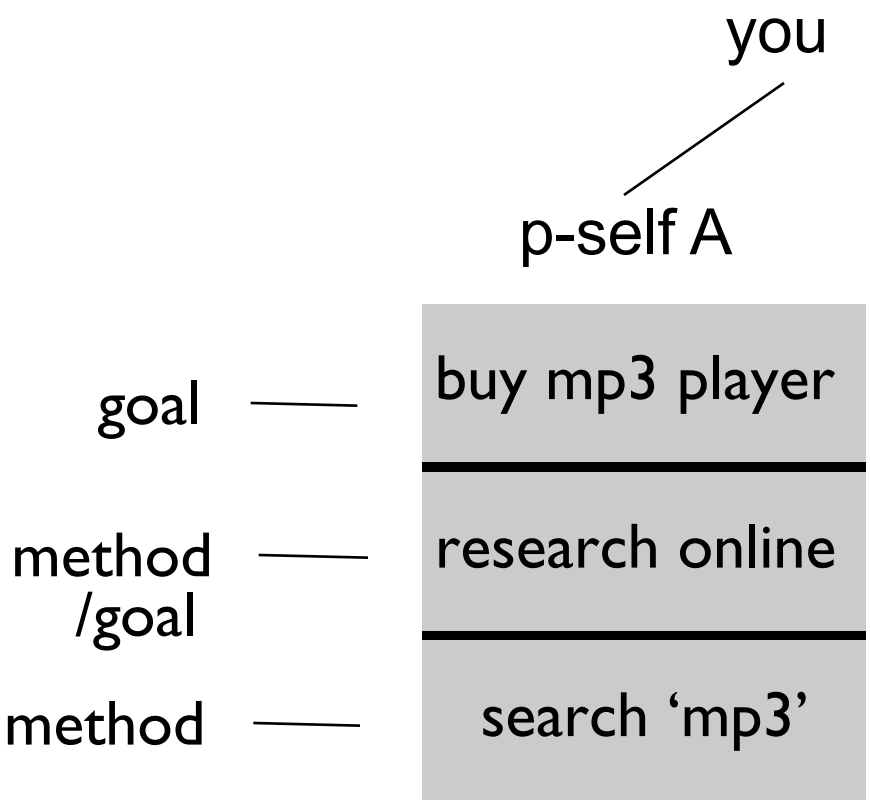
- not necessarily consistent in their goals
- shifting in priority or focus

*after Pask*

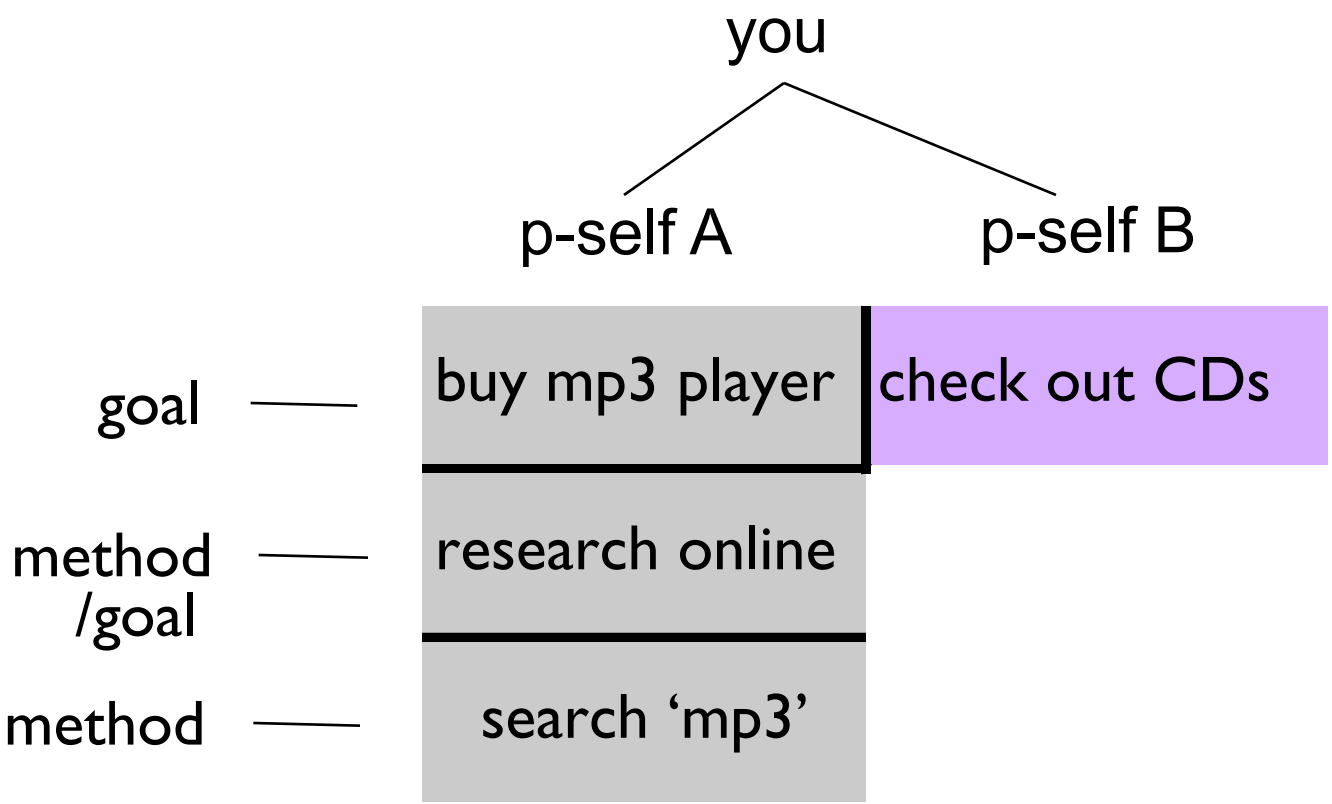
# goal model—construct—interaction



# goal model—construct—interaction



# goal model—construct—interaction



feature proposal—cybernetic modeling—linking

system captures my shifts in goals

- tracks and manages my changing focus
- allows for multiple perspectives (p-selves) in single user


Netscape: SerreptitiousSearch.com - Search Results
OnTheTrail.Net
I am now in OnTheTrail of
learning javascript
Go
JavaScript World
http://www.jsworld.com
This good-looking and useful Web site will help you learn more about the exciting Internet language. There is lots of information to absorb, and tons of great examples that will keep you busy for hours on end.
Listed in Snap Directory Computing: Internet: Web Building: JavaScript
Find more sites about: javascript, javascript help, javascript examples
Complete FREE Guide to HTML and JavaScript, The
http://www.geocities.com/SunsetStrip/Alley/5616
First select if you're using Netscape or Internet Explorer, then choose what language you'd like to learn more about. This tutorial-based site offers a thorough guide for the real novice Web site designer.

Netscape: SerreptitiousSearch.com - Search Results

## OnTheTrail.Net

**I am now in OnTheTrail of** learning javascript **Go**


**JavaScript World** www.jsworld.com
This good-l /eb site will help you learn more about the
exciting Inte e is lots of information to absorb, and tons of
great examp u busy for hours on end.
Listed in Sn ting: Internet: Web Building: JavaScript
Find more sites about: javascript, javascript help, javascript examples

**Complete FREE Guide to HTML and JavaScript, The**
http://www.geocities.com/SunsetStrip/Alley/5616
First select if you're using Netscape or Internet Explorer, then choose what language you'd like to **learn** more about. This tutorial-based site offers a thorough guide for the real novice Web site designer.
Listed in Snap Directory: Computing: Internet: Web Building: Formatting

# feature proposal—cybernetic modeling—linking

replace ‘Open Link in New Tab’ with

| | |
|---|---|
| ‘Seek Goal’ | pursue link for current goal to ‘learn javascript’ |
| ‘Next Goal’ | remember url as future goal, but continue to ‘learn javascript’ |
| ‘Seek Next’ | pursue link as new current goal, and shift focus to ‘find javascript programmer’ |

feature proposal—cybernetic modeling—linking

organizes my windows into goal threads

maintains my contexts for multiple, simultaneous, multi-windowed goals

makes re-tracing more efficient

combines history, bookmarks, back, forward

minimizes separate functions, increases control

produces a re-usable research record to share

# media—interaction—cybernetics

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—entailment-based user experience

goal-making—participation—double-loop systems

# participative systems

*http://pangaro.com/PS*

# ‘participants’

act on their own

behave in complex ways that make sense to us

interact with us directly

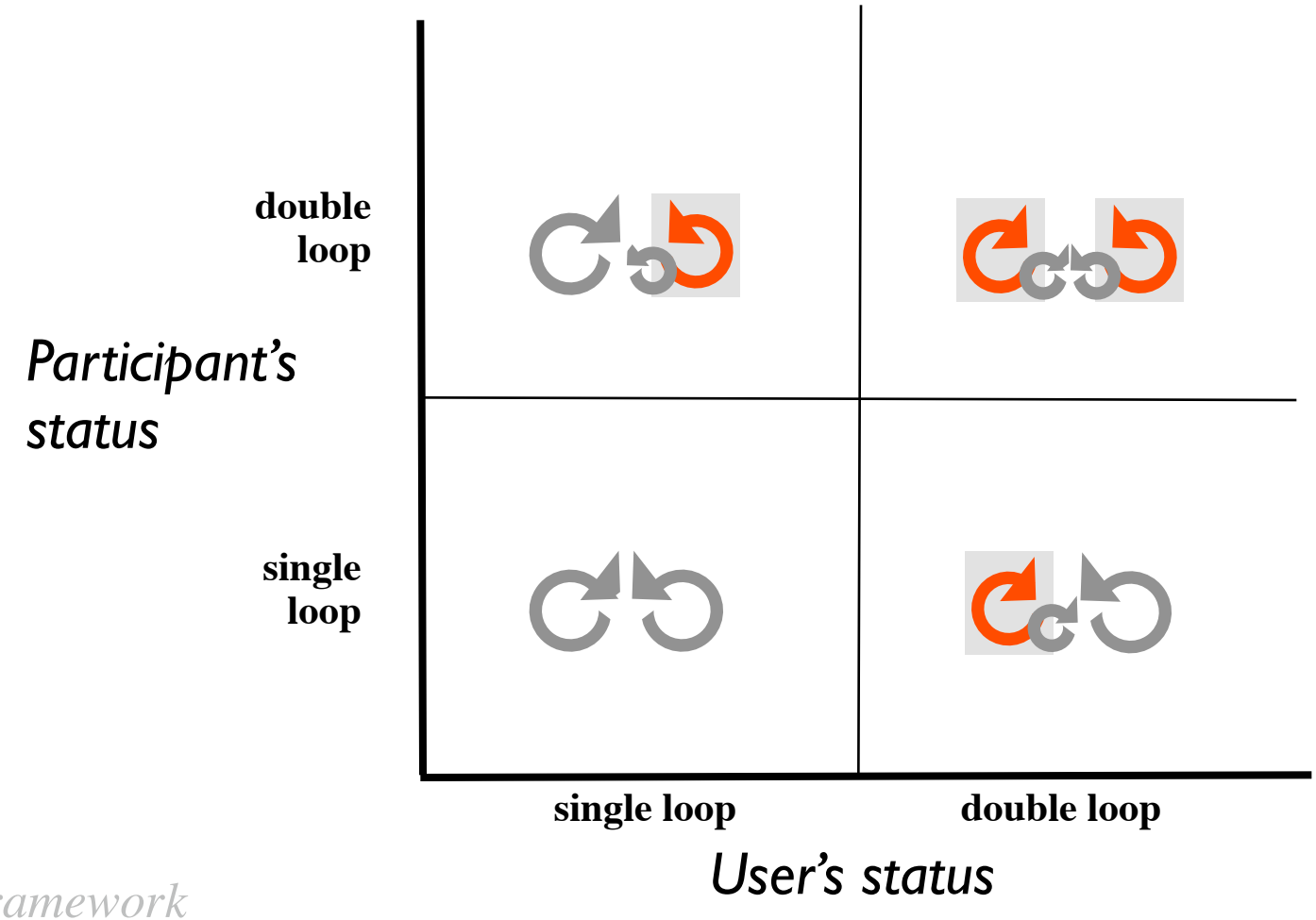
work with us in achieving our goals

modify their own goals

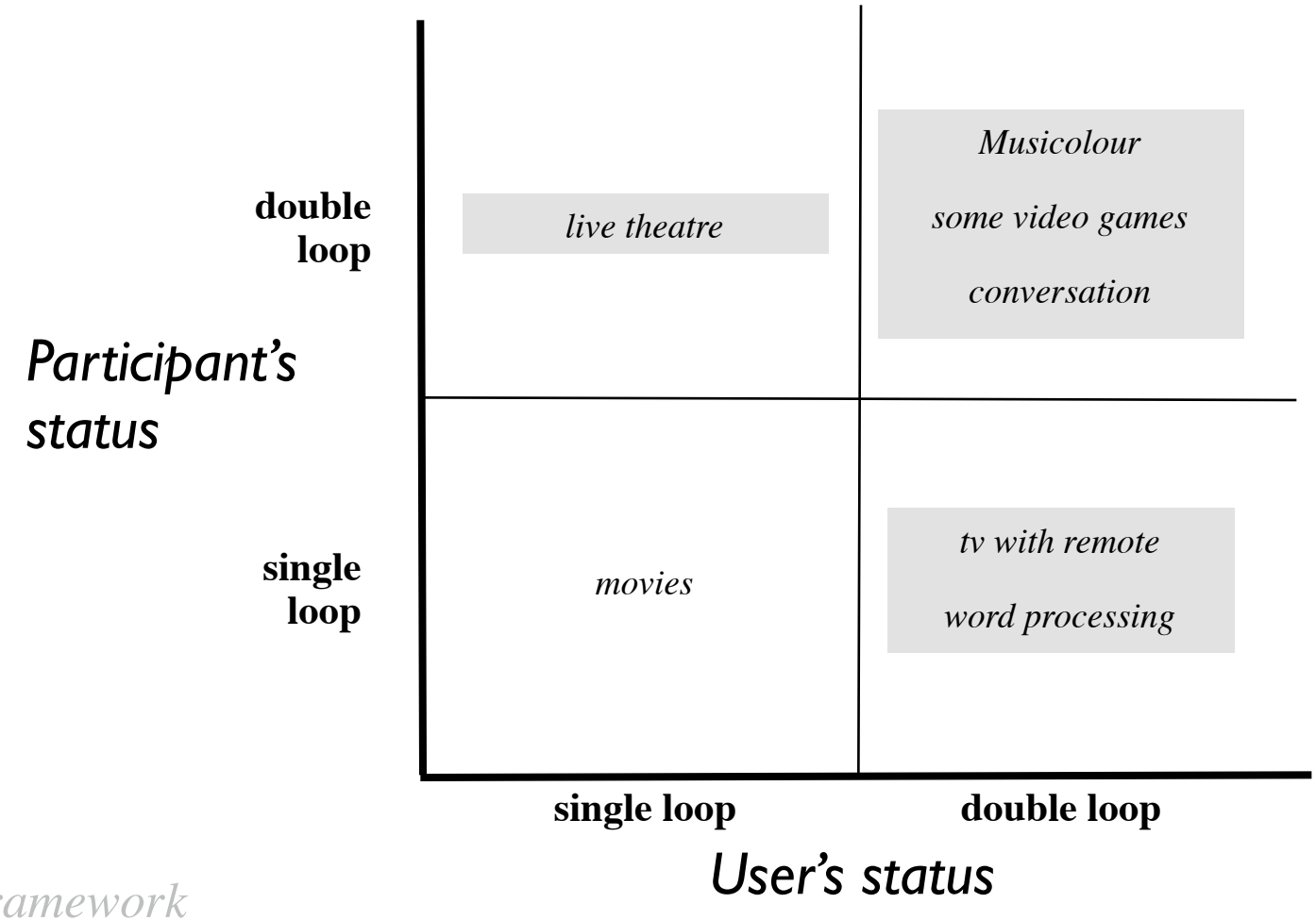
collaborate with us in the creation new goals

