anticipation

the end. is where we start from

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

1.

anticipation is a characteristic of the living

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

anticipation occurs in all spheres of life:

mobility

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

anticipation occurs in all spheres of life:

sports

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

anticipation occurs in all spheres of life:

stem cells

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

anticipation occurs in all spheres of life:

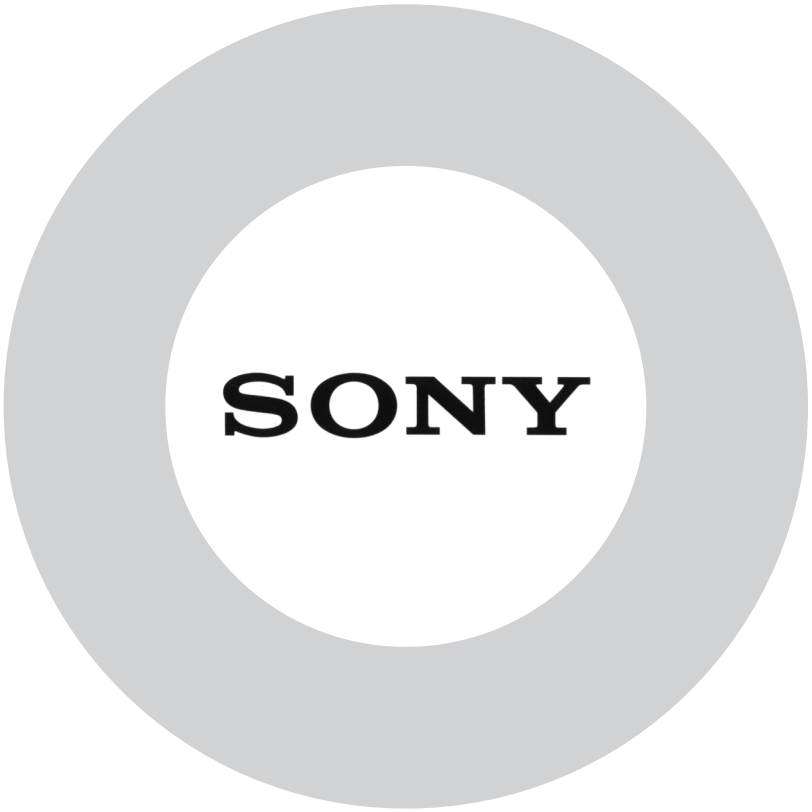
sustainability

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

anticipation occurs in all spheres of life:

trust

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin



anticipation occurs in all spheres of life:

branding

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

anticipation occurs in all spheres of life:

design & engineering

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

anticipation occurs in all spheres of life:

expectations

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

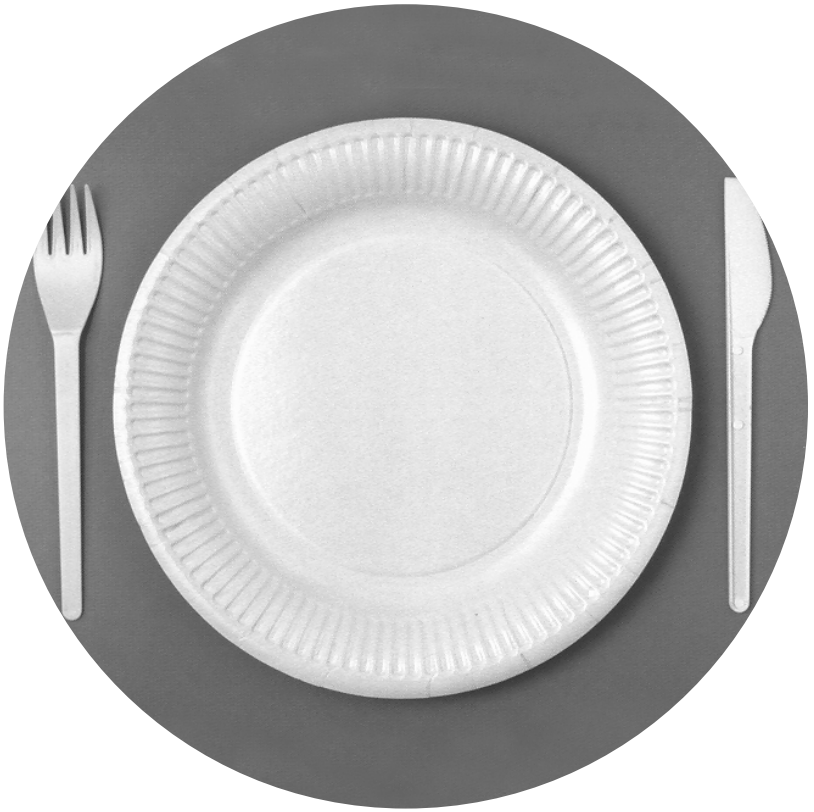
anticipation occurs in all spheres of life:

prevention & homeland security

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

anticipation occurs in all spheres of life:

human computer interaction



anticipation occurs in all spheres of life:

nourishment

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

anticipation occurs in all spheres of life:

safety

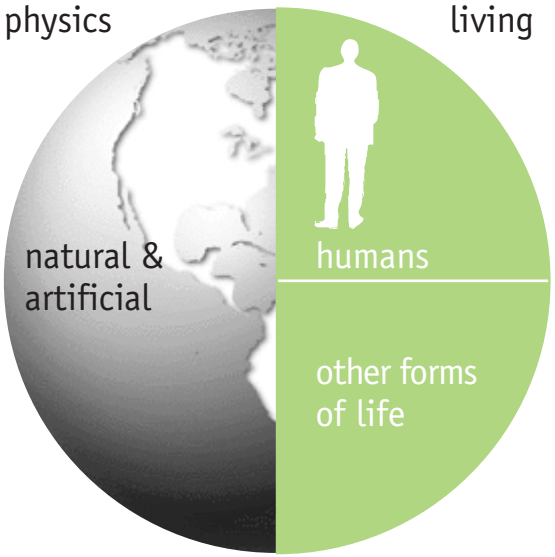
Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

2. the physical and the living

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

THE PHYSICAL AND THE LIVING 1

the world
physics of action & reaction



the living
is part of the physical world:
anticipation & reaction

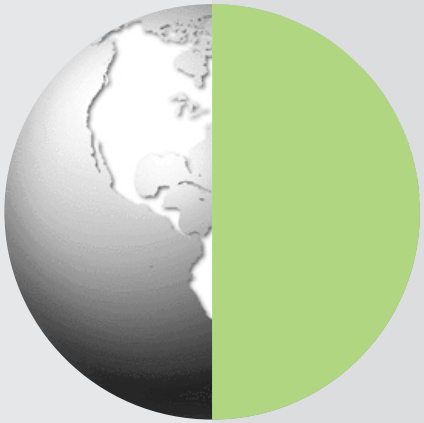
Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

THE PHYSICAL AND THE LIVING **2**

the physical

potential energy = mgh kinetic energy = $\frac{1}{2}$ mv² v = gt

reactive models



the living

cat jump: animal anticipates movement

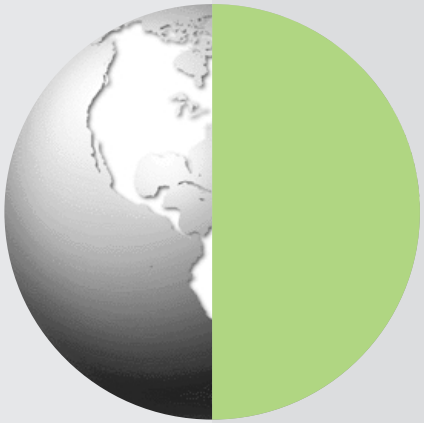
anticipatory models

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

THE PHYSICAL AND THE LIVING 3

the physical

physics:
- *data rich*
- *theory rich*
- *major research effort*



the living

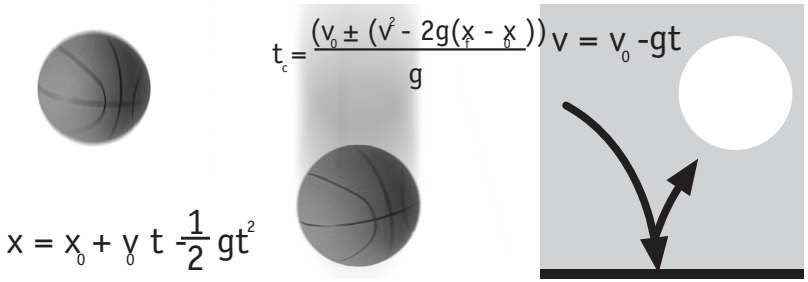
anticipation:
- *data rich*
- *theory poor*
- *benefits from biology and cognitive sciences*