collaborate with us on the design of new partners

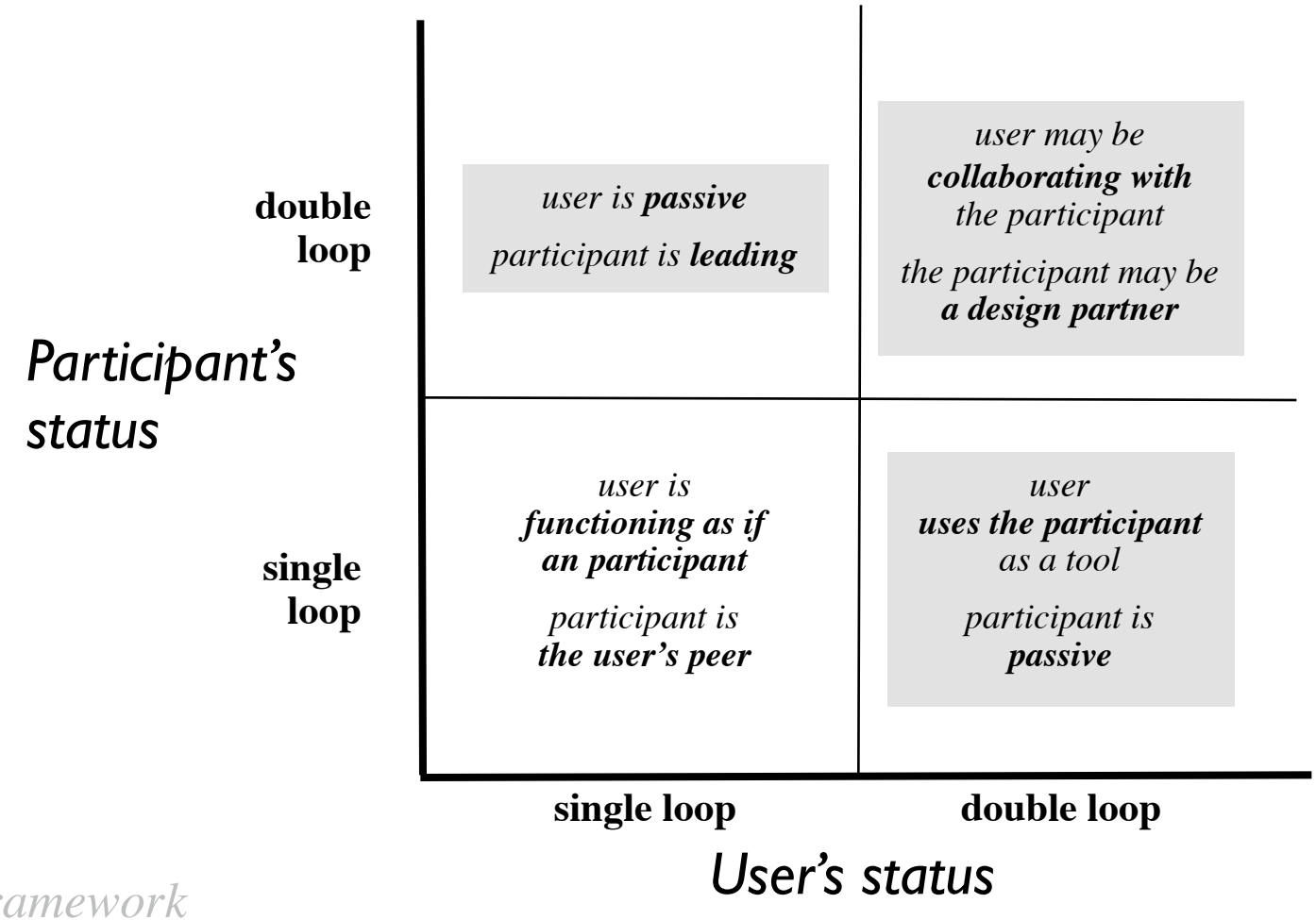
# space of participative systems



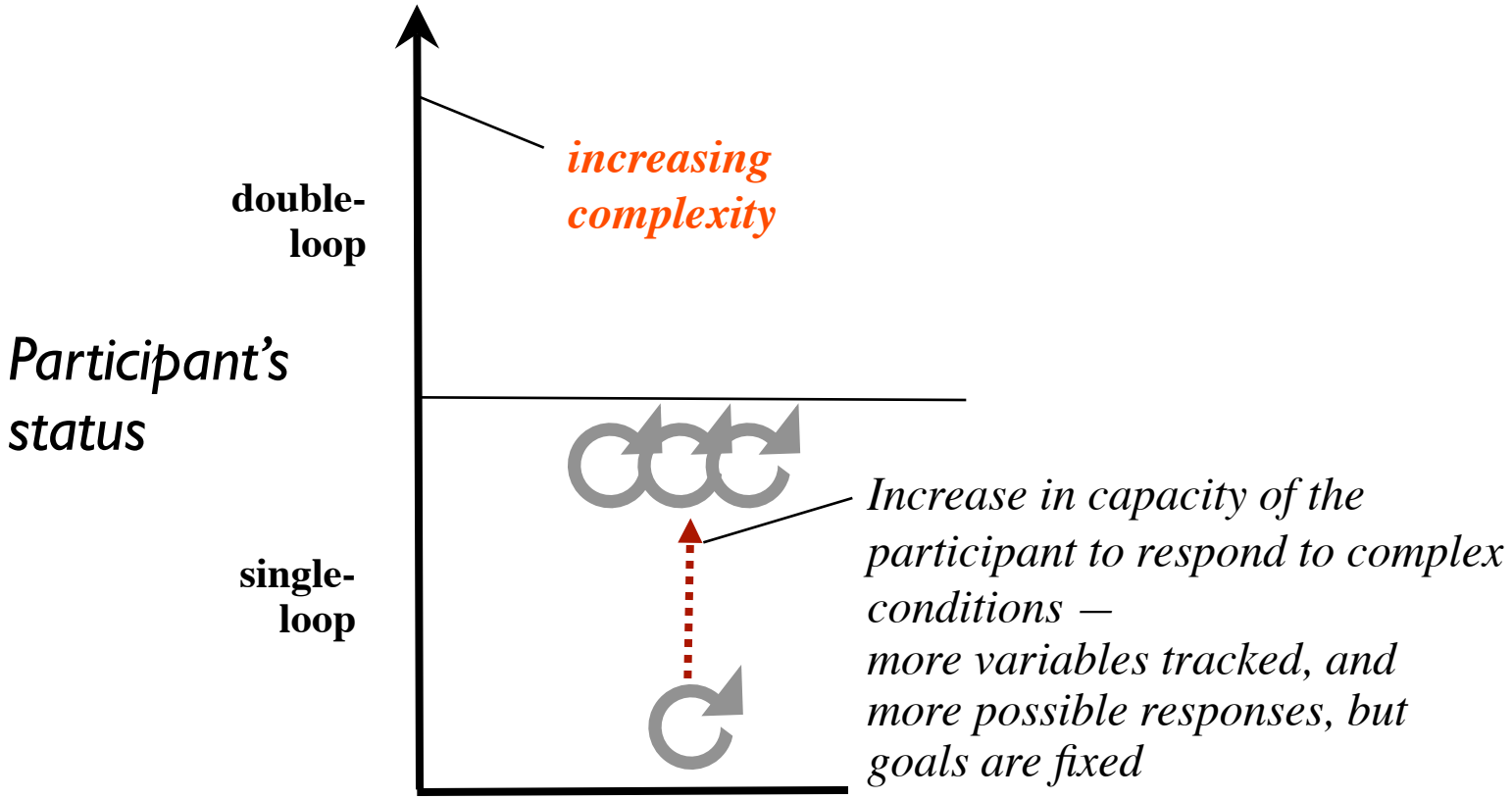
# system variations — interactive media



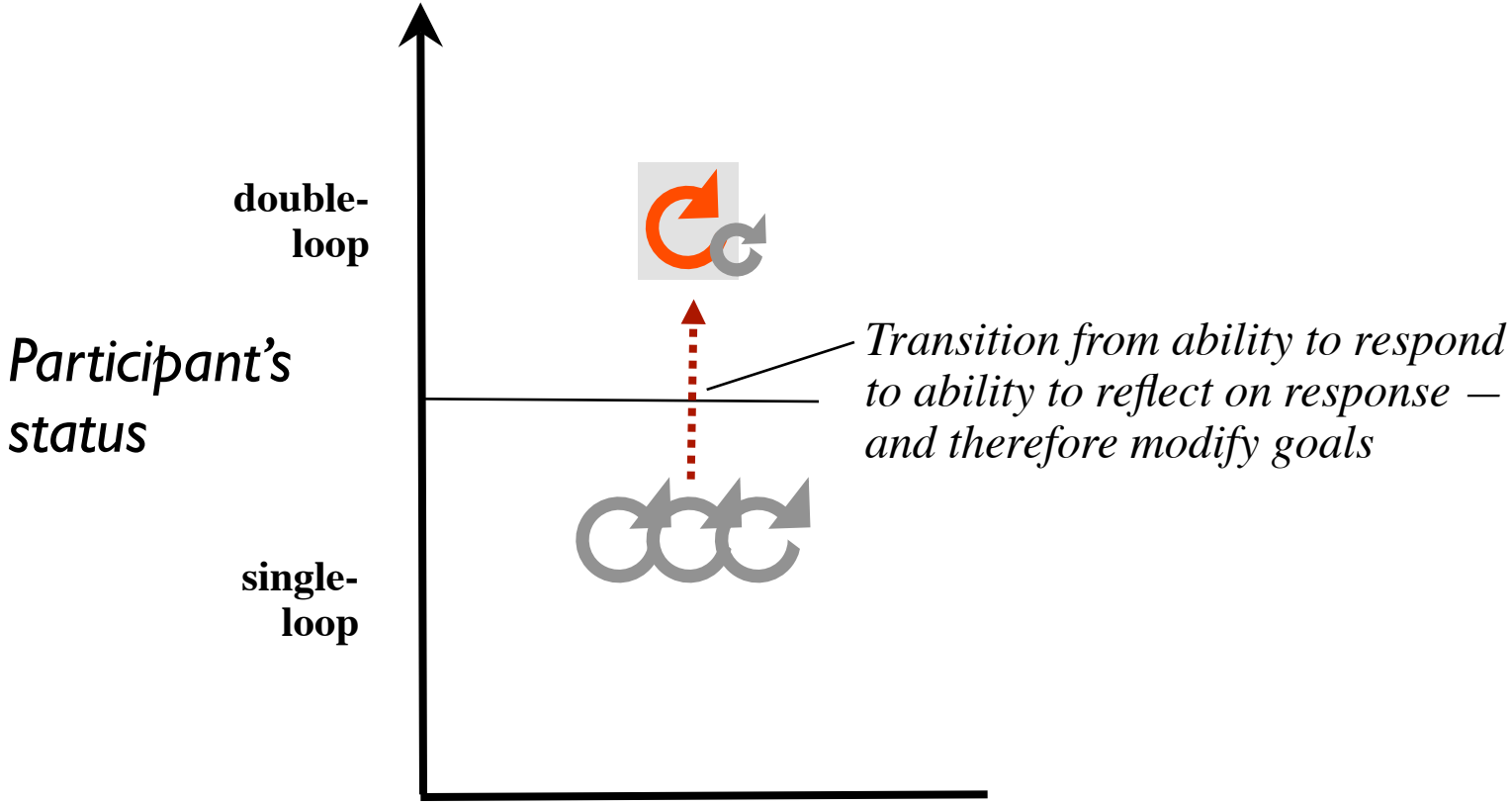
# system variations — summary



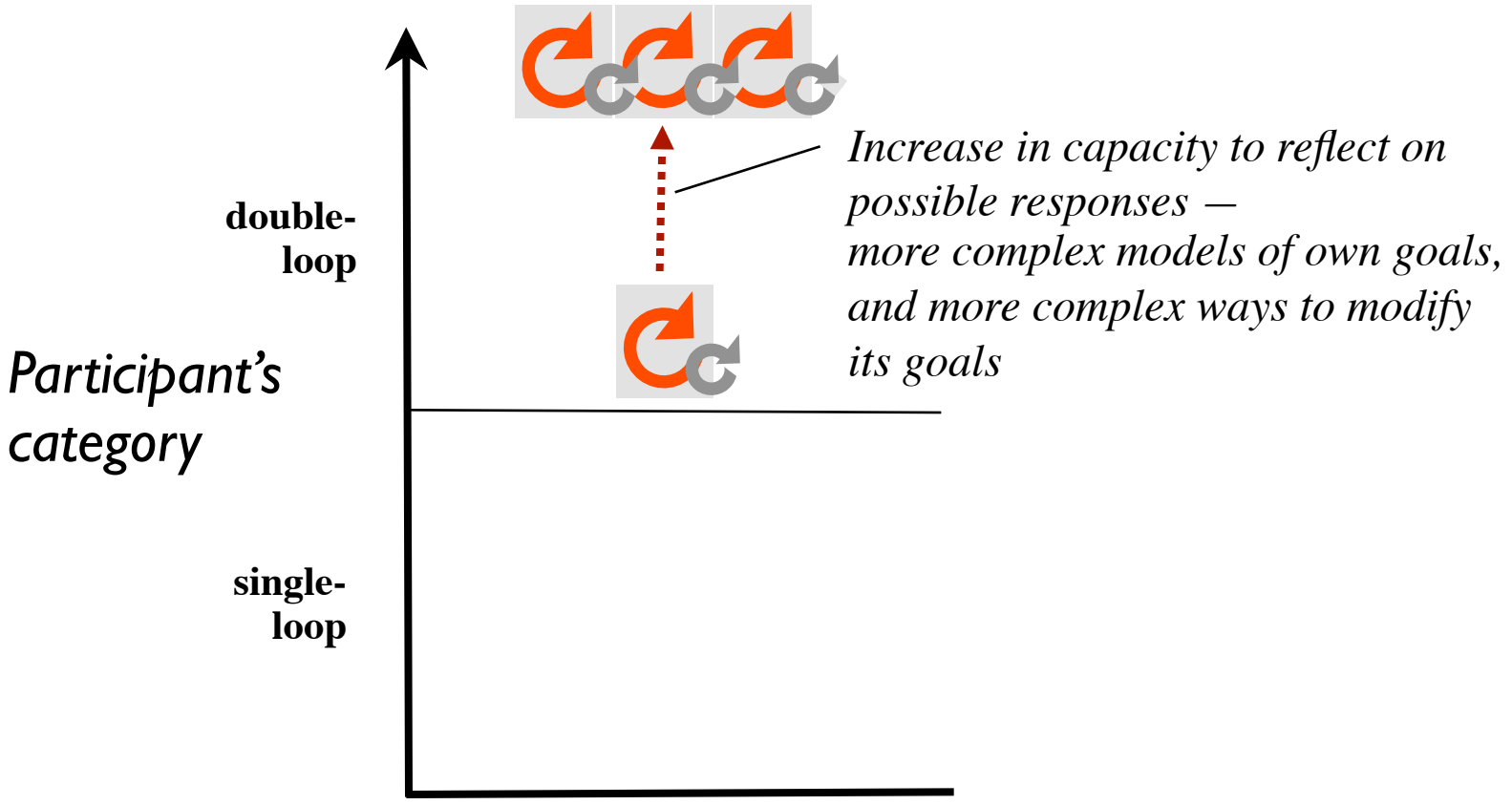
# increasing system variety — single-loop



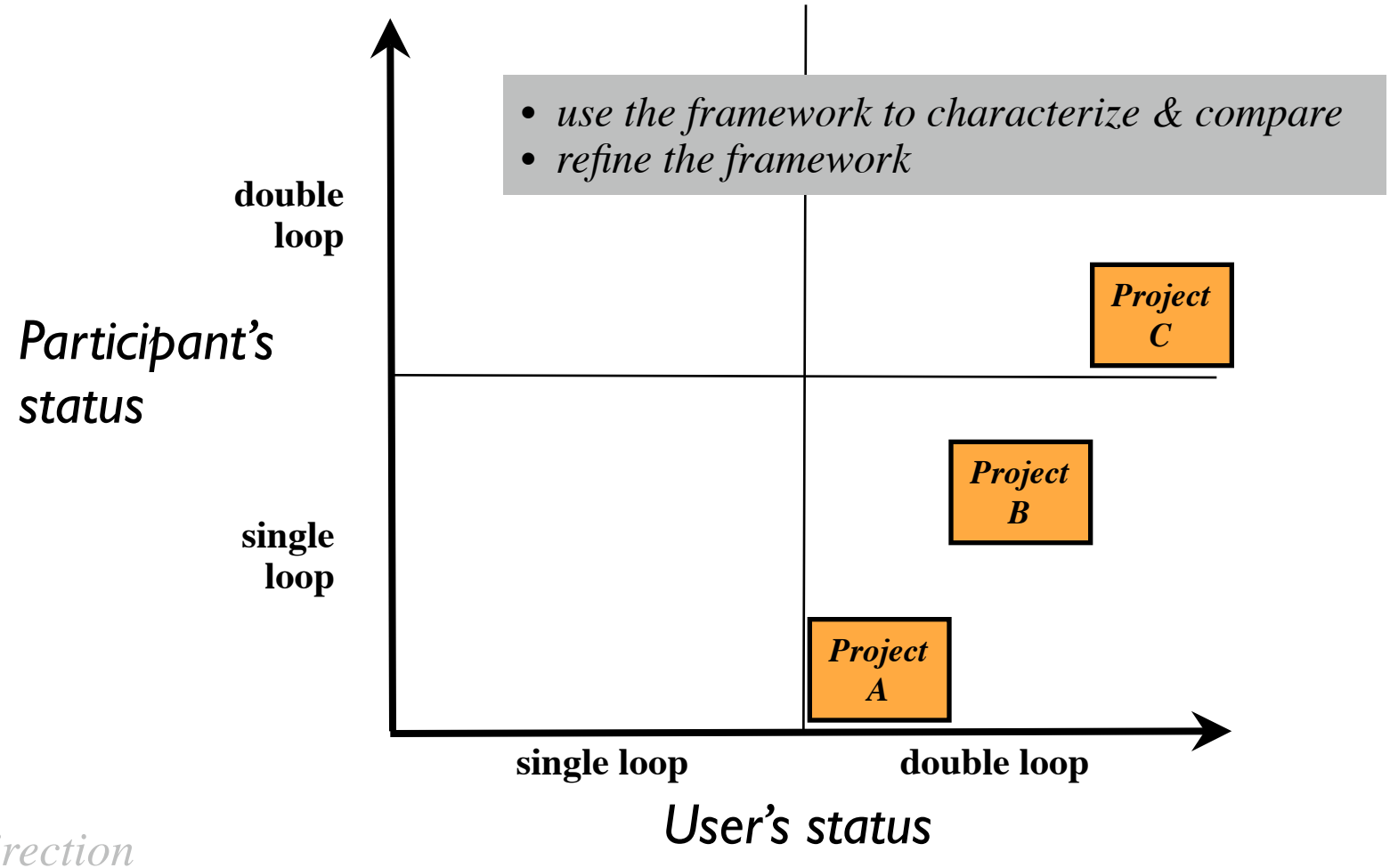
# increasing system variety — transition to double loop



# increasing system variety — double-loop

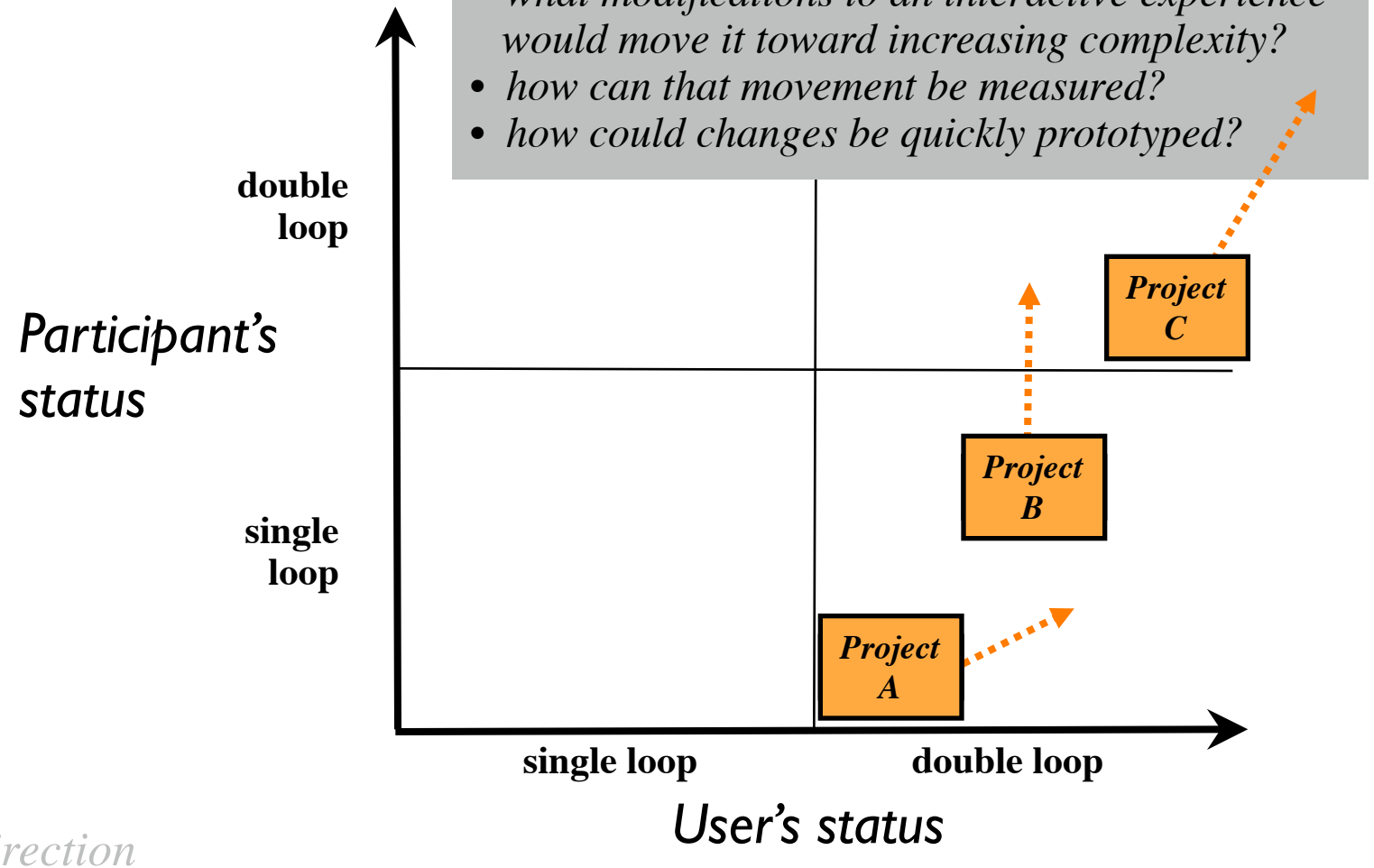


# categorize media projects



# propose interactivity metrics

- *what modifications to an interactive experience would move it toward increasing complexity?*
- *how can that movement be measured?*
- *how could changes be quickly prototyped?*



# summary goals for participative systems

encompass complexity, collaboration, and goal-directed systems in a single framework

provide a framework to characterize, compare, and extend any given product or service

propose a means to construct collaborative design partners

# media—interaction—cybernetics

outline

cybernetics—point-of-view—models
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# meaning-making—participation—entailment

| 27 texts<br>16 terms | This software, called THOUGHT SHUFFLER, helps you create, navigate, and understand electronic content of any sort. Click around to start shuffling. | Terms can be defined by you, defined ahead by the author, or suggested by thought shuffler. | Terms can be found in the text automatically by thought shuffler and offered as suggestions. |
|---|---|---|---|
| THOUGHT SHUFFLER | THOUGHT SHUFFLER | THOUGHT SHUFFLER | THOUGHT SHUFFLER |
| CELLS | | | |
| CLICK | CLICK | | |
| SINGLE CLICK | | | |
| DOUBLE CLICK | | | |
| SUGGESTIONS | | | SUGGESTIONS |
| UNDERSTAND | UNDERSTAND | | |
| DEMOS | | | |
| TERM | | TERM | TERM |
| NEW TERM | | | |
| TEXT | | | TEXT |
| NEW TEXTS | | | |
| PERMISSION | | | |

http://pangaro.com/thoughtshuffler

# cybernetics quoted

'…communication and control in animal and machine'
— *Norbert Wiener*

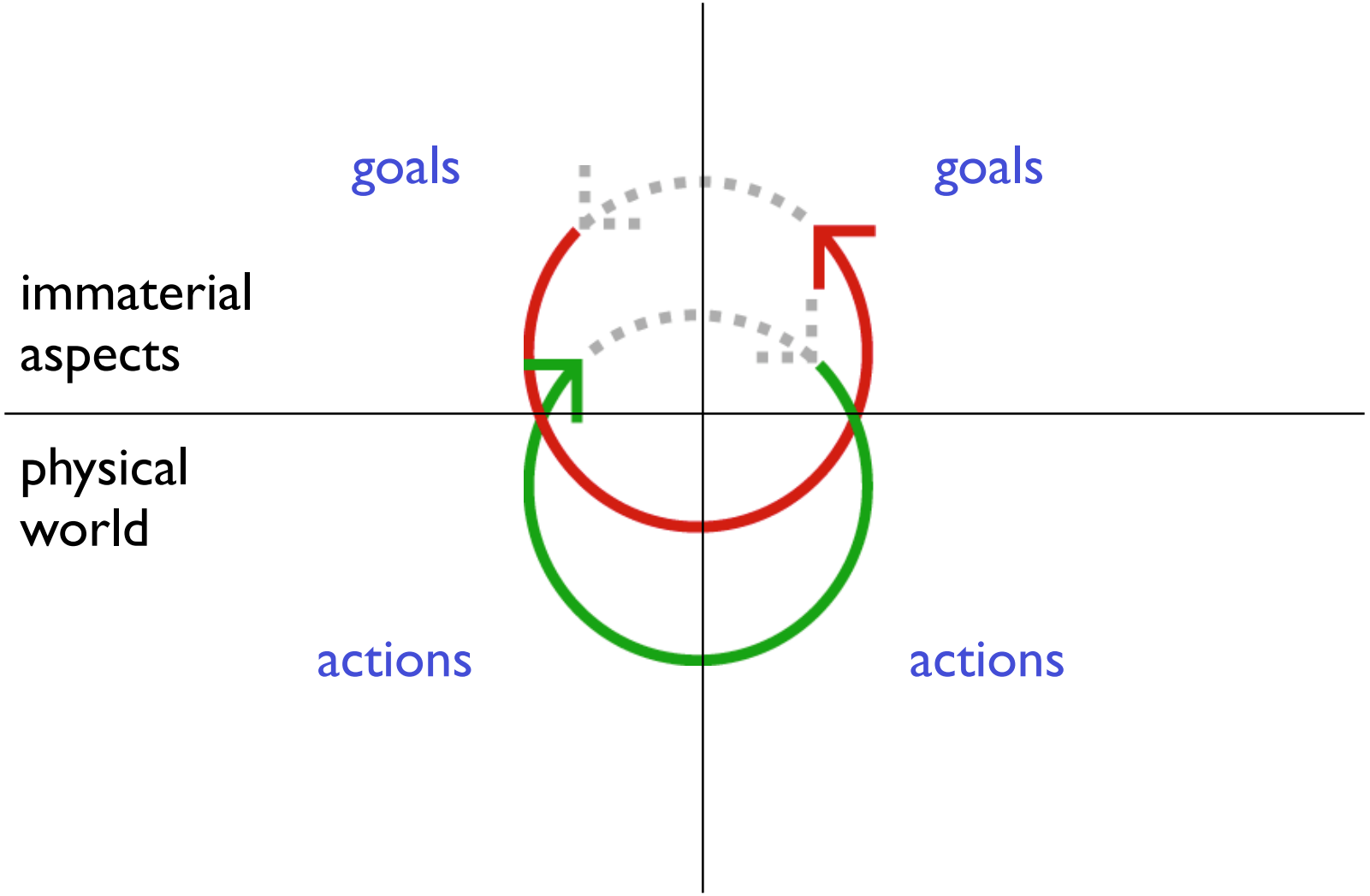
'… the science of observing systems'
— *Heinz von Foerster*

'… the art of defensible metaphors'
— *Gordon Pask*

'… the study of the immaterial aspects of systems'
— *W. Ross Ashby*

'… only practiced in Russia and other under-developed countries'
— *Marvin Minsky*

# shared models—immateriality—'conversation'



# humberto maturana—languaging—living together


Aqua Ri:
Ri
Ri
Corpus

# cybernetics summarized

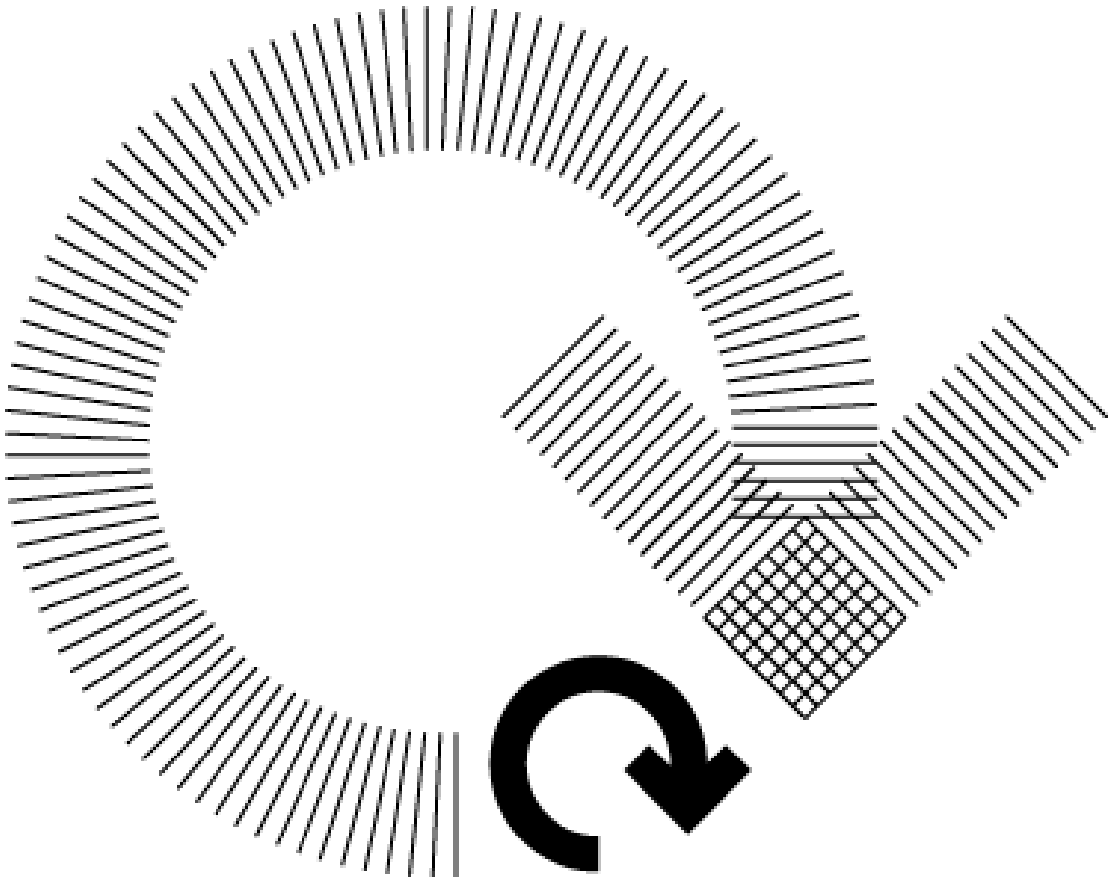
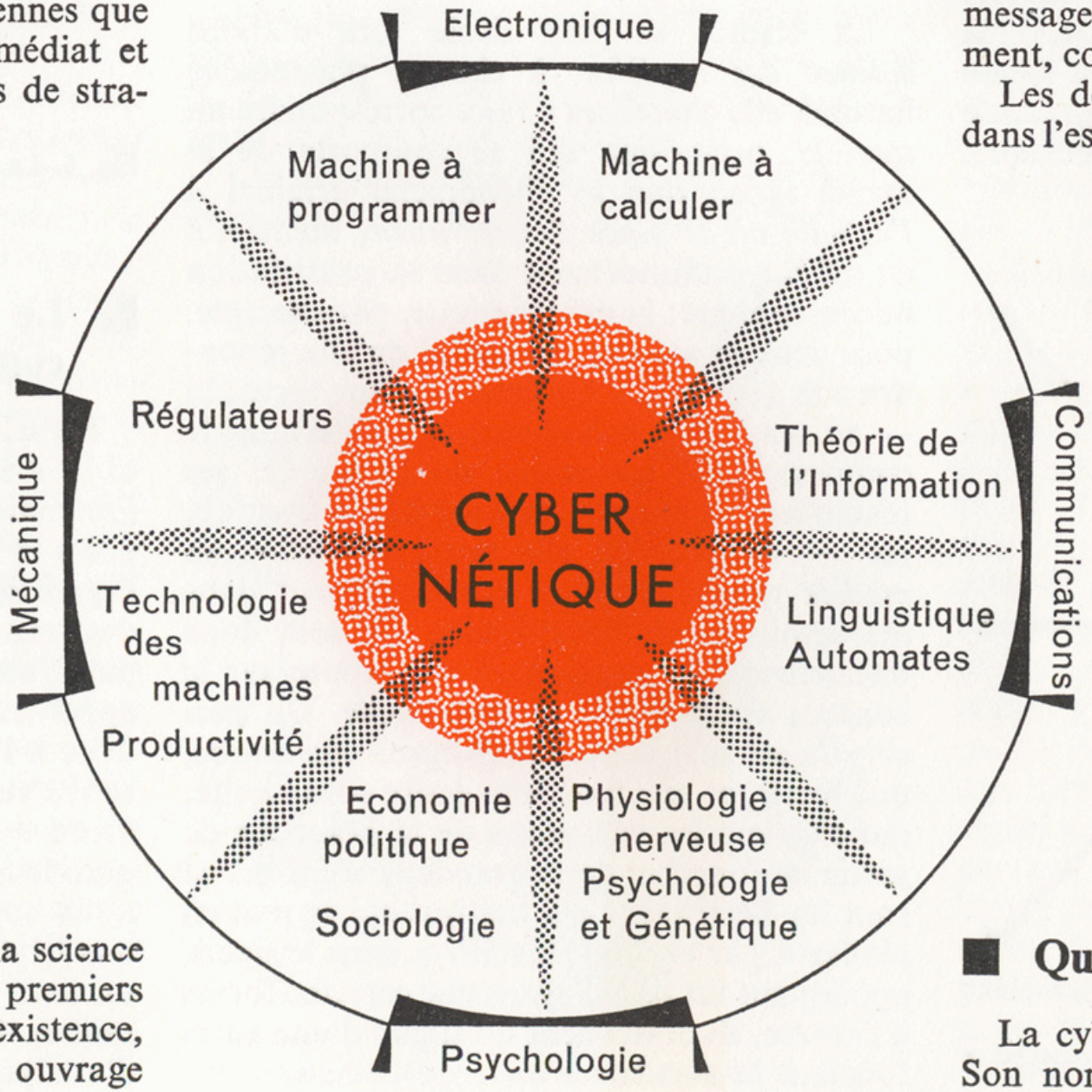


Fig. 2. Cybernétique, science-carrefour.