THE PHYSICAL AND THE LIVING **4**

characteristics of the physical

- homogenous

- predictable



- deterministic

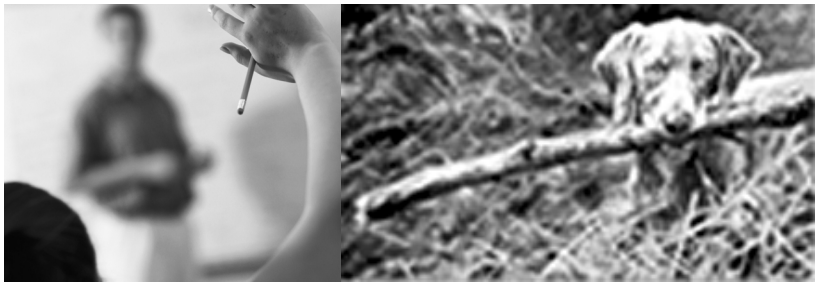
THE PHYSICAL AND THE LIVING **5**

characteristics of the living

- heterogenous

- holistic memory

- learning



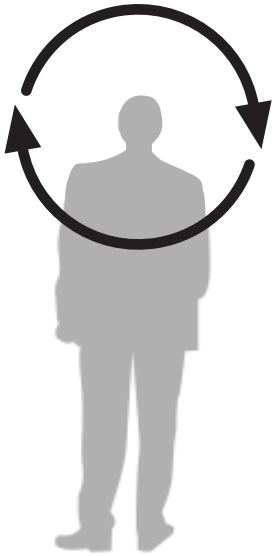
Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

THE PHYSICAL AND THE LIVING **6**

characteristics of the living

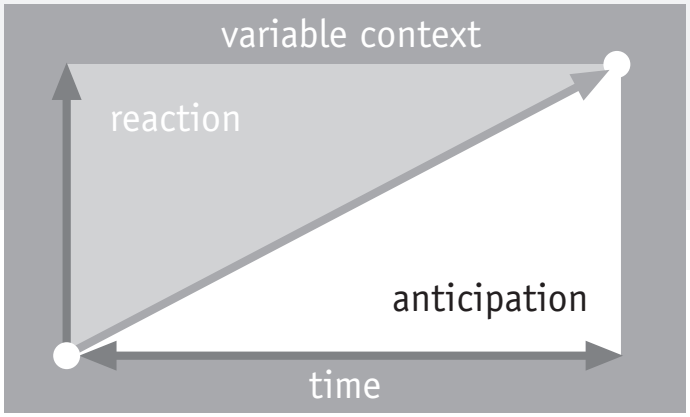
- self repair

- creativity

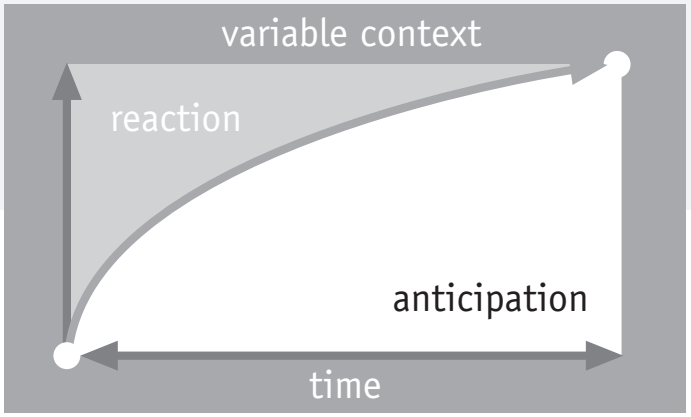


Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

reaction and anticipation are complementary



awareness and use of anticipation can improve human and machine performance



Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

3.
applications
car and driver

CAR AND DRIVER **1**

the car
the embodiment of physics in machine form. action and reaction.

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

human being

action *reaction* *anticipation*

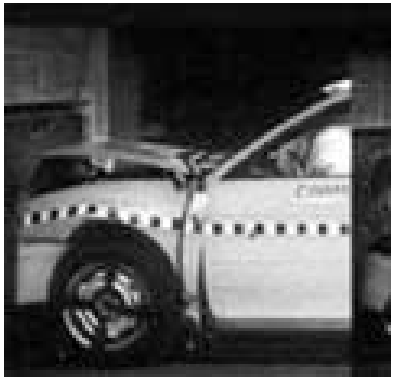
Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

the driven car: a hybrid

meeting point between physical determinism and anticipation

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

drivers are different
how to make them the same



training

automation

statistical models

anticipation comes into picture

proactive behavior

learning / experience

navigation

expertise

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

CAR AND DRIVER **6**

objectives

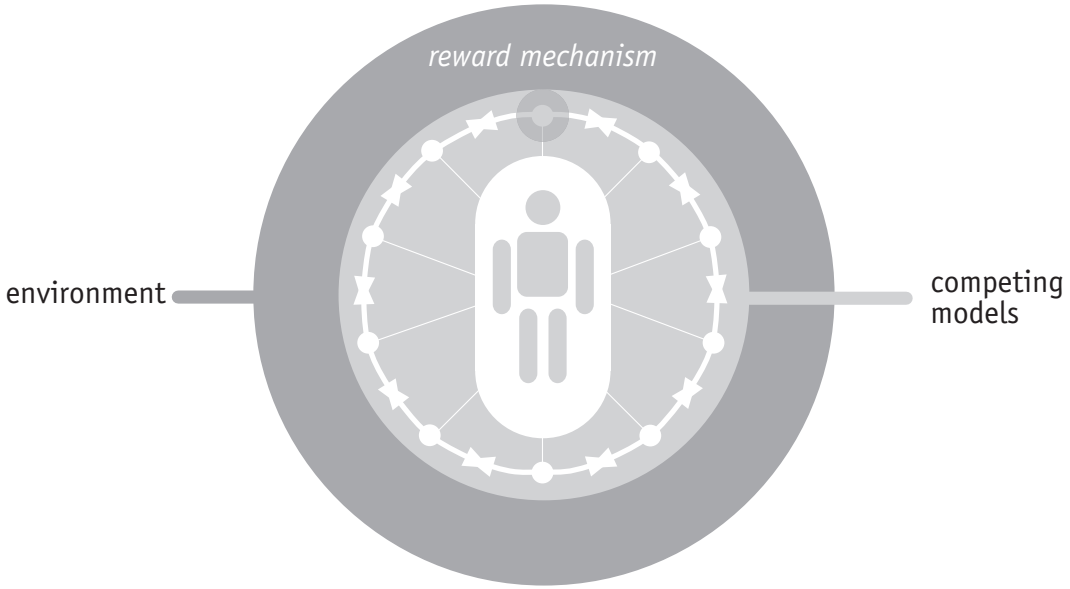
- build upon anticipatory characteristics

- augment the role of anticipation

- facilitate anticipatory characteristics

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

suggestions for research subjects



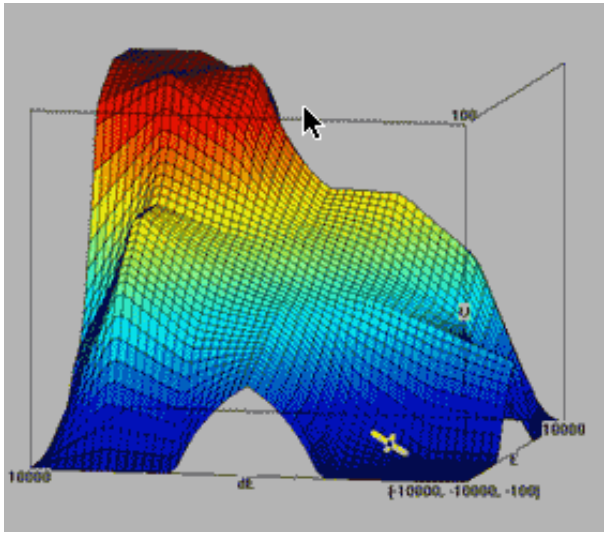
- model of itself. faster than real time model definition
- model conflict implementation
- the living bus complementary to the digital bus
- the co-aging model.