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des vieux
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son œuvr
et van Ker
quelquefo
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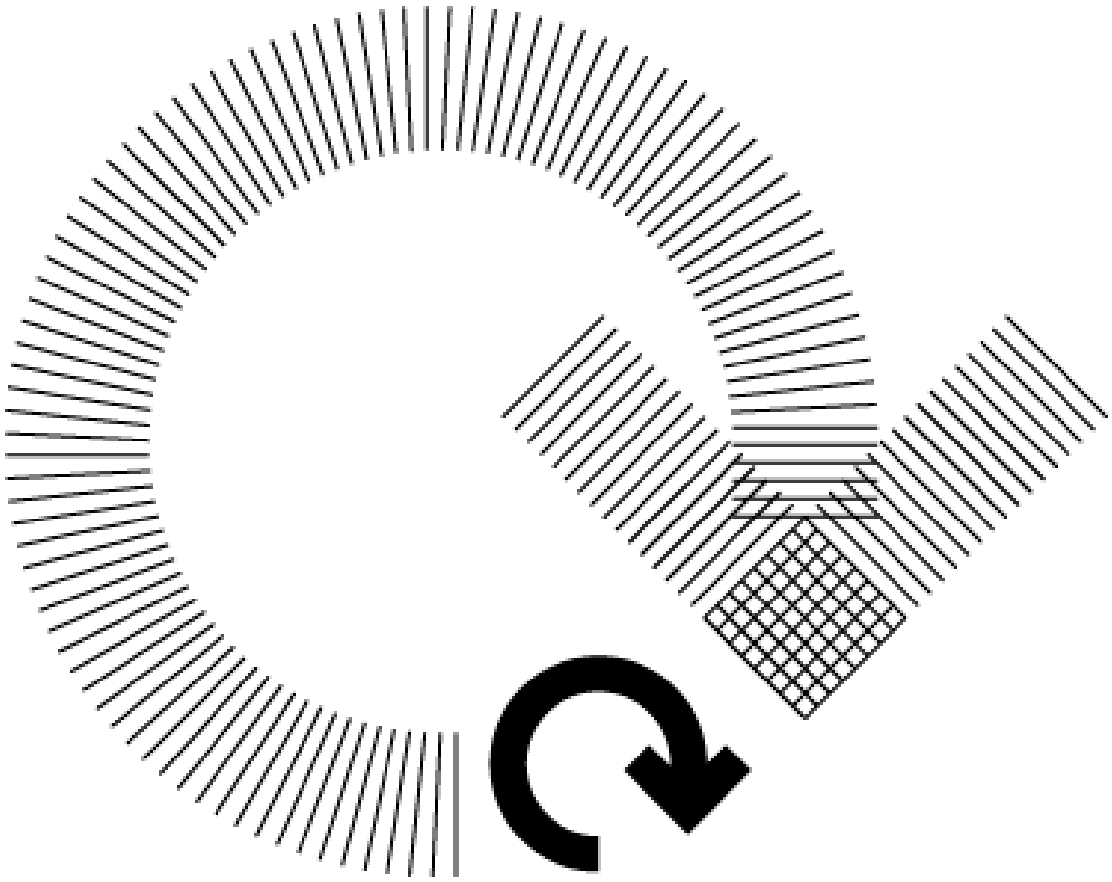
de la cybe

## Qu'est-ce que

La cybernétique e
Son nom platonicie

# appendices & support slides



# goals of cybernetic modeling

see causality as a loop

- shift from hierarchy of power to participation in shared goals

place actions in the context of goals

understand what is possible for a system

- possibilities are defined by 'requisite variety' (rv)
- rv enables the design of changes to the system to improve it

measure the degree of mutual understanding

- define 'conversation', 'agreement'

define and realize 'intelligent systems'

discuss participation, choice, ethics

# domain of cybernetic modeling

includes goals — the 'why' of actions as well as 'how'

- systems are defined by boundaries
- systems have goal(s)
- information flow from the environment to the system relevant to achieving a goal defines 'feedback'

goals bound to actions, actions bound to goals — *'through-looping'*

systems as abstractions

- not about what a system is made of
- not delimited by subject domain or discipline or distinctions such as biological, physical, ecological, psychological, or social

# scope of cybernetics

explanation of communication = *psychology*
modeling of learning = *cognitive science*
limits of knowing = *epistemology*
hearer makes the meaning = *post-modernism*
reality as social construction = *constructivism*
reliable methodologies of describing = *science*

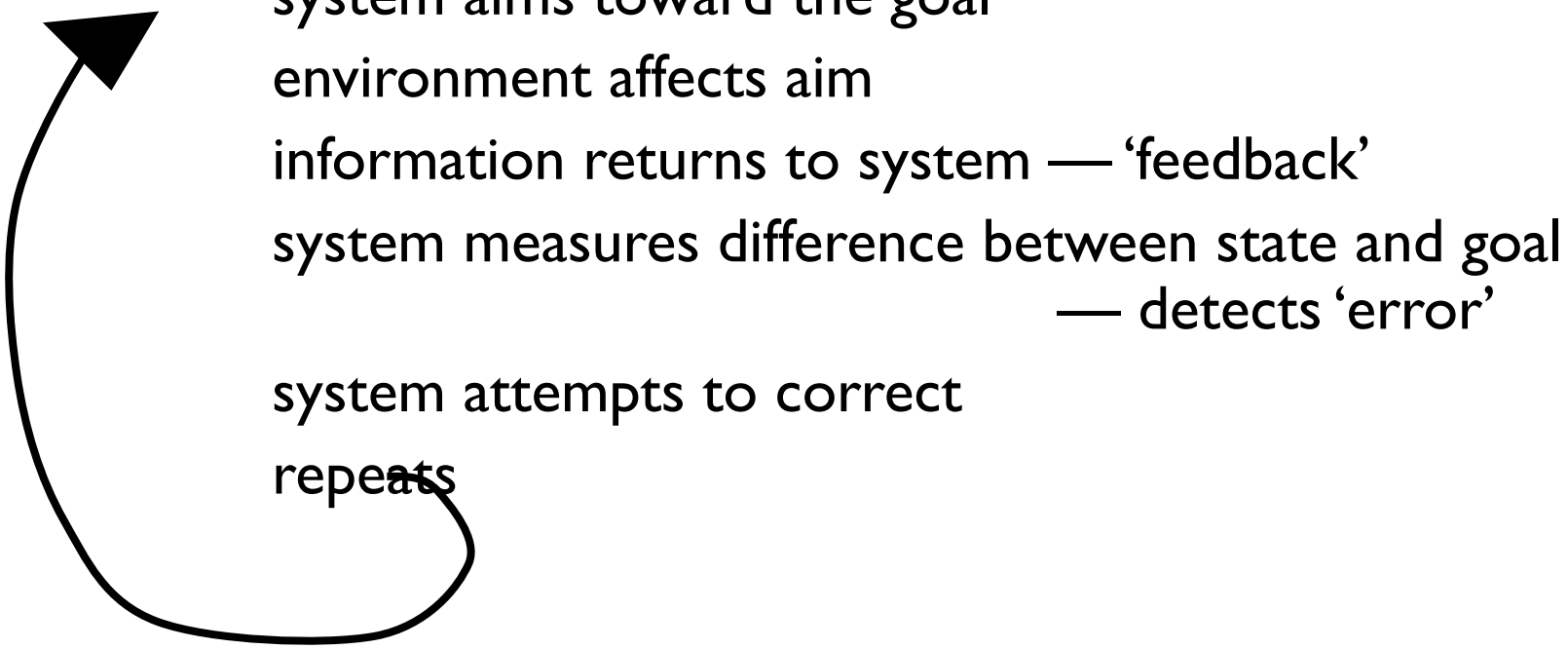
measuring understanding & agreement
= *science of subjectivity*
= *second-order cybernetics*

# cybernetic modeling

- not about what a system is made of
  - not delimited by subject domain, discipline, or distinctions such as biological, physical, ecological, psychological, social, linguistic
- includes goals — the 'why' as well as the 'how'
  - systems are defined by boundaries
  - systems have goal(s)
  - information flow from the environment to the system relevant to achieving a goal defines 'feedback'
- connects goal to action — 'looping-through'

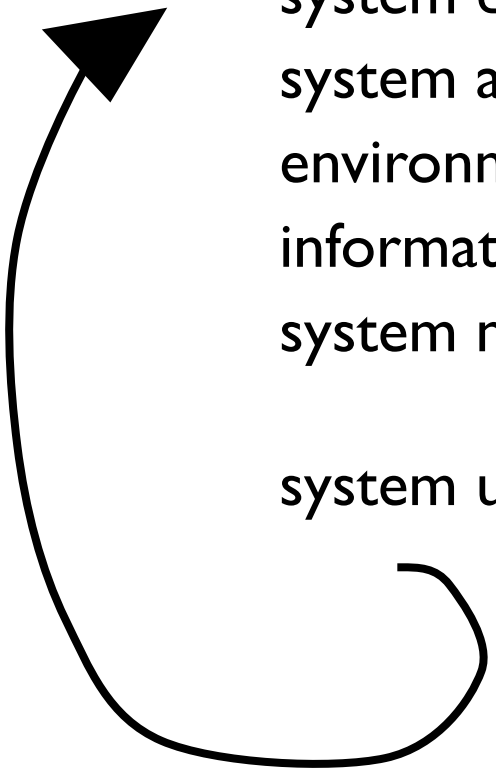
system—goal—feedback—steering

# CYBERNETIC MODELING



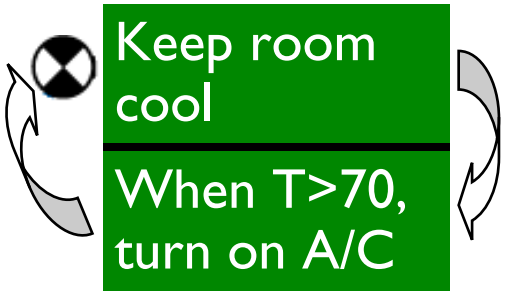
system—changing own goals—second-order model

CYBERNETIC MODELING—second-order



system defines a new goal
system aims toward the goal
environment affects aim
information returns to system — ‘feedback’
system measures difference between state and goal
— detects ‘error’
system unable to correct

# ‘goal’ defined




articulation of a desired end-state

in the context of

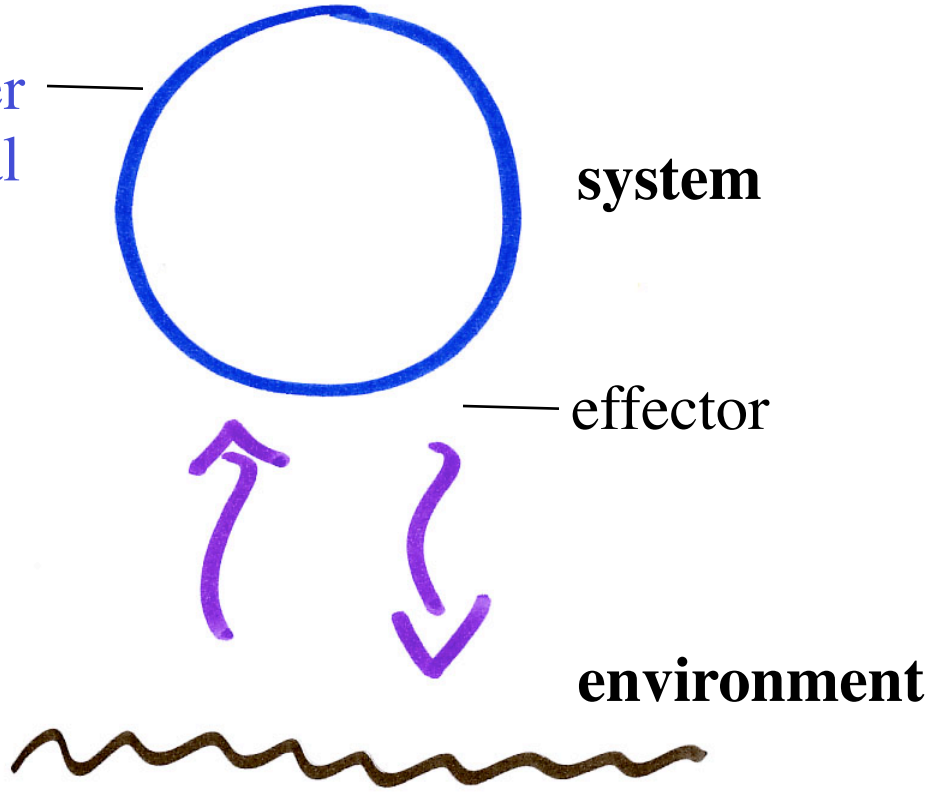
- one (or more) means or methods to achieve that state — a.k.a. sub-goal(s)
- process of selecting and executing a sub-goal
- process of evaluating the efficacy of a method by comparing results to the goal
- revising of the relationships of goal and sub-goals

# requisite variety—effectors

Sufficient variety?

- What are the parameters in the environment that the system can effect?

- Within what range of those parameters can the system maintain control?