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

fuzzy logic and soft-computing for mobility research

soft computing: tolerant of imprecision, uncertainty and partial truth. driving embodies soft computing.

- computing the unpredictable
- computing the imprecise
- computing the chaotic
- computing multi-dimensional and multi-domain



Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

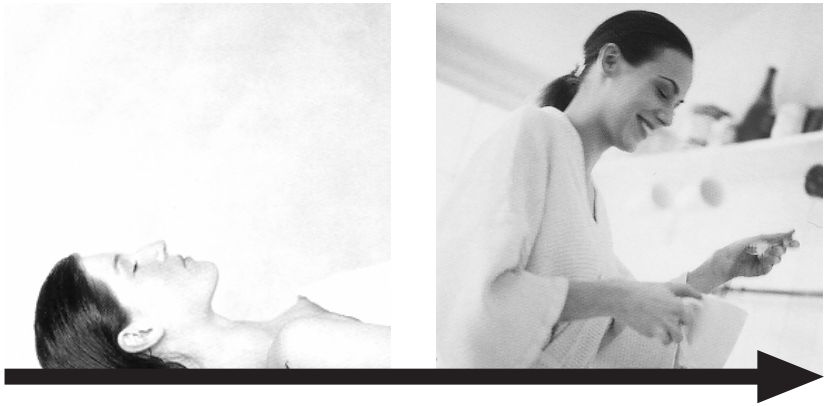
4.

applications
body and mind

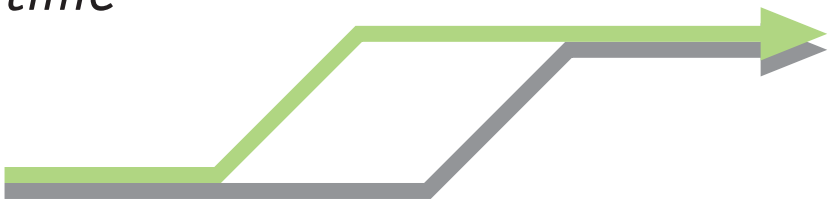
BODY & MIND 1

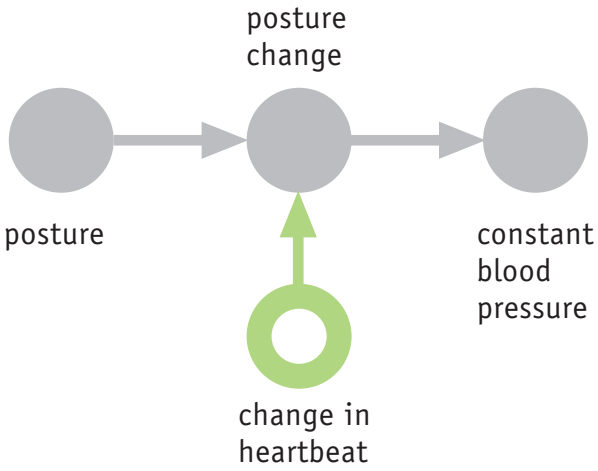
blood pressure

heartbeat changes in anticipation of posture change



time





Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

BODY & MIND **2**

anticipatory medicine

- highly individualized
- maintaining an optimal protein profile.

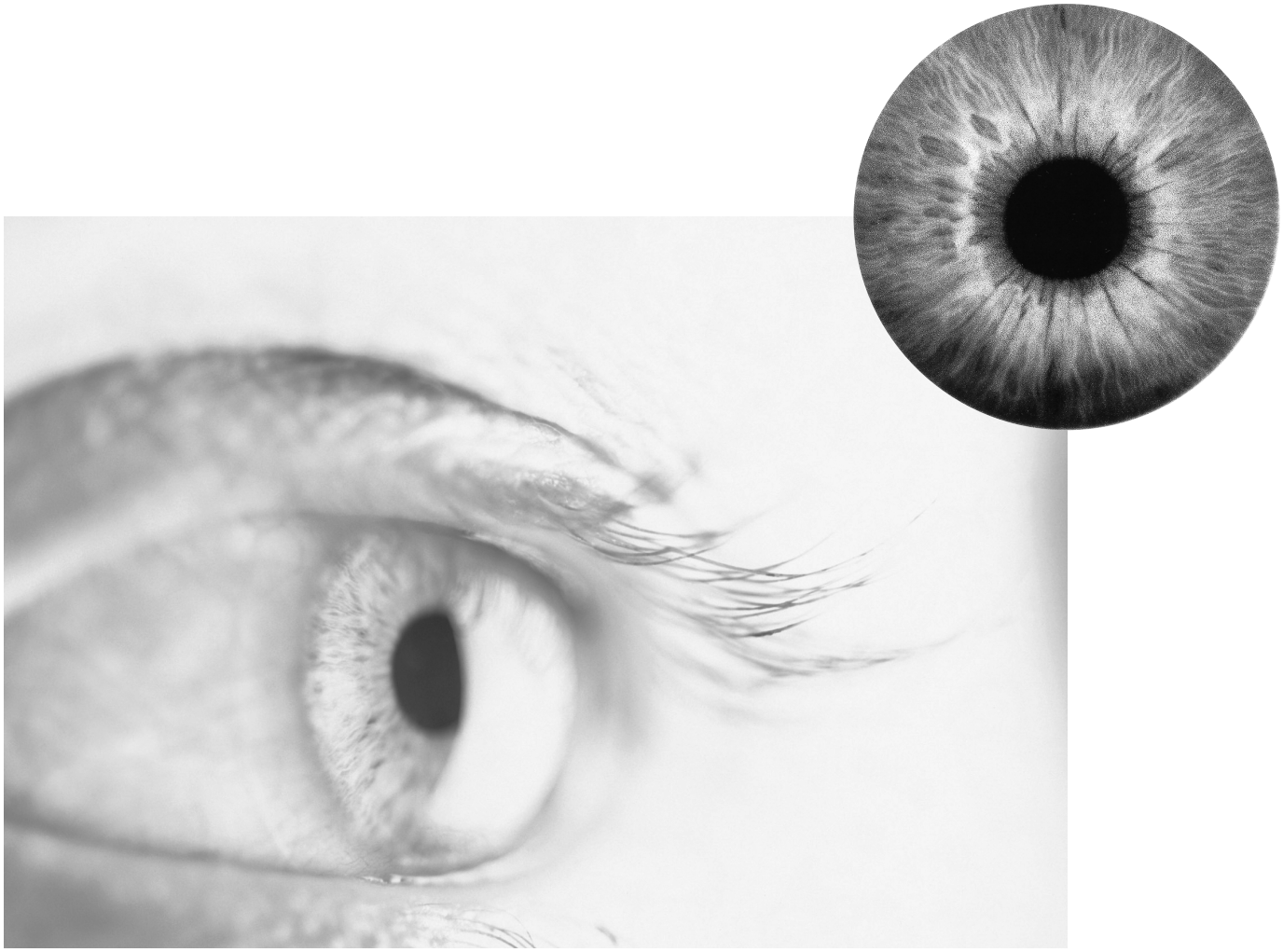
protein profile:

- mirrors state of health
- changes in protein profile are anticipatory

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

anticipatory implants

an artificial eye lens could adapt its performance by anticipating the patient's aging process



Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

BODY & MIND 4

sleep

hormonal activity as endogenous wake up call

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

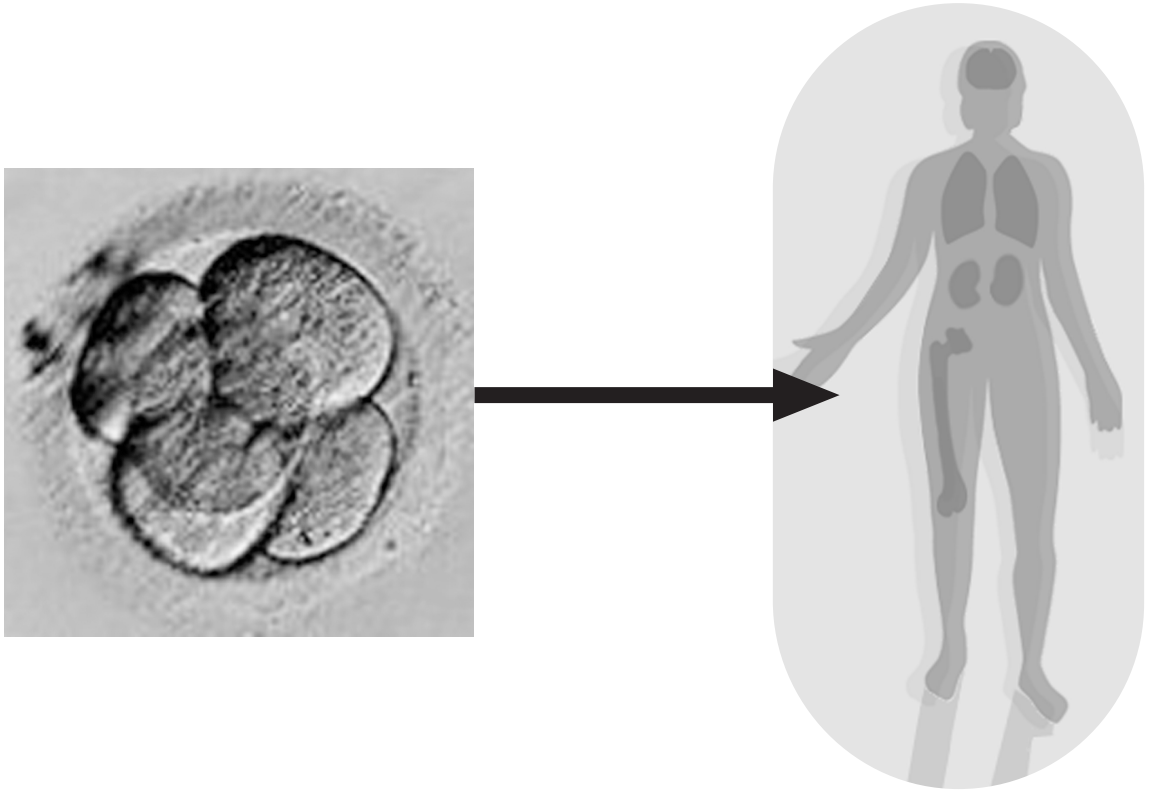
expectations & trust

divorce is in the DNA

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

stem cell

the stem cell contains a predictive model of itself

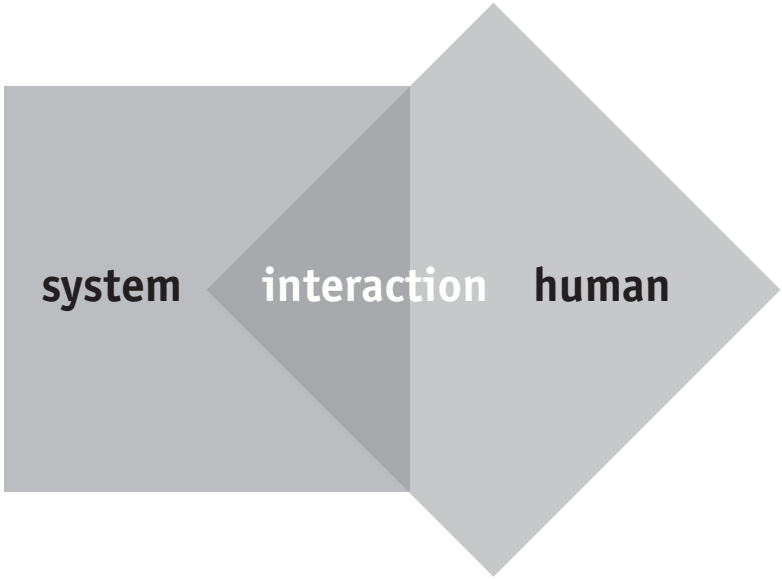


Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

5. applications human computer interaction

Where is the human in HCI ?

from reaction to anticipation



to Edsger Dijkstra
in memoriam

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

In their capacity as a **tool**, computers will be but a ripple on the surface of our culture. In their capacity as **intellectual challenge**, they are without precedent in the cultural history of mankind.

Edsger Wybe Dijkstra

living entity hybrid entity physical entity

variety of forms of interaction

human *performs* ACTIVITIES FUNCTIONS *available* computer

Levels of understanding:
- pragmatic: we are what we do
- epistemological

pragmatic level:
we are what we do
janet project

Go from A to B
- grid as metaphor
- natural language query

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

pragmatic level

living physical

interaction

desktop

- distributed computer
- computing grid
  (intelligent matter)

A C T I V I T I E S

- programming
- text processing
- data processing
- image processing
- layout
- web

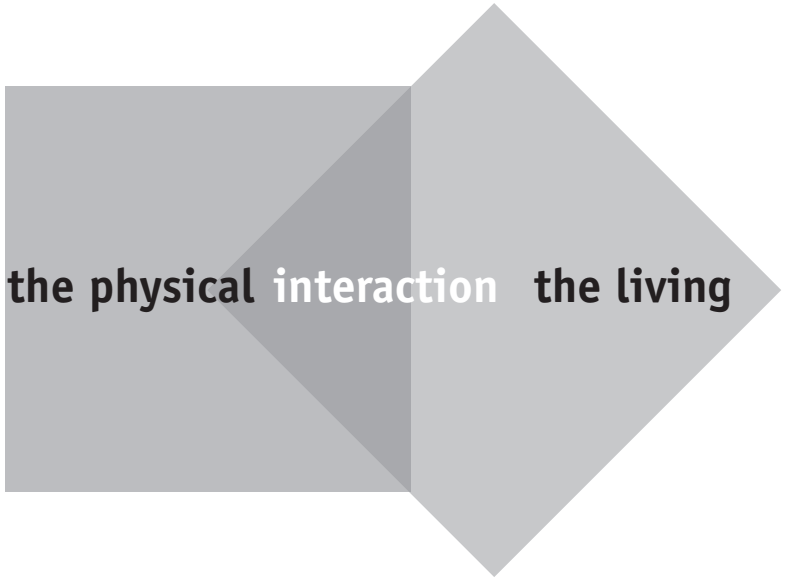
- servers
- terminals
- PDAs
- cell phone
- embedded

epistemological level

interaction

living	machine
- heterogenous	- homogenous
- storage free holistic memory	- sequential storage and retrieval
- capable of learning	- limited learning capabilities
- proactive = anticipation and reaction	- reaction
- creativity: generation and processing of data	- conventional (pre-programmed) non-creative data processing
- complexity	- ease of use
- non-deterministic	- deterministic

interaction -
the purpose is mediation



hybrid → living + physical

interaction -
the purpose is mediation

interface

- I/O aspects
  non-symmetrical
- representation
- dynamics

methods
of interaction

- hardware
- software

means
of interaction

- language
- images
- sounds
- thoughts
- emotions
- multimodal

interaction -
the purpose is mediation

forms
of interaction

- direct
- mediated

goals
of interaction

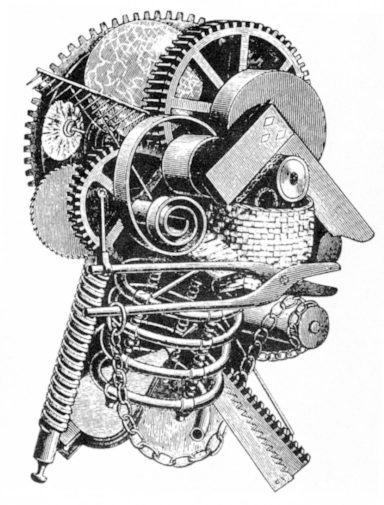
- expression
- communication
- functionality
- evaluation

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

reductionist approach:

human = machine

Cartesian tradition



- homogenous: all the same or trained to become the same
- focus on standard behavior
- cause-and-effect sequence
- limits creativity
- functionality

the goal is to reduce complexity

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

functionalist approach:
individual = user = function as a goal

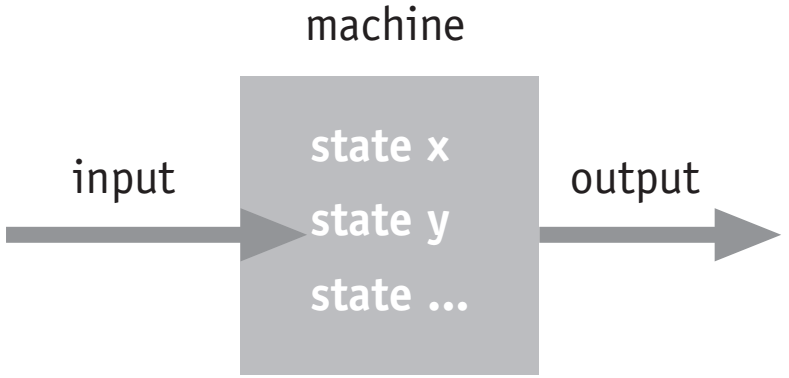
HCI:
How to create a *virtual machine* (of representation, models, navigation, interaction) between the user and the computer

functionalist approach:
machine-state-model

- Machine-state-model for conception and design
- Machine-state evaluation

Usability

- Evaluation of how successful we are in making the user behave like a machine
- Assumes an average individual
- Vicious cycle: Expectations become value



functional-relational approach
alternatives

- Contextual: supporting interaction with environments
- genetic
- ecological (Brunswick, Gibson)
- intelligent
- agent-based
- immersive
- self-adaptive

we are infinitely different

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

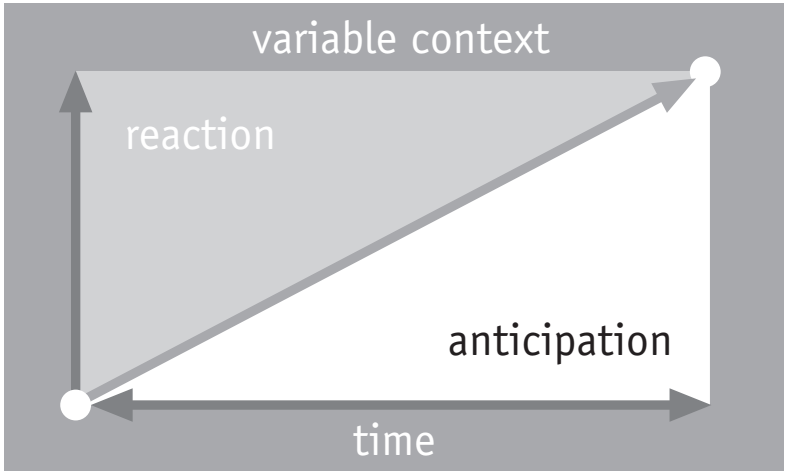
anticipatory HCI
is proactive

An **anticipatory system** is a system whose current state depends not only on a previous state, but also - or especially - on a **future state.**

anticipatory HCI

Fundamental switch from a functional perspective to a functional **and** relational perspective.