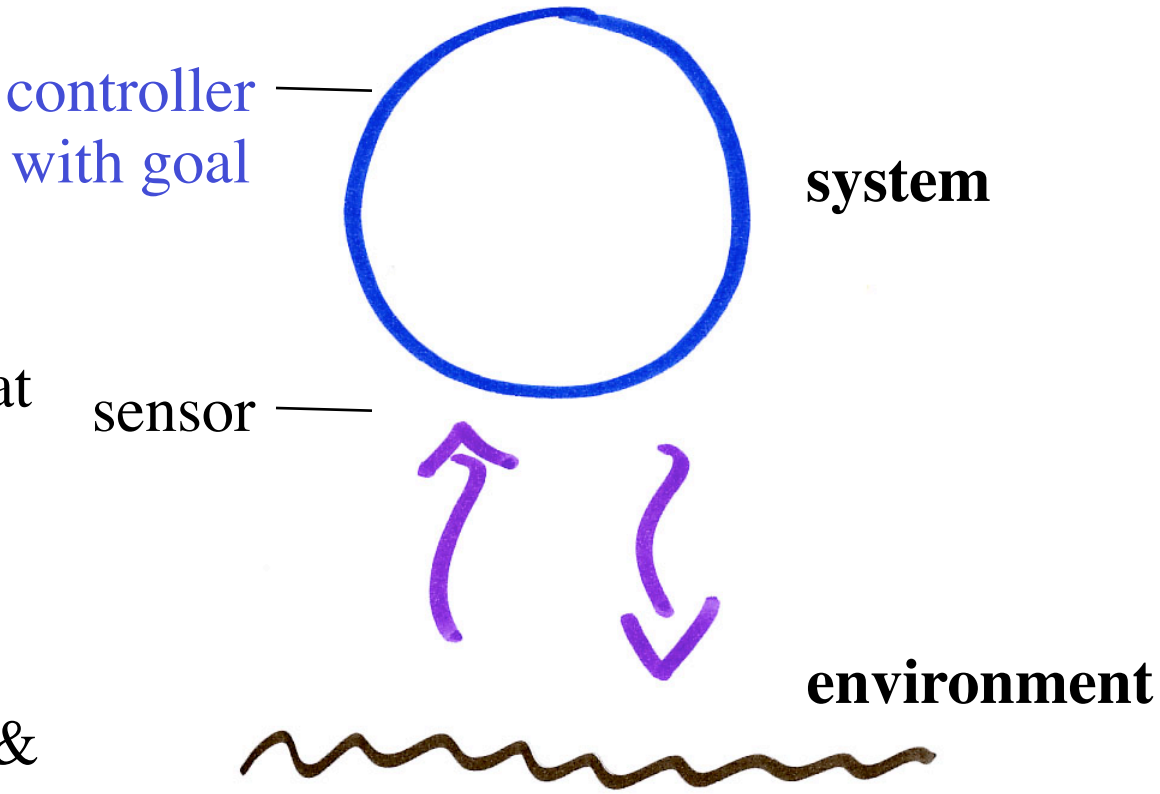


# requisite variety—sensors

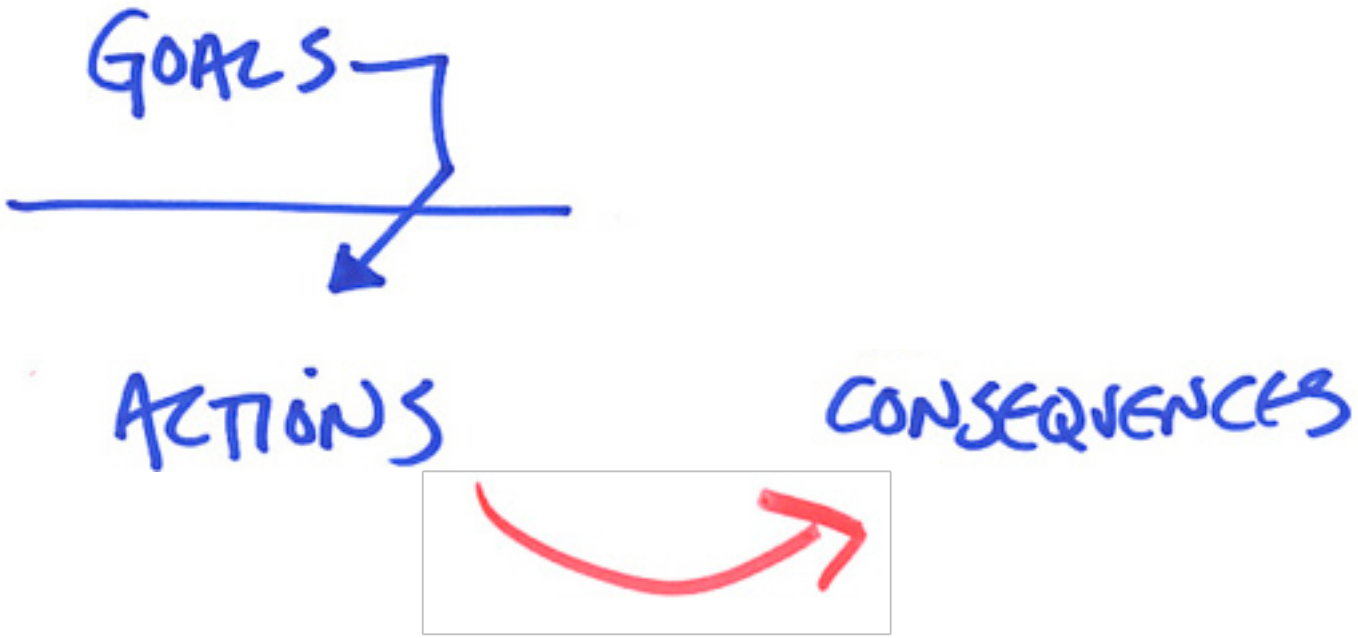
Sufficient variety?

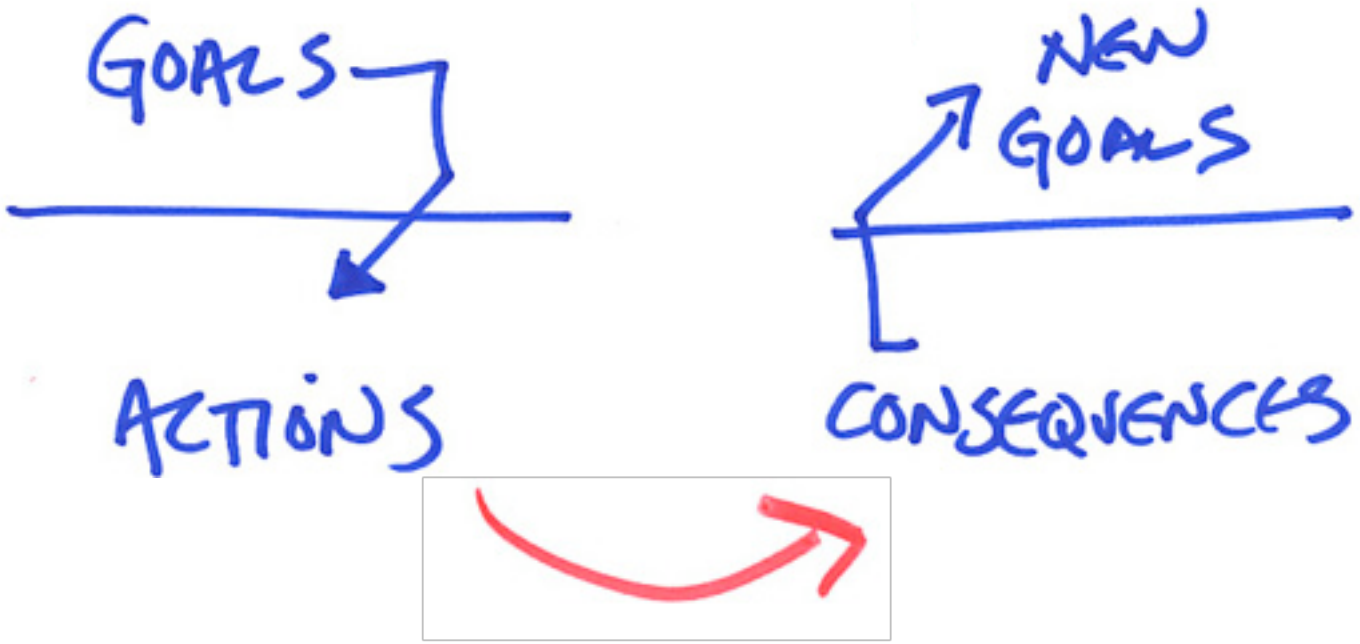
- Is there sensing of environment such that deviations from goal can be detected?

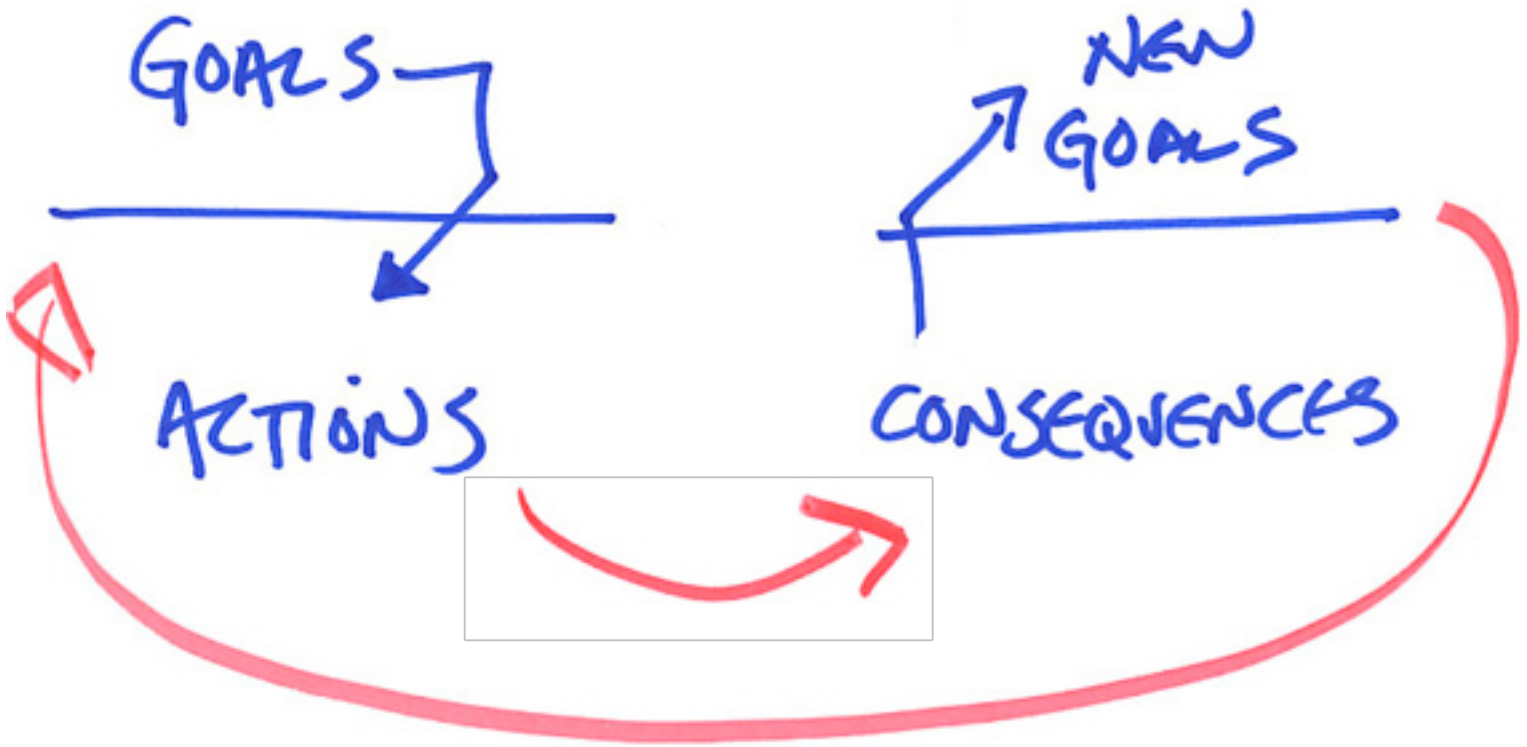
- Do the sensors have sufficient resolution & speed so that the system can respond in time?




GOALS
ACTIONS

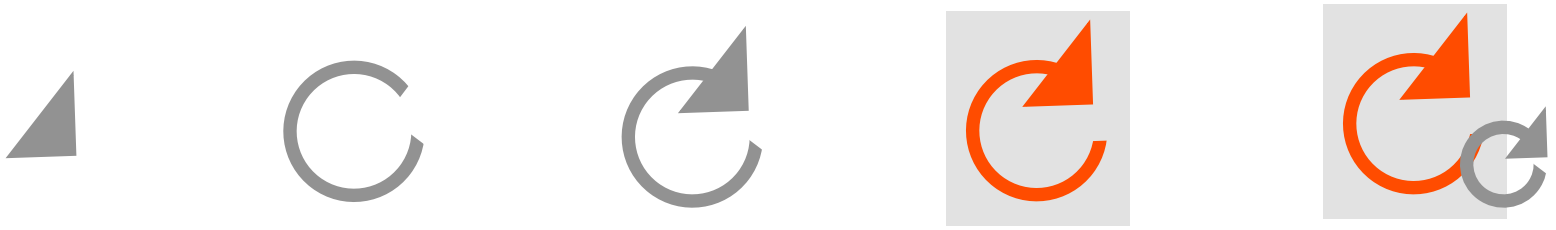

GOALS
ACTIONS
CONSEQUENCES


GOALS
ACTIONS
NEW
GOALS
CONSEQUENCES


GOALS
NEW GOALS
ACTIONS
CONSEQUENCES

goal-making—participation—double-loop systems

participative systems



# ‘participants’

act on their own

behave in complex ways that make sense to us

interact with us directly

work with us in achieving our goals

modify their own goals

collaborate with us in the creation new goals

collaborate with us on the design of new partners

# interaction framework

to understand existing interactions with participants, and to propose new and more interesting ones, we need a framework to characterize degrees of

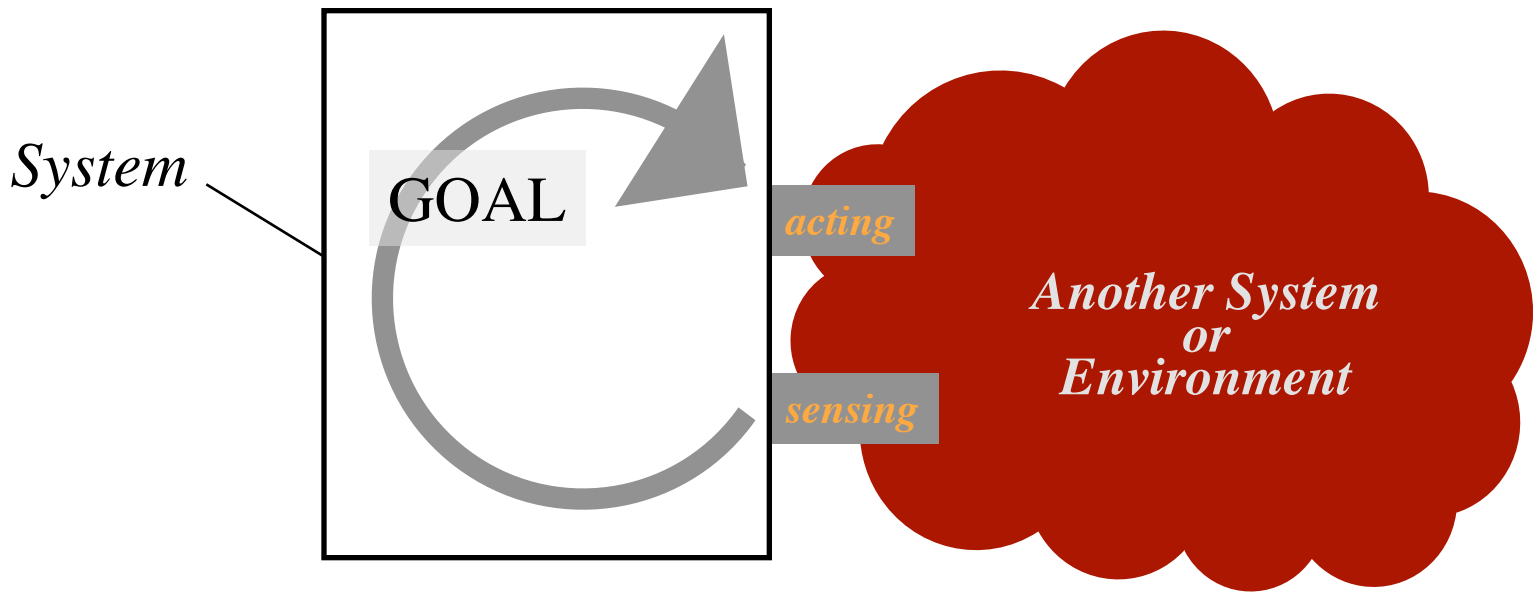
- autonomy
- complexity
- interactivity
- collaboration
- goal-setting

# categorizing systems — single-loop system

*after C Argyris 1992*

can detect and react

thermostat senses temperature below 70°f setpoint and turns on heat

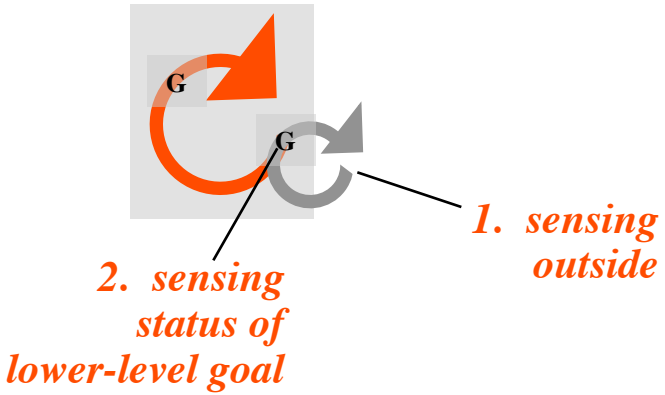


# categorizing systems — double-loop system

*after C Argyris 1992*

can detect and react on multiple levels

- system can sense from outside itself
- system can also sense the status of its lower-level goal: is it achieved, how closely, for how long…