from **reaction**
to reaction and **anticipation**

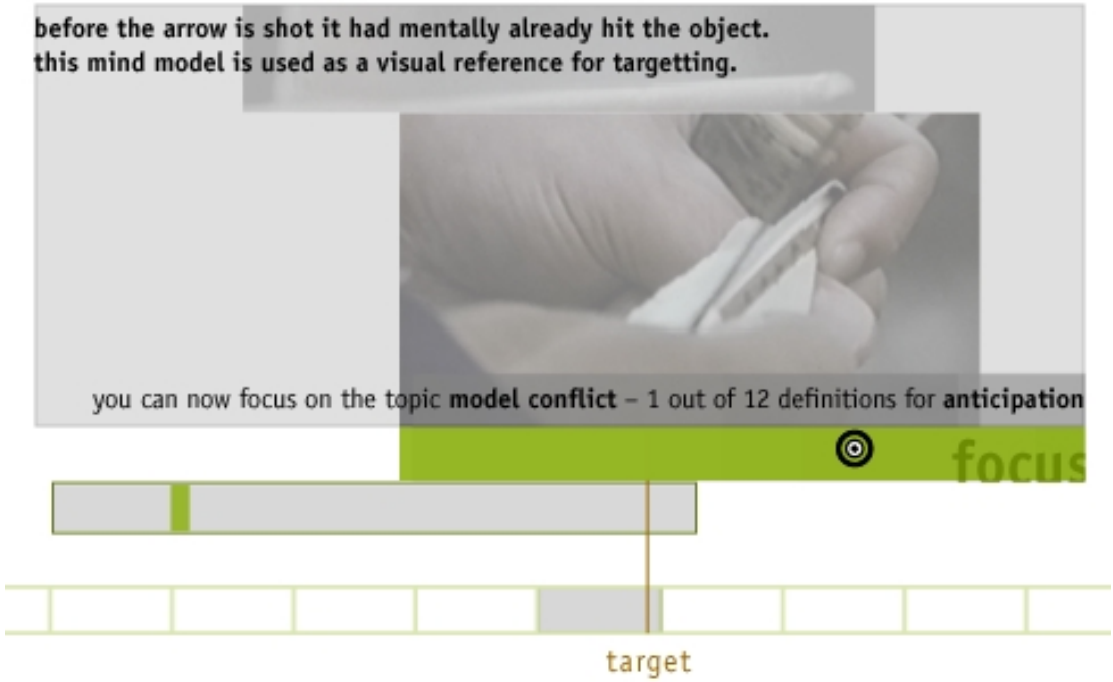


example: dvd project

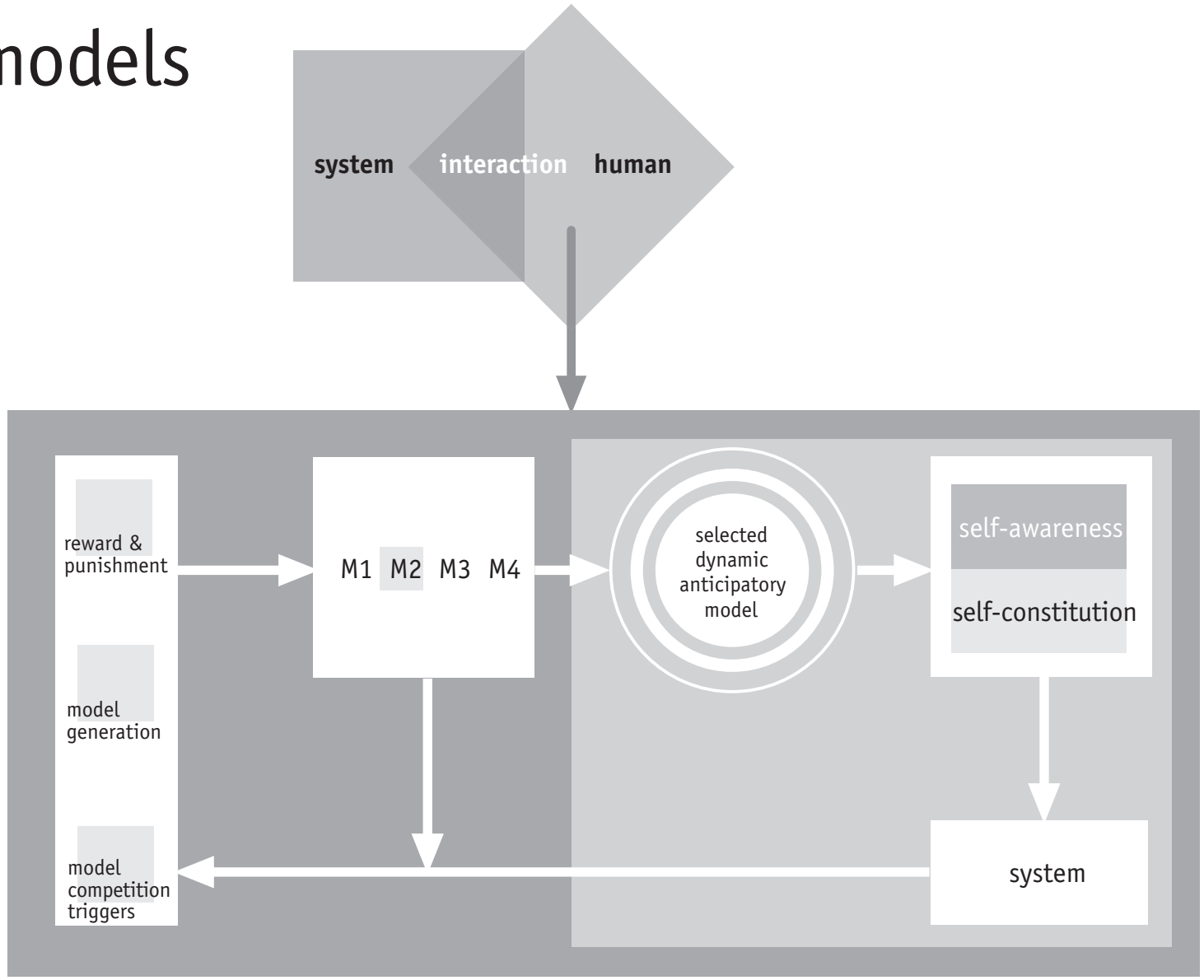
DVD interface

- preview elements as attractors for indirect relations

- opaque layers encourage individual imagination



conflicting models

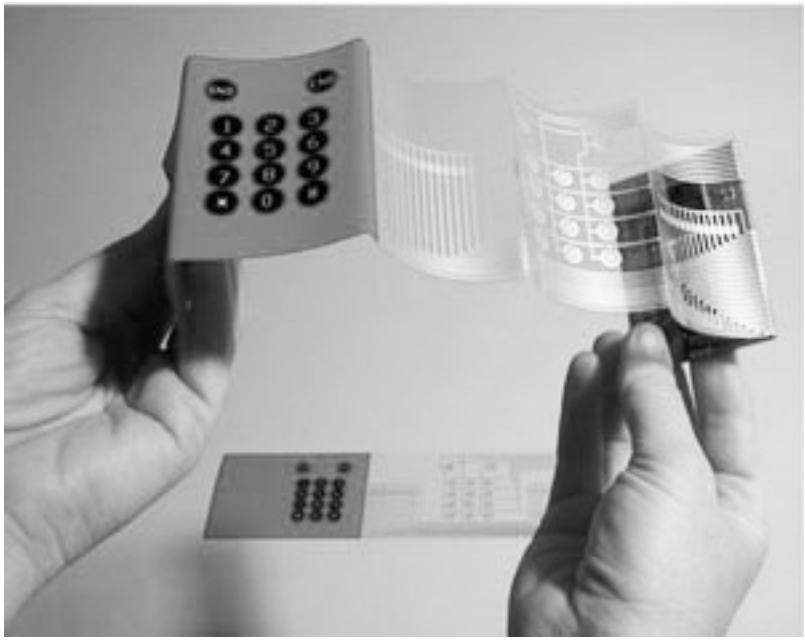


From:

What needs are new technologies supposed to meet?

To:

What new needs and expectations can be generated?



Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

soft interaction

Soft interaction as a possible implementation of anticipatory computing (cf. Zadeh).

- human beings
- NASA: reading thoughts and minds

pragmatic level:
NASA project

A computer is connected directly to the user. It considers the electromagnetical tension of the human skin and anticipates actions.

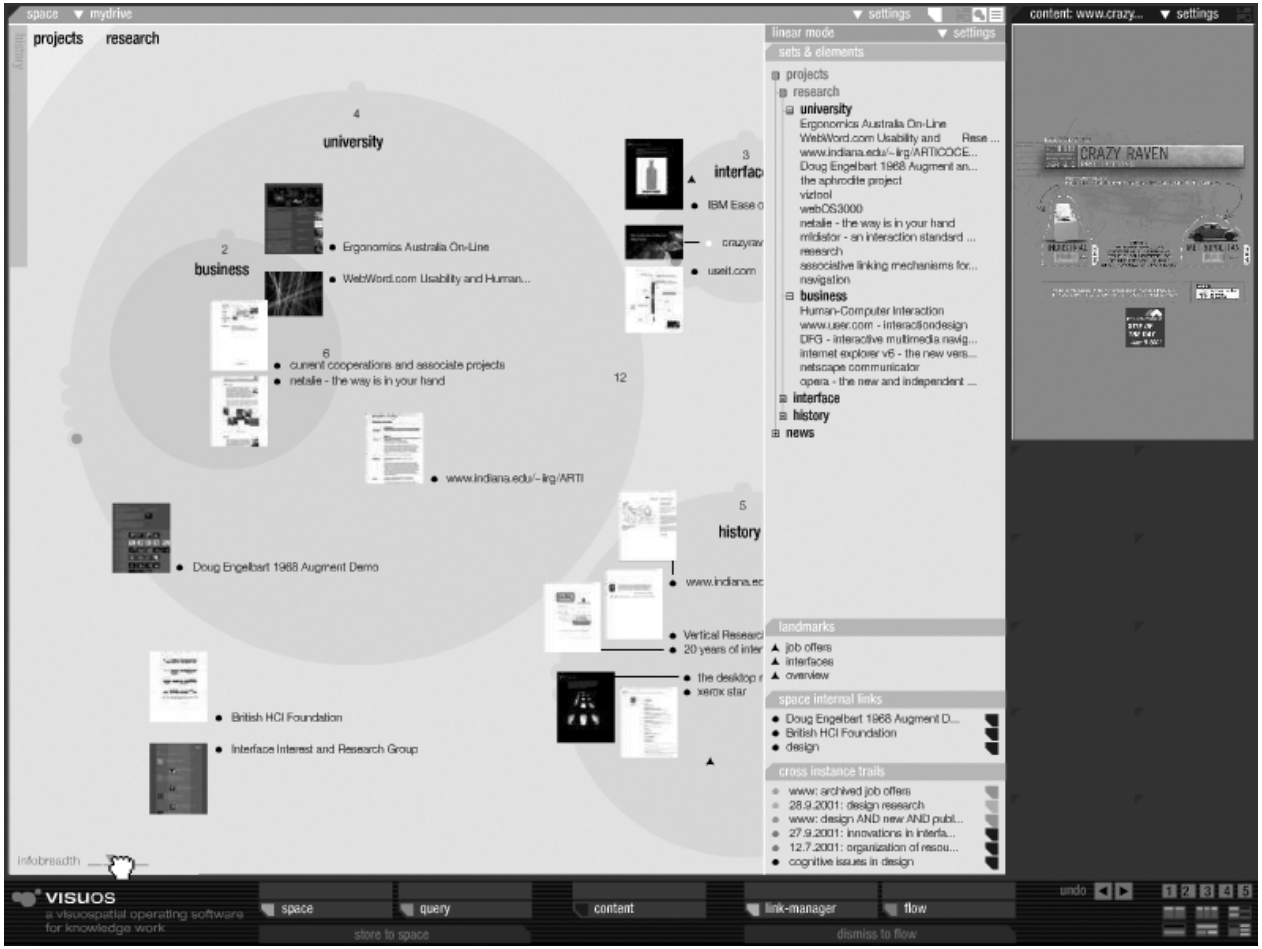
Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

soft interaction

- dynamic model of user's characteristics: age, time, season, context, etc. affect the individual
- personalized interactions reflecting the characteristics
- generation of alternatives
- learning function
- multimodal interaction

pragmatic level:
visuos project

A visual operating software for knowledge work



Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

soft interaction

Usability

- Evaluation of how much better the **individual** performs, not the machine.

- **Human-centered** instead of machine-centered perspective.