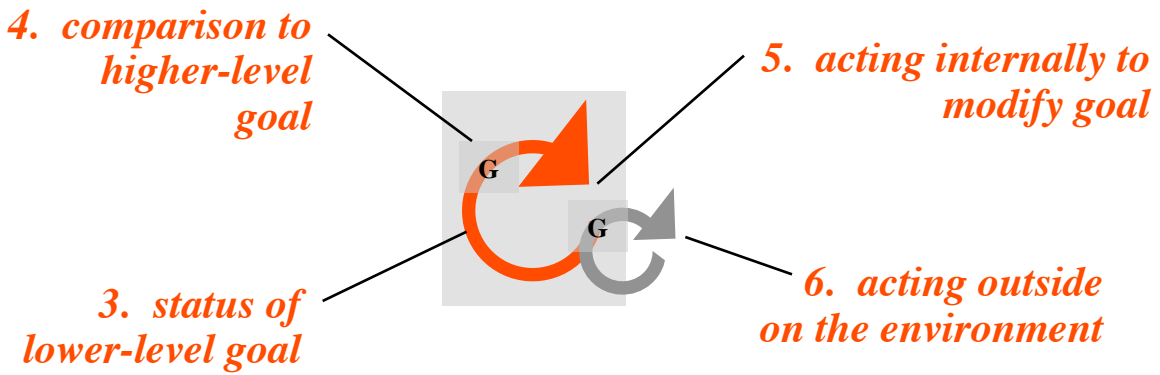
# categorizing systems — double-loop system

has goals that are dynamic and changeable

system compares status of lower-level goal to higher-level

higher-level goal may take action to modify lower-level goal

this new goal causes actions to be taken outside



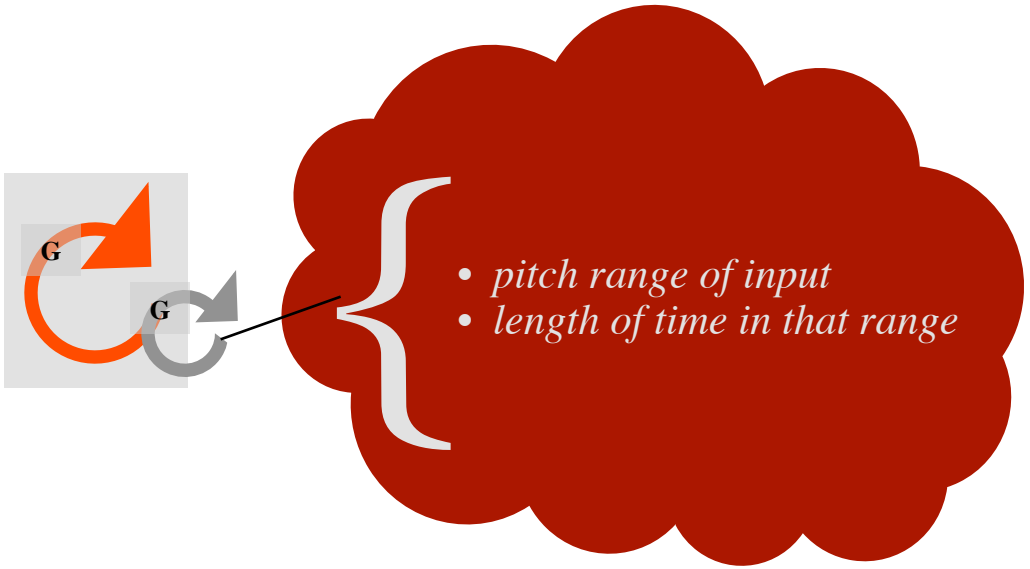
# categorizing systems — double-loop system

Pask's Musicolour

avoids boredom [second-order goal]

by varyingmapping of sound to light [first-order goal]

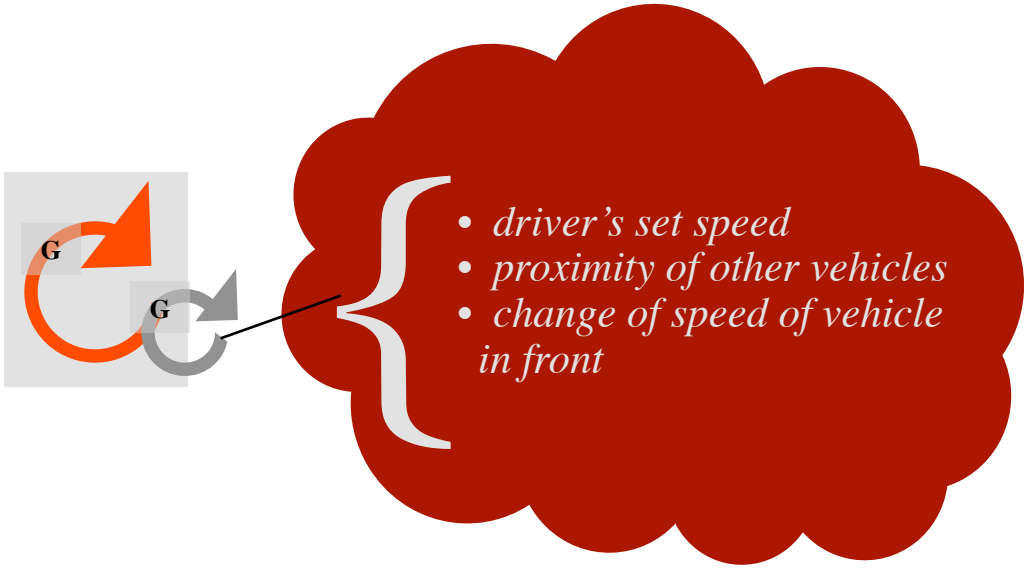
in response to changing inputs from musician



# categorizing systems — double-loop system

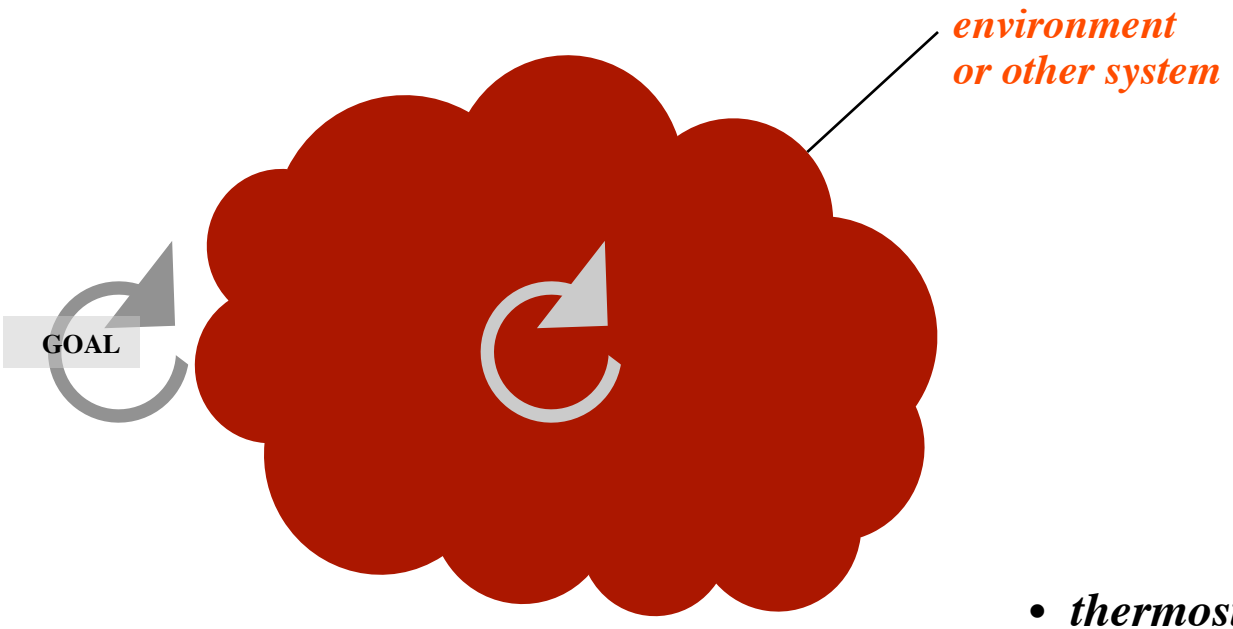
adaptive cruise control

avoids collisions with vehicles [second-order goal]
by varyingset cruising speed [first-order goal]
in response to changing speed of vehicles in front



# single-loop interactions

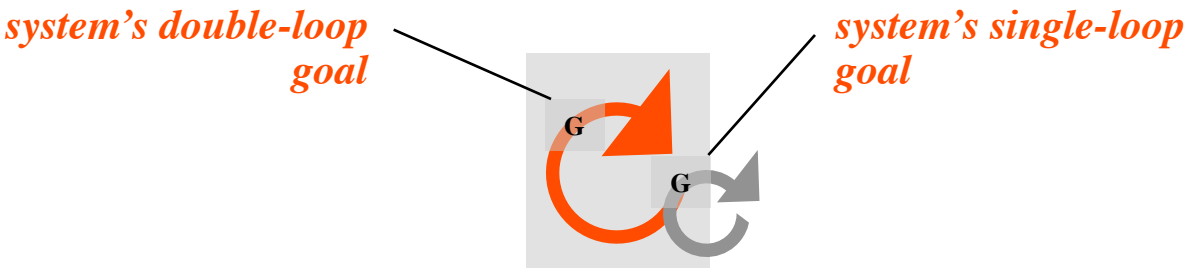
single-loop systems ***interact*** with an environment or other system while trying to achieve their own, unchangeable goal




- ***thermostat***
- ***cruise control***

# double-loop interactions

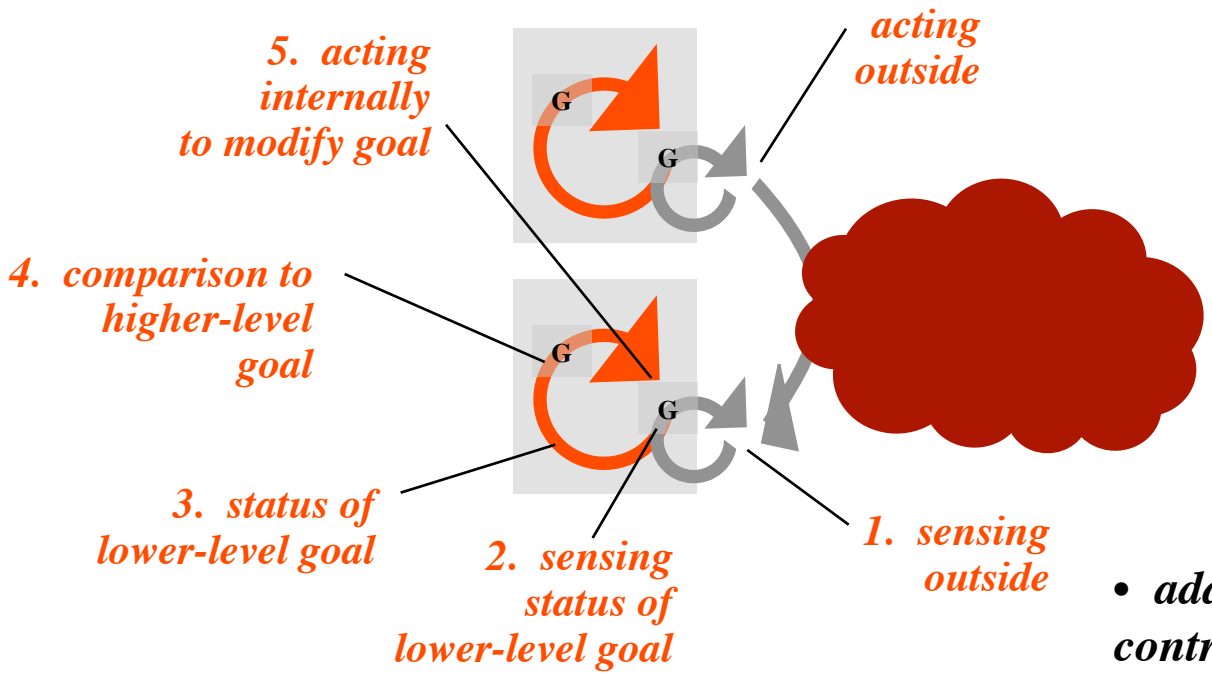
double-loop systems go beyond mere interaction to ***participate*** in the modeling and changing of their own goals




- ***adaptive cruise control***

# participative systems

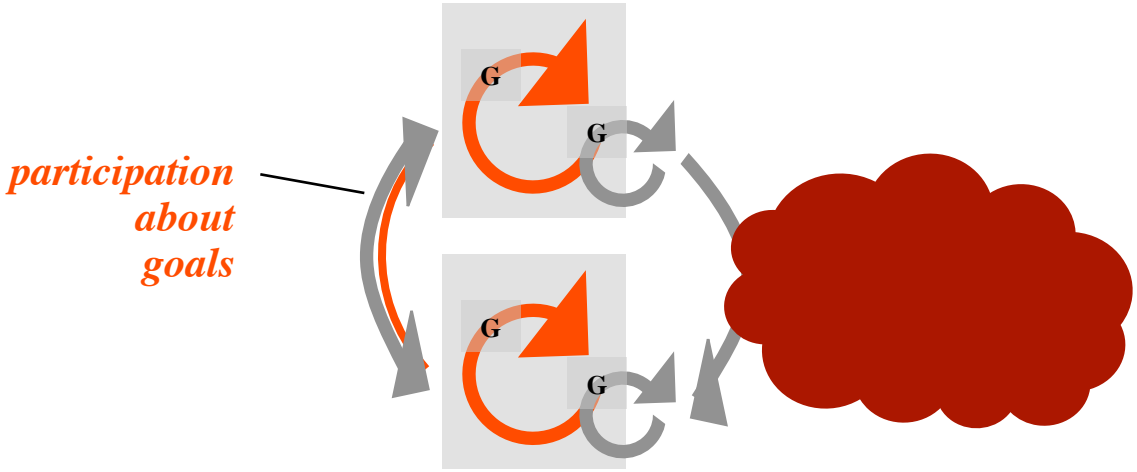
double-loop systems ***participate***
with other systems ***implicitly***
when goals are changed because of others' actions




- *adaptive cruise control plus driver actions*

# participative systems

double-loop systems may ***participate explicitly*** with other double-loop systems in goal-setting



# participative systems — definition

modify themselves as a result of interactions

participate in changing their goals

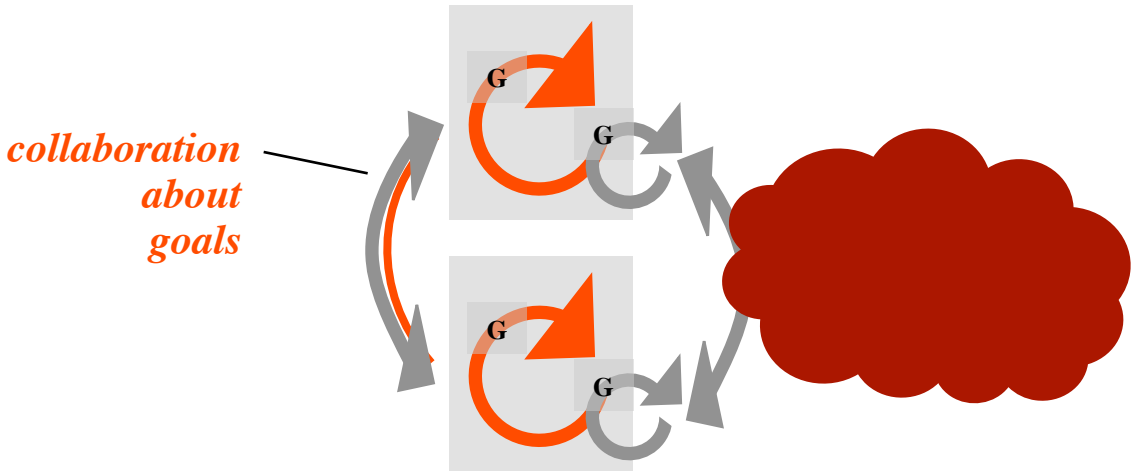
influence other double-loop systems to test and modify their goals

participate in the creation of new possibilities

***only double-loop systems are participative***

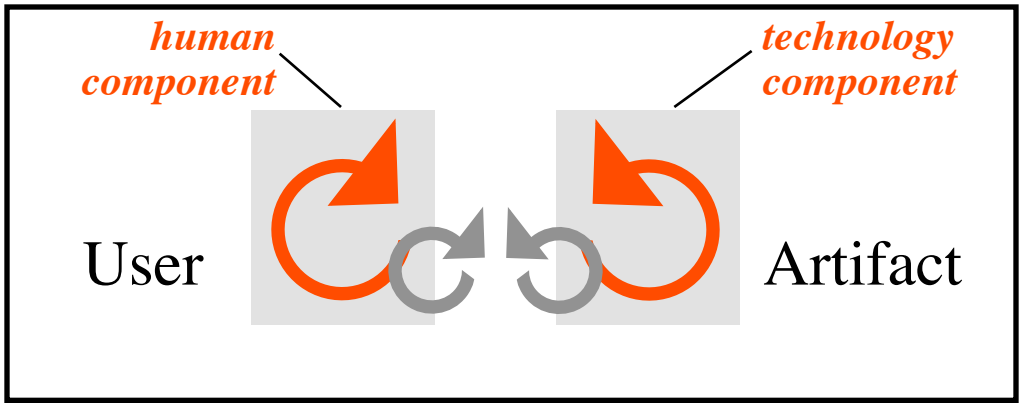
# participative systems — collaboration

when double-loop systems interact with other double-loop systems for the ***same*** goals, they ***collaborate*** with each other




- ***adaptive cruise control plus driver actions***

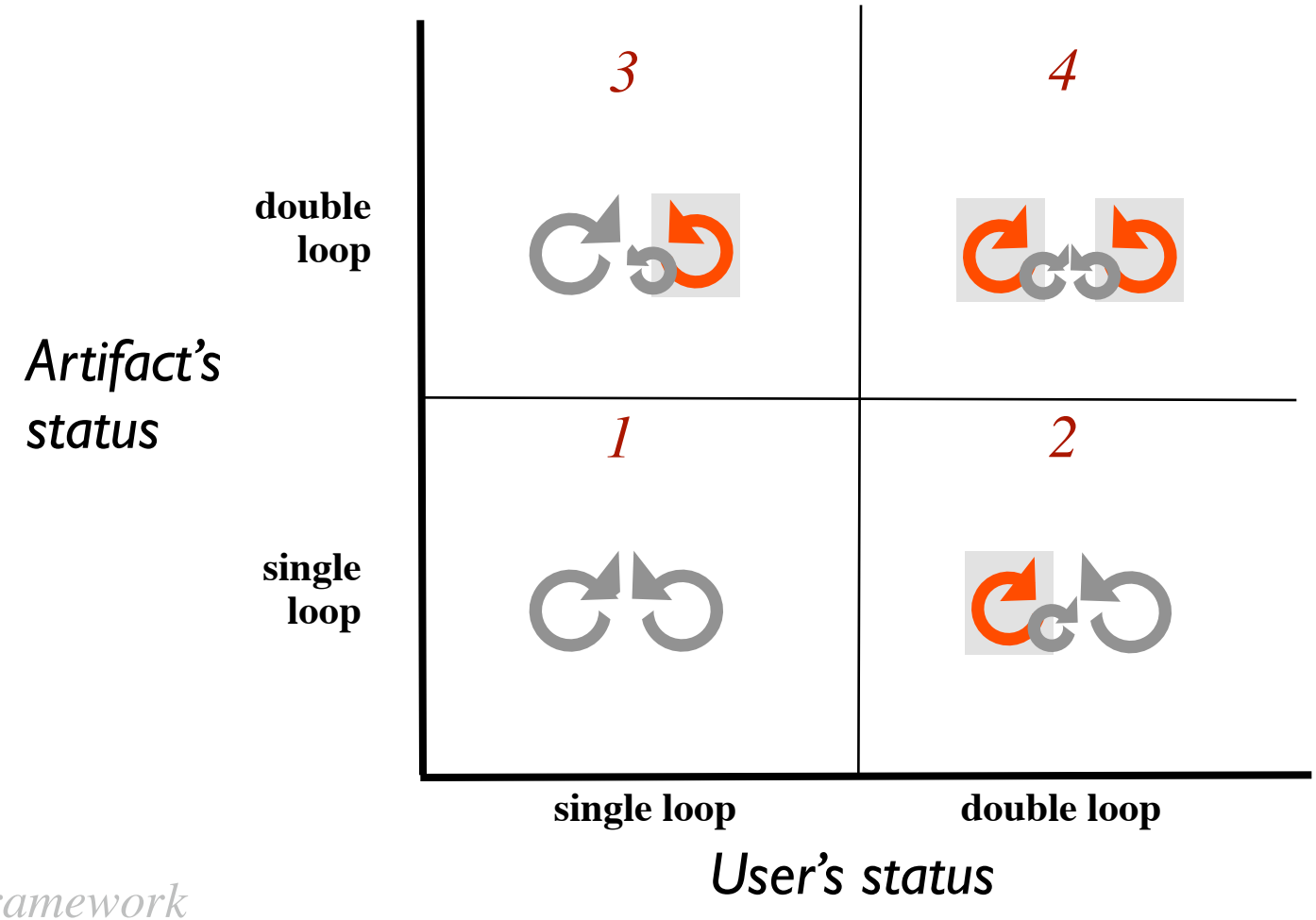
# composing systems — humans and technology