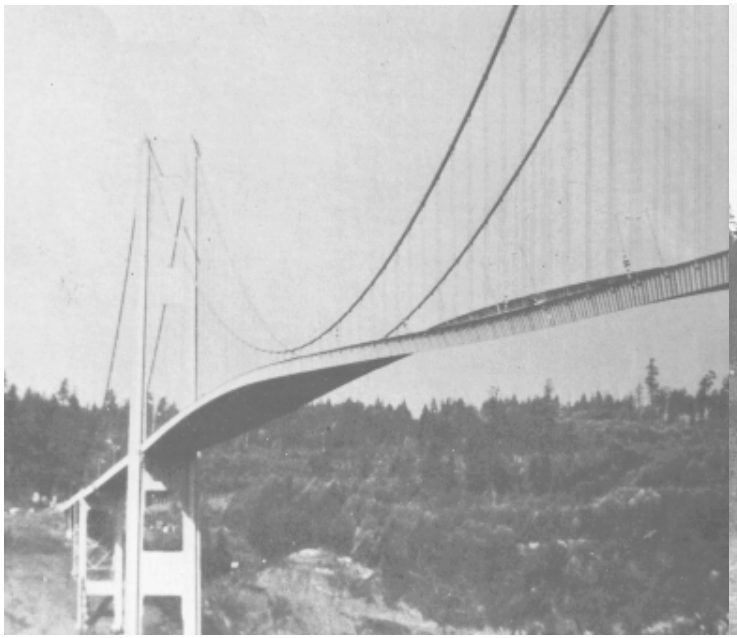
the mind is the last available resource

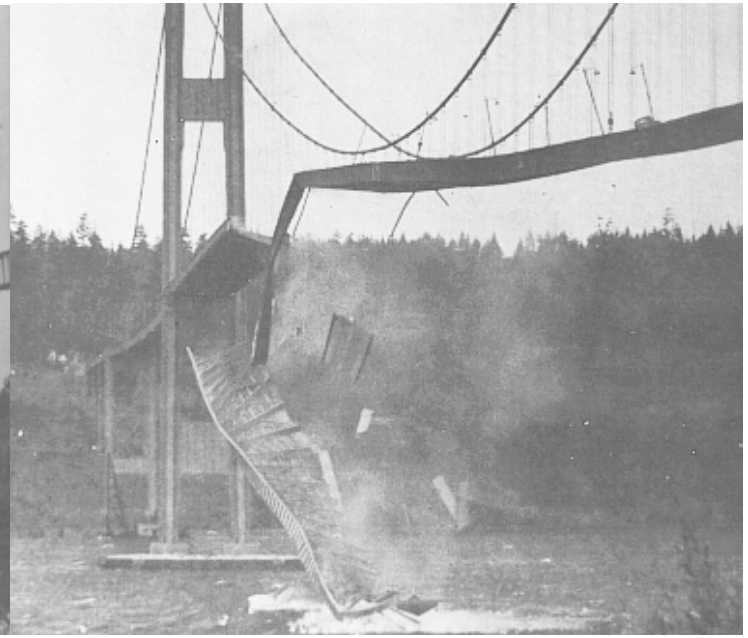
6. applications design & engineering

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

tacoma bridge failure

simulation as an anticipatory test





Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

self-repair

technopolymer with
animal protein

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

7.

applications
branding

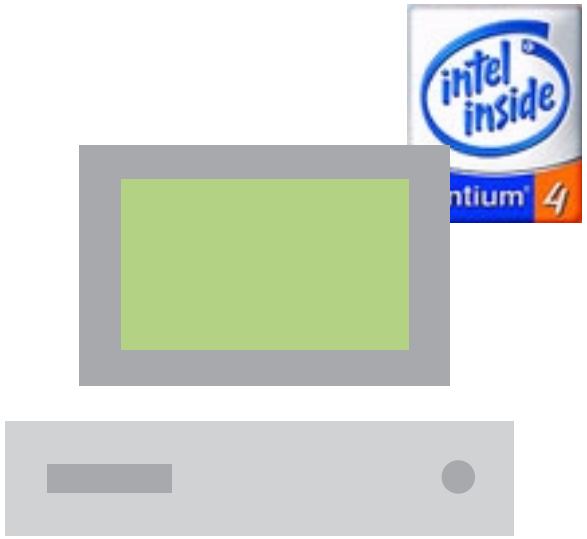
Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

BRANDING 1

co-relations of identities

an expectation-based process

person



product

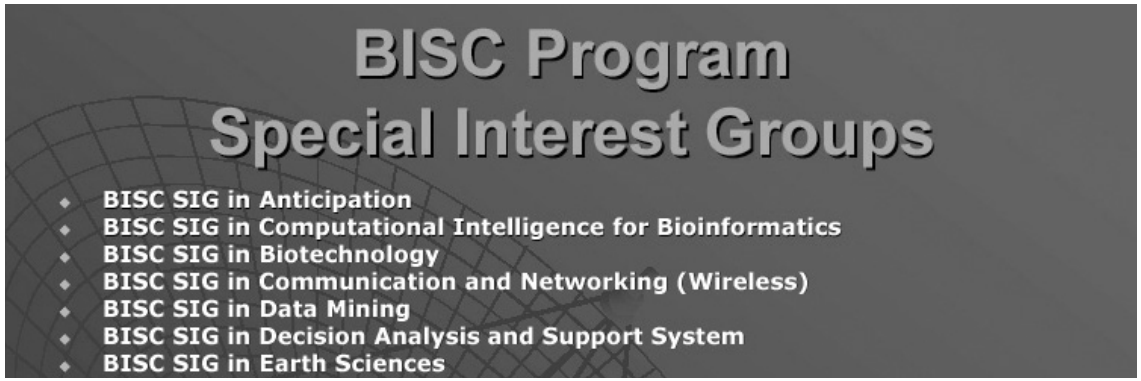
Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

8. implementation

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

IMPLEMENTATION **1**

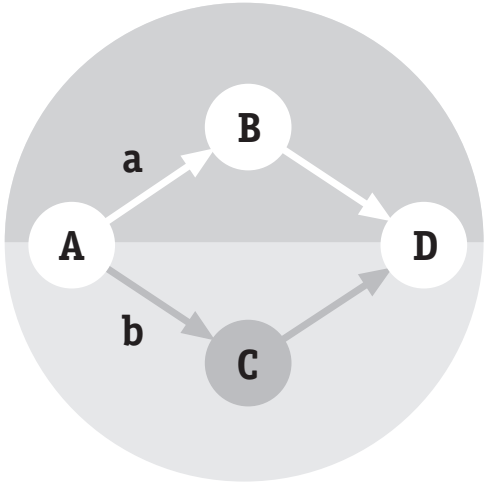
Berkeley Initiative in Soft Computing
special interest group in anticipation and soft computing founded at UC Berkeley, USA



IMPLEMENTATION **2**

the trip planning problem

- flight from A to D
- two choices:
  (a) connection in B
  (b) connection in C



- if I choose (a), arrival in D at time t1
- if I choose (b), arrival in D at time t2

IMPLEMENTATION 3

the problem

- the connection time, CB, in B is short
- should i miss the connection from B to D, the next flight will bring me to D at t3
- t3 is later than t2
- what should i do?

decision = f (t1, t2, t3, CB, CC)

existing methods of decision analysis do not have the capability to compute f

reason: nominal values of decision variables ≠ *observed values of decision variables*

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

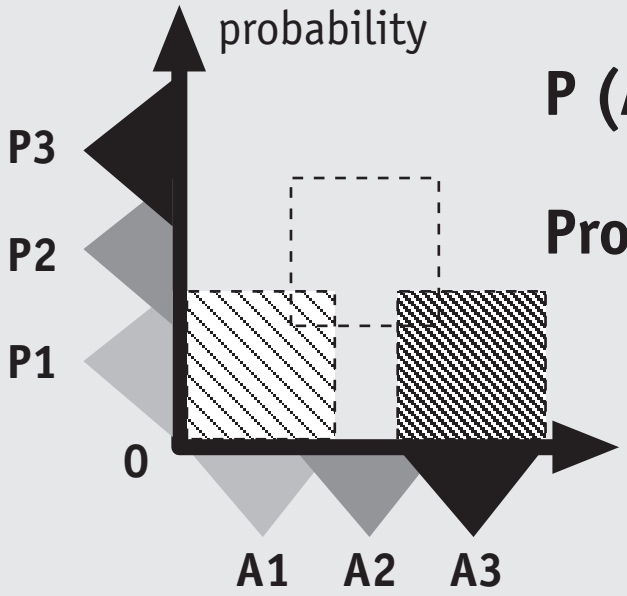
IMPLEMENTATION 4

analysis

- we need information about the probabilities of missing connections in B and C
- measurement-based information about these probabilities do not exist before the flight
- the only information available is perception-based
- with this information, i can compute perception-based granular probability distributions of arrival times in D for (a) and (b)
- the problem is reduced to ranking of granular probability distributions

IMPLEMENTATION **5**

perception-based granular probability distribution



P (AT) = P1\A1 + P2\A2 + P3\A3

Prob {AT is A;} is P;

IMPLEMENTATION **6**

computational theory of perceptions

the point of departure in the computational theory of perceptions is the assumption that perceptions are described by propositions expressed in a natural language

examples

- economy is improving
- Robert is very honest
- it is not likely to rain
- traffic is heavy

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

IMPLEMENTATION 7

- in general, perceptions are summaries
- perceptions are intrinsically imprecise

- imprecision of perceptions is a manifestation of the bounded ability of sensory organs and, ultimately, the brain, to resolve detail and store information