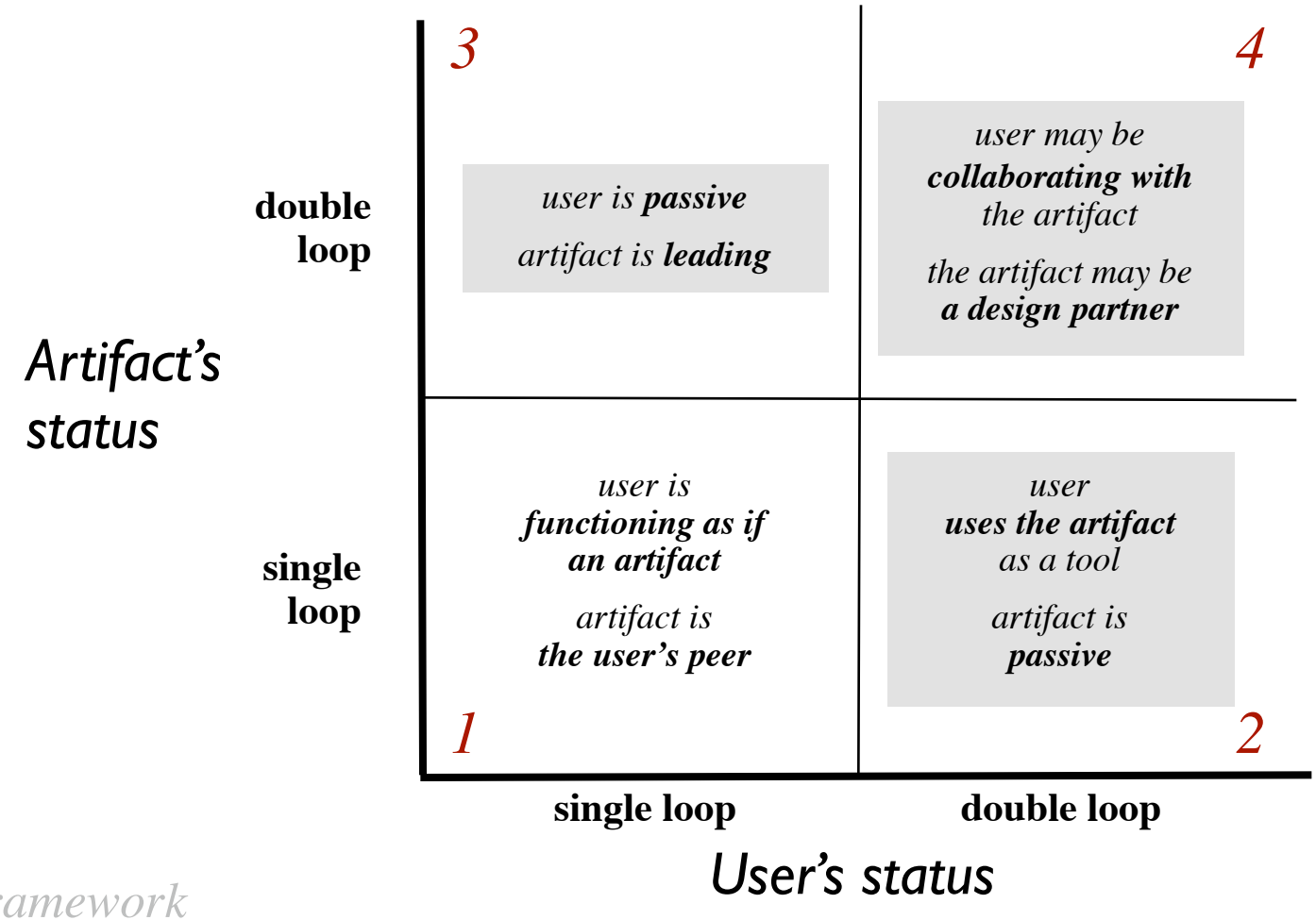

User may be single- or double-loop sub-system

Artifact may be single- or double-loop sub-system

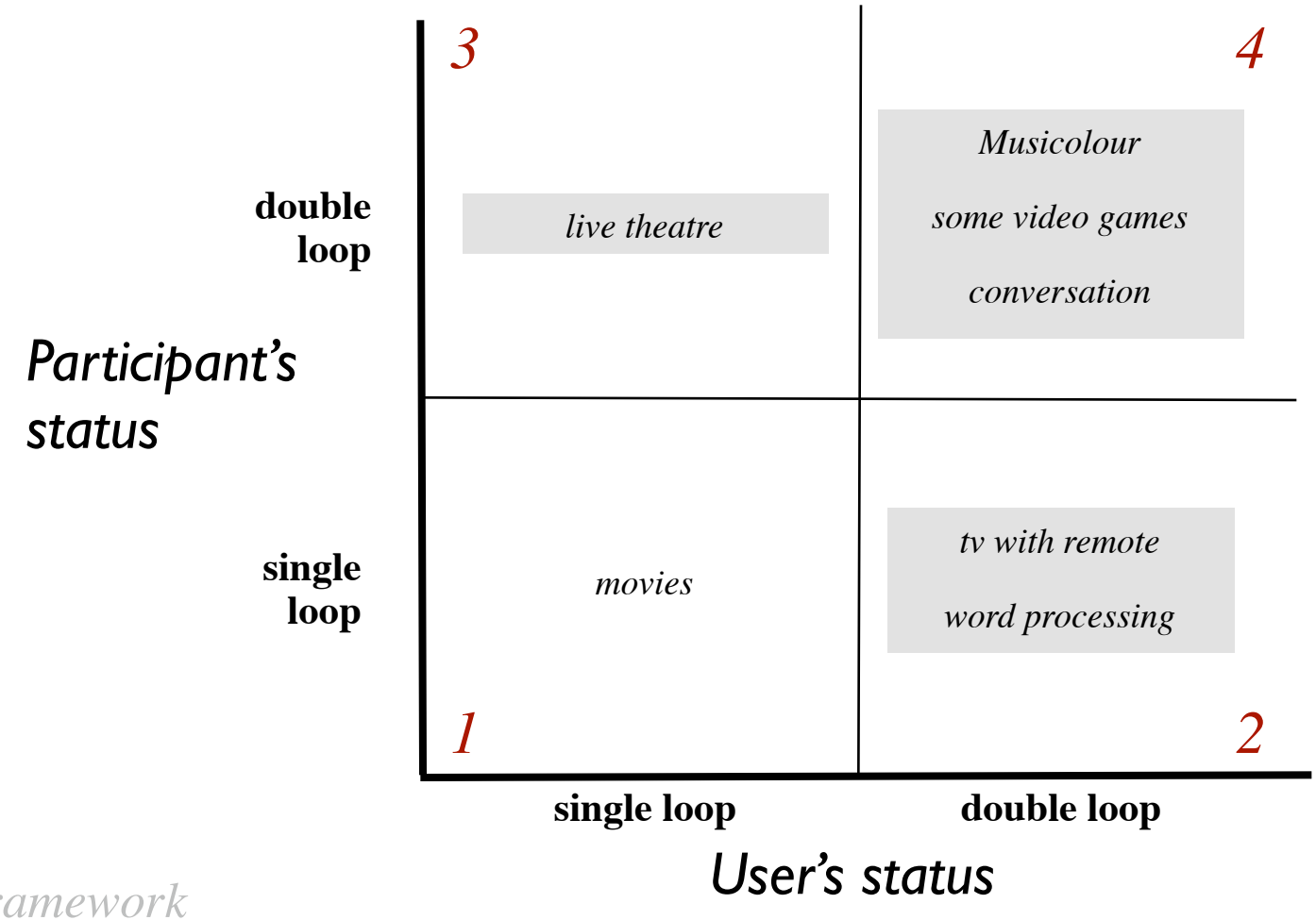
# space of participative systems



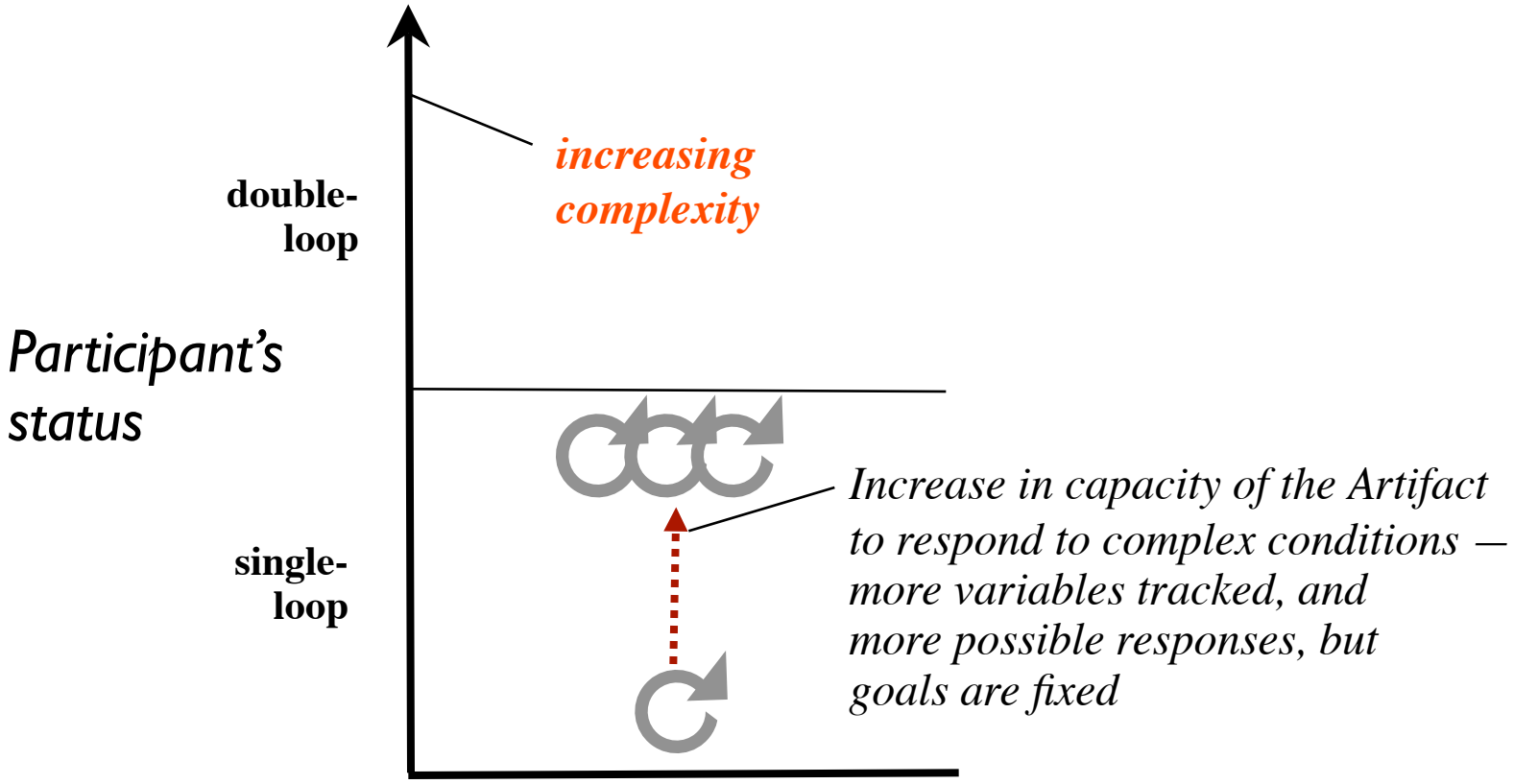
# system variations — summary



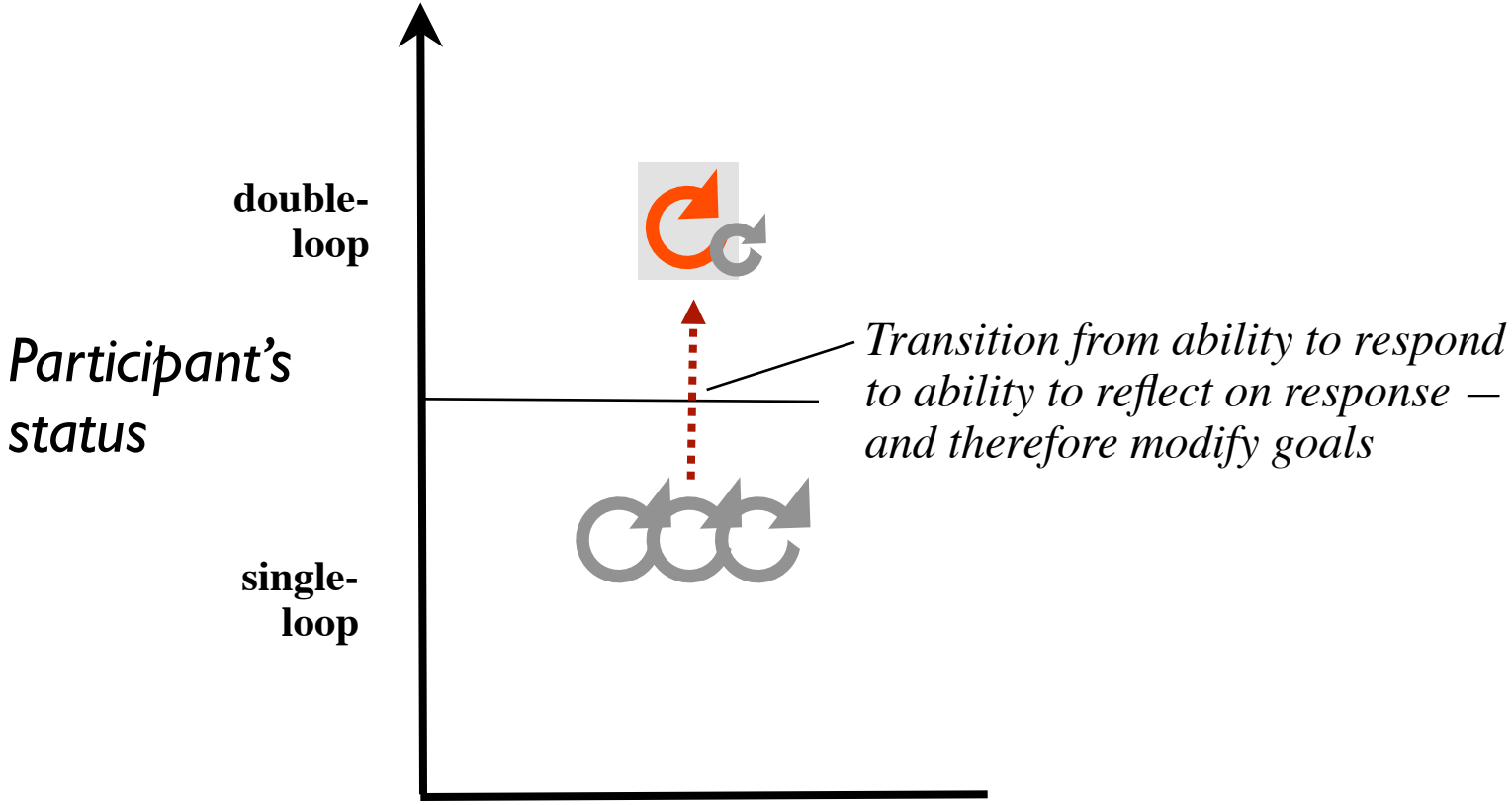
# system variations — interactive media



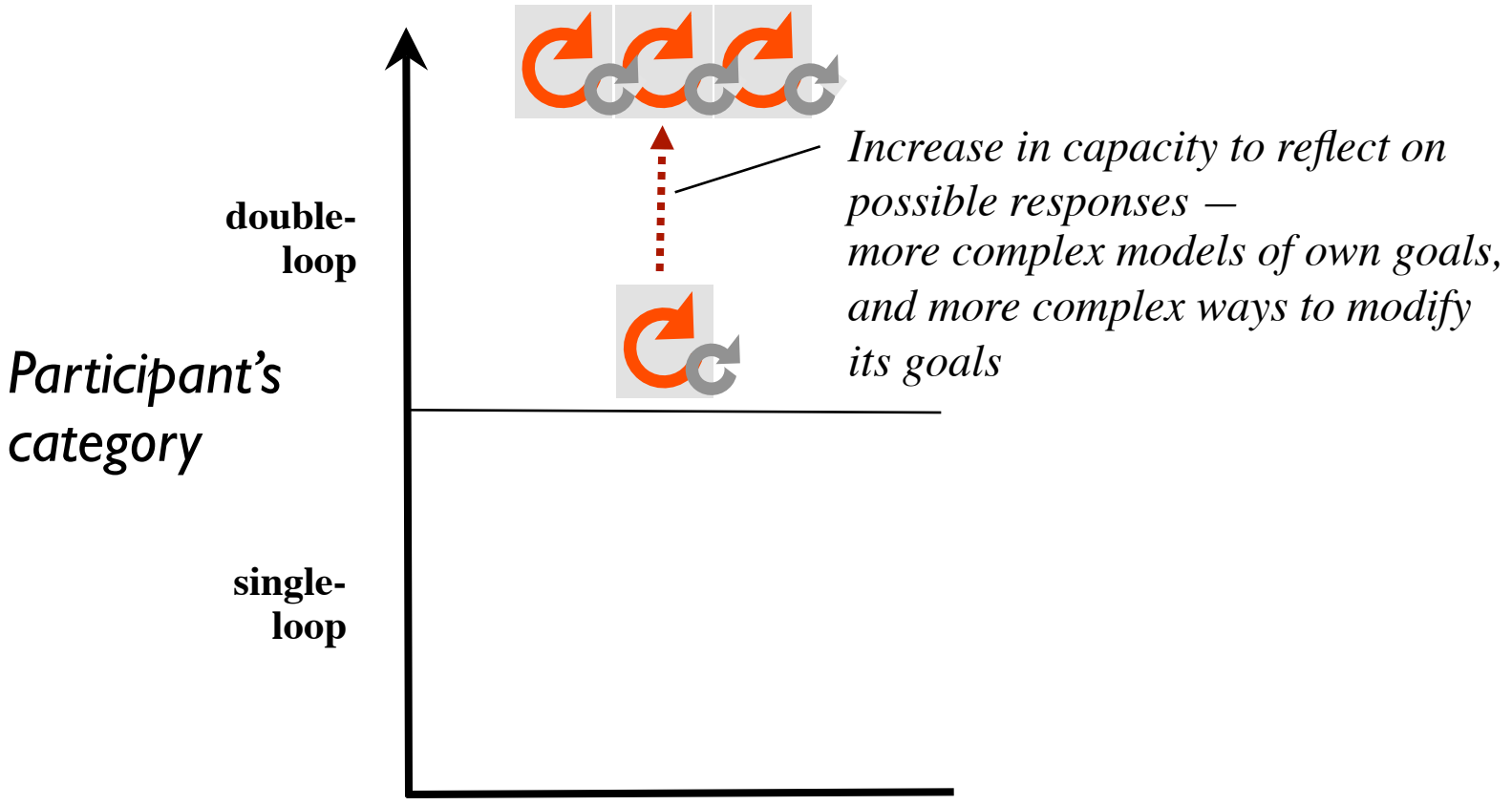
# increasing system variety — single-loop



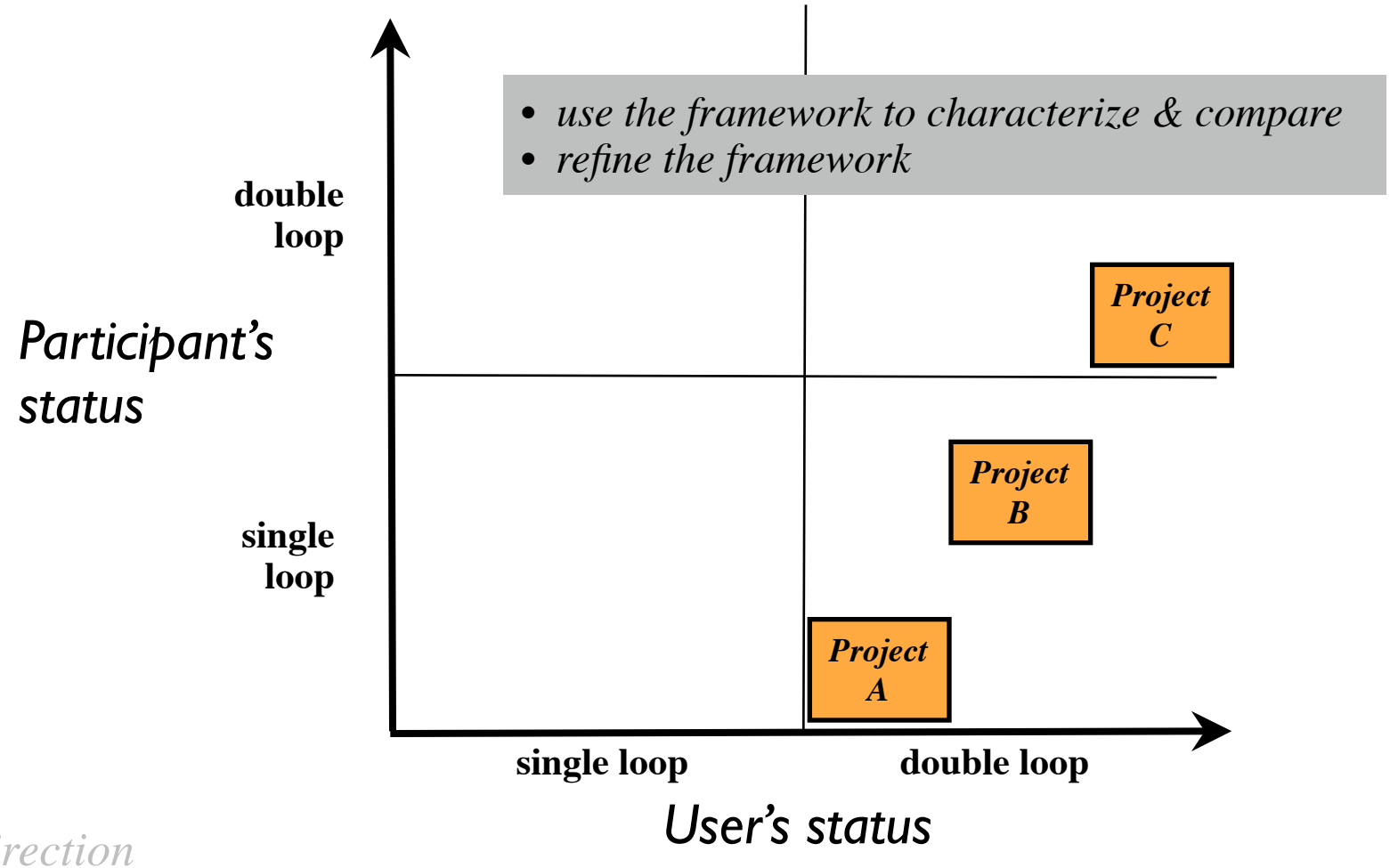
# increasing system variety — transition to double loop



# increasing system variety — double-loop

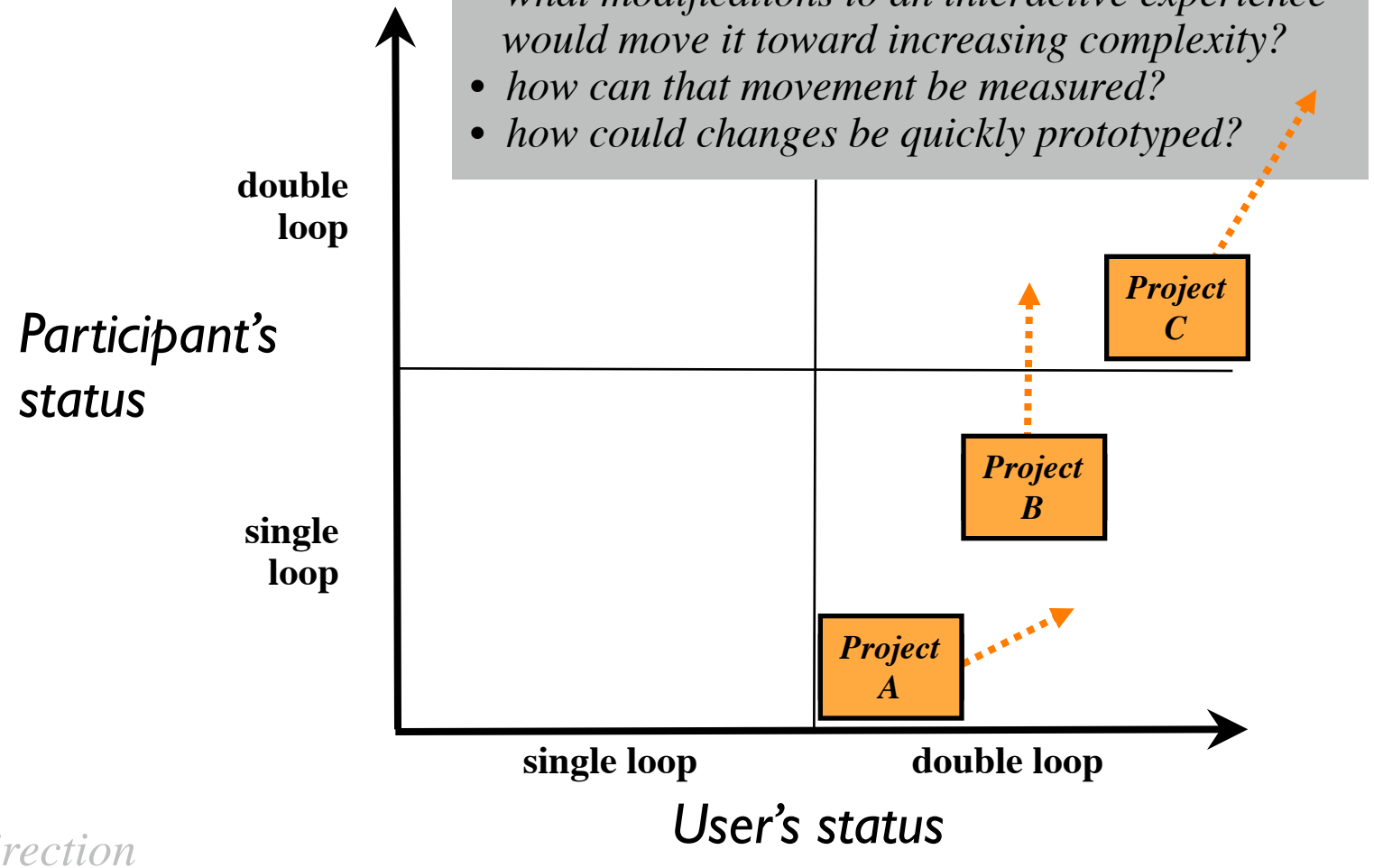


# categorize media projects



# propose interactivity metrics

- *what modifications to an interactive experience would move it toward increasing complexity?*
- *how can that movement be measured?*
- *how could changes be quickly prototyped?*



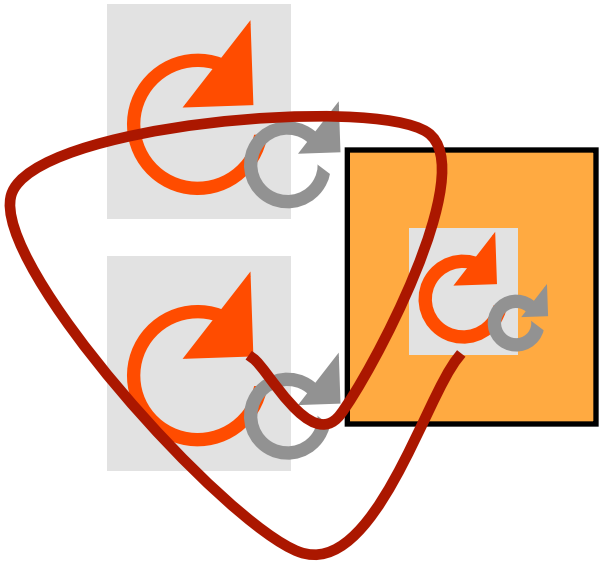
# summary goals for participative systems

encompass complexity, collaboration, and goal-directed systems in a single framework

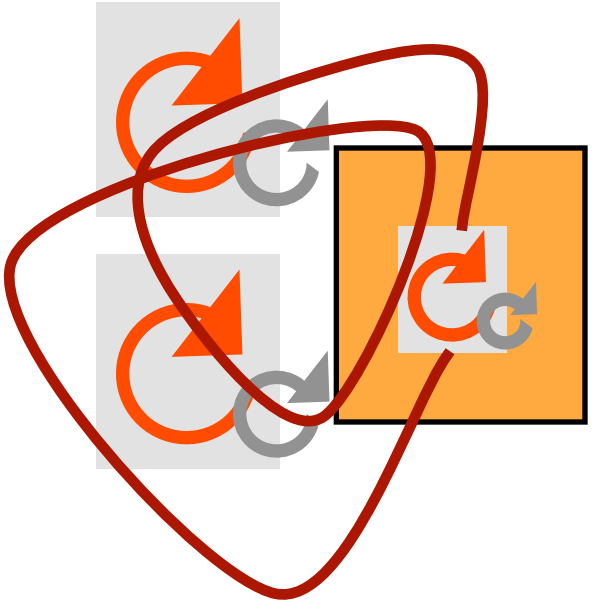
provide a framework to characterize, compare, and extend any given product or service

propose a means to construct collaborative design partners

# participative design



# participative design



# related publications (selected)

1943 Bigelow, Rosenbleuth, & Wiener
*Behavior, Purpose, and Teleology*

1943 McCulloch & Pitts
*A Logical Calculus of the Ideas in Nervous Activity*

1948 Wiener
*Cybernetics*

1949 Shannon & Weaver
*Mathematical Model of Communications*

1952 Ashby
*Design for the Brain*

1956 Ashby
*An Introduction to Cybernetics*

1961 Pask
*An Approach to Cybernetics*

# analogs to cybernetics

disciplines relying on feedback processes:

refining and clarifying goals = *design*

understanding customer needs = *consultative selling*
organizing evidence to support conclusions = *law*
directing and measuring work = *management*
diagnosing treatments based on symptoms = *medicine*
specifying appropriate physical systems = *engineering*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