- perceptions are f-granular in the sense that (a) the boundaries of perceived classes are fuzzy; and (b) the values of perceived attributes are granular, with a granule being a clump of values drawn together by indistinguishability, similarity, proximity or functionality

- it is not possible to construct a computational theory of perceptions within the conceptual structure of bivalent logic and probability theory

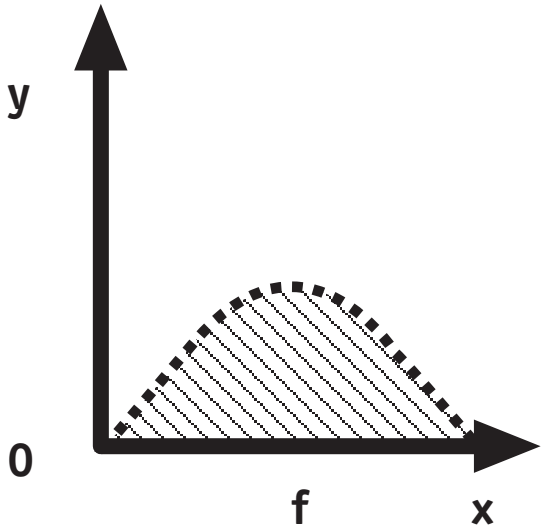
measurement-based vs. perception-based information

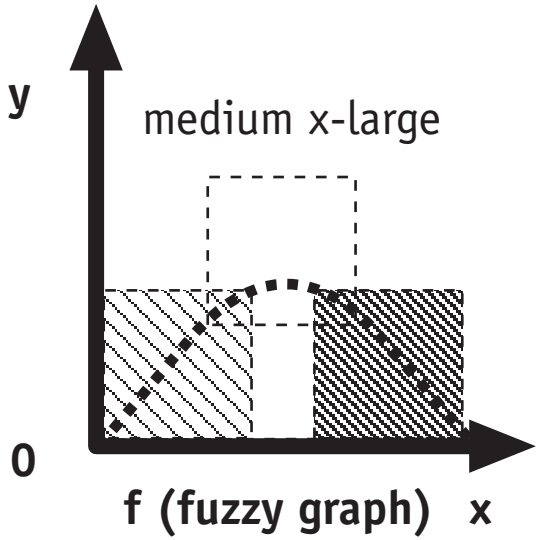
information

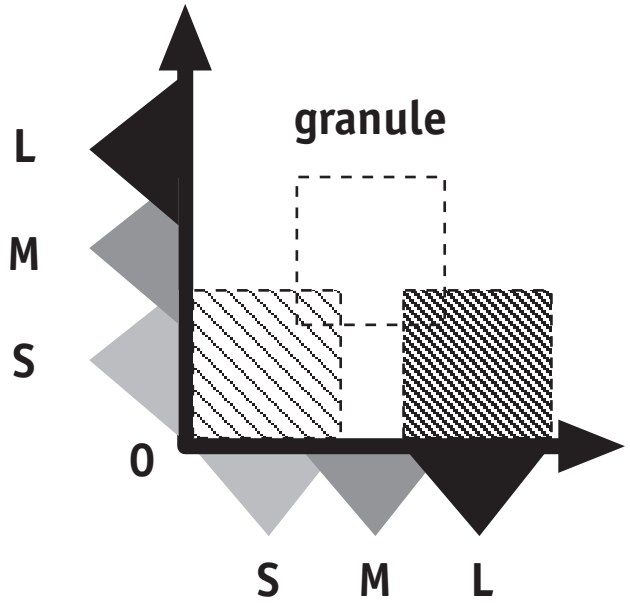
measurement-based	**perception-based**
- it is 35 C° - Eva is 28 - Tandy is three years older than Dana	- it is very warm - Eva is young - Tandy is a few years older than Dana - it is cloudy - traffic is heavy - Robert is very honest

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

perception of a function

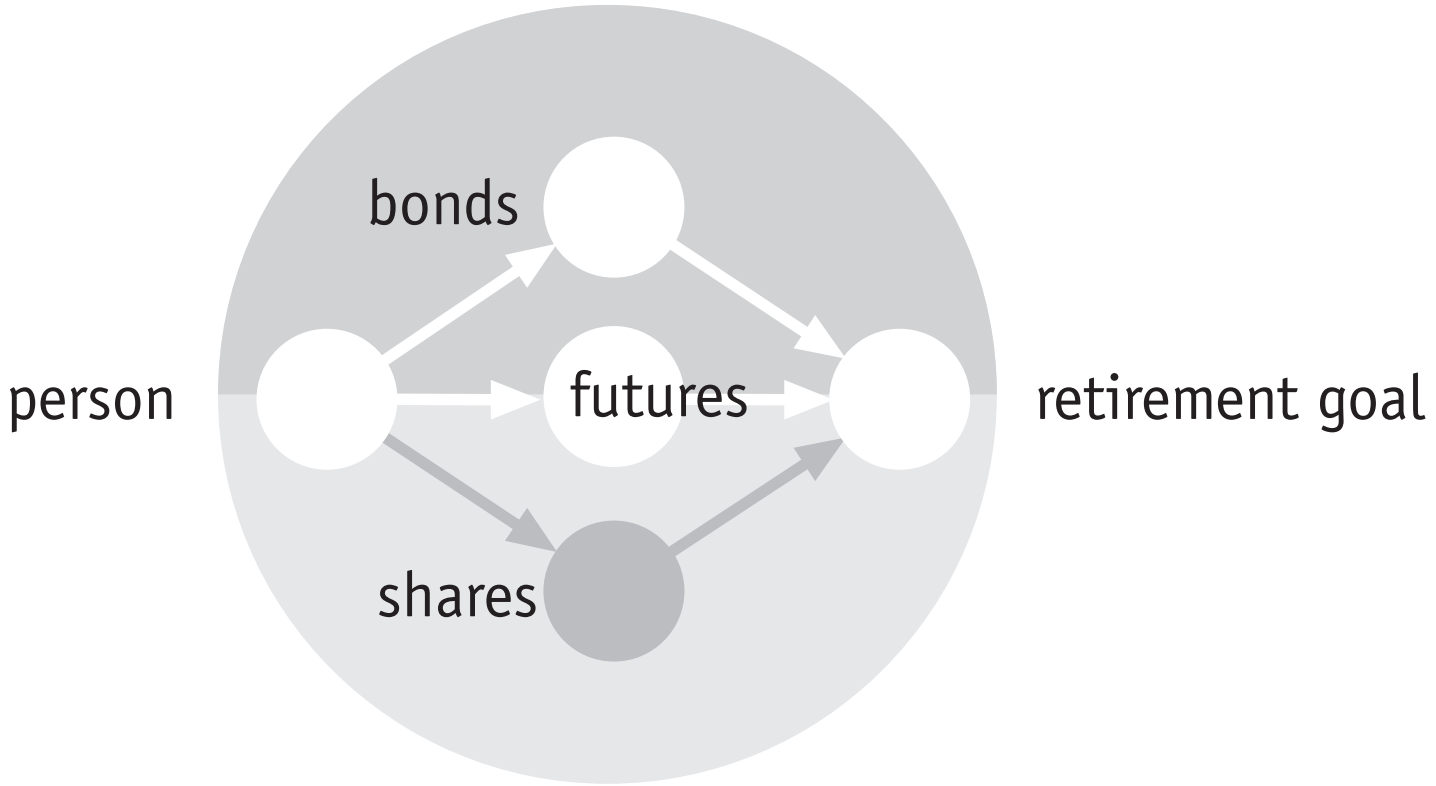






f → **f*: if x is smaller then y is small**
if x is medium then y is large
if x is large then y is small

example: investment



Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin

9. remarks

REMARKS **1**

[a]Ich bin vom Erfolg Ihres innovativen Ansatzes in Richtung Antizipation berzeugt. Forschung und Entwicklung, wie Sie sie betreiben, m §ten in Deutschland die Regel statt die Ausnahme sein.

Roland Berger

Unternehmensberater

[a]The paradigm that Prof. Nadin brought up as anticipatory computing opens many promising possibilities.

Jean-Claude Latombe

Chair, Computer Science

Stanford University

REMARKS 2

book publication

Wuppertal University
Computational Design
Prof. Dr. Dr. Mihai Nadin