TECHNOMATHEMATICAL IMPLEMENTATIONS. Non-human forms of embodiment

[Statement for workshop *Science of Embodiment*, organized by
Guerino Mazzola, Paris (ENS, rue d'Ulm), 2012]

A focus on time-critical signal processing in humans and machines
Mico-tempor(e)alities: Vibrating nerves, vibrating strings
[Analysis of hearing provides an example]
[The acoustic experience of the computer as (physical) body]
Statement: A vote for disembodied studies of *implementations*
Technological implementations. Human and non-human forms of
embodiment under time-cricital perspective (short version)

A focus on time-critical signal processing in humans and machines

One focus of a future *science of embodiment* leads to the analysis
of time-critical signal processing both in animals and in
machines, thus reactivating previous cybernetic assumptions under
the specific perspective of such micro-tempor(e)alities.

The core inspiration for a *science of embodiment* initiative is the
acknowledgement of "the human body's unity of perception-in-
action" (Mazzola); this implies the notion of time-critical signal
processing in animals and machines (encompassing both electronic
and technomathematical systems). The expression "in animals and
machines" of course alludes to the programatic sub-title of
Norbert Wiener's *Cybernetics* of 1948.[1] Signal processing as a topic
of applied mathematics - in the neo-cybernetic sense - does not
refer to electrical engineering only, but to organic bodies as
well.[2] Signal analysis (the basic archaeological level, with
signals being defined as time-varying or spatial-varying physical
quantities) then turns into an active mastering: operations on
signals. Signals of interest range from sound, images, sensor data
to telecommunication (such as radio signals). Technical media, in
this context, act as agents of signal analysis: biological data
(from the human body) are retrieved (and transformed) by time-
varying measure media (such as sonography, electrocardiograms).

Mico-tempor(e)alities: Vibrating nerves, vibrating strings

For example, the memory technique in oral poetic performances
(singers of tales) relies on senso-motoric synchronisation and
feedback, sometimes significantly coupled with a string instrument
(Homer in Greece, *guslari* in ex-Yugoslavia). "Aucune activité de

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1   Norbert Wiener, Cybernetcis or Communication and Control in the Animal and the Machine, 1948
2   See, for example, J. D. North, Application of Communication Theory to the Human Operator, in: Colin Cherry
     (Hg.), Information Theory. Papers read at a Symposium on 'Information Theory' held at the Royal Institution,
     London, September 12th to 16th 1955, London (Butterworths Scientific Publications) 1956, 372-389

la matière ne peut échapper au rhythme" (d´Udine[3]). "La diffusion
nerveuse est comparable à la propagation du courant électrique à
travers un réseau de fils conducteurs" <Jousse, 17>. The subject
of *embodiment* as form of *kinesthetics* epistemologically activates
the assumption that both machines (technical or mathematical) and
animals are governed by analogous feedback-processes. "By
consistently embracing all these technologies, we inevitably
relate ourselves to them as servomechanisms"; as such, e. g., the
businessman becomes a servomechanism of his clock, and explicitely
"the cyberneticists - and soon the entire world - of his
computer". McLuhan concludes: "This continuous modification of man
by his own technology stimulates him to find continuous means of
modifying it <...>. Man's relationship with his machinery is thus
inherently symbiotic" – a shift of perspective from body-centered
to system-orientated *embodiment*.[4] This requires to bring together
disciplines which are usually institiutionally separated in the
academic faculties: humanities, engineering, cultural studies,
mathematics, neuro-sciences, media studies.

[Analysis of hearing provides an example]

Inserting microelectrodes into the auditory nerve for recording
the events creates a human-machine coupling in the cybernetical
sense of McLuhan's definition of media as extensions of man.
When J. C. R. Licklider researched the essentials of what
constitutes "hearing" in humans and animals (auditory analysis),
he explicitely asked: "Is there, built into the auditory nervous
system, a mechanism <...> that supplements the cochlear frequency
analysis?"[5] His very use of terms stems rather from electronic
engineering than from traditional physiology, thus dis-embodying
the analysis of human hearing. But "the analytical properties of
the ear cannot be explained entirely in terms of the mechanics of
the cochlea."[6]

[The acoustic experience of the computer as (physical) body]

Gerard Alberts, reader in the history of mathematics and computer
science at the University of Amsterdam, has researched on the
sounds which emanated from computers in the archaic age 1950-1960,
where loudspeakers were mounted not primarily to generate
mathematics-based music compositions (like the ILIAC suite), but

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3   As quoted in: Marcel Jousse, Le Style oral rythmique et mnémotechnique chez les Verbo-moteurs, in: Archives de
     Philosophie vol. II, Cahier IV: Études de Psychoogie Linguistique, Paris 1925, 10

4 See as well J. C. R. Licklider, Man-machine symbiosis, 1960

5   J. C. R. Licklider, Auditory Frequency Analysis, in: Colin Cherry (Hg.),
     Information Theory. Papers read at a Symposium on 'Information Theory' held
     at the Royal Institution, London, September 12th to 16th 1955, London
     (Butterworths Scientific Publications) 1956, 253-268 (254)

6   J. T. Allanson / I. C. Whitfield, The Cochlear Nucleus and its Relation to
     Theories of Hearing, in: Cherry (Hg.) 1956: 269- (269)

for auditory monitoring (audification / sonification) of a very program in execution - in the absence of visual monitors, there was a direct auditory interface to the computer body.

When Alberts delivered his lecture within the frame of the weekly lecture "Medium und Affekt" on December 18, 2010, he titled his talk "Die Körperlichkeit des Rechnens" - an embodied approach *de corporis machinae*, reminding of the corpor(e)ality of calculations within the machine (different from simply symbolic mathematics) - a core epistemological issue of media archaeology.

Statement: A vote for disembodied studies of *implementations*

In a neo-cybernetic view, the media-archaeologically extended perspective liberates the term "embodiment" from its narrow restriction to organic human bodies (just as Deleuze / Guattari pointed attention to the "non-organic body") and concentrates on aspects where human and non-human forms of embodiment-in-action meet: mathematics, implemented in the physical (and organic) world, means being-in-time. The very term "implementation" tries to avoid the anthropocentric interpretation of *embodiment*. In a similar way, *instantiation* refers the idea that in order for a property to exist, it must be object or have a substance. This is not limited to human bodies; in computer science, the "instance" refers to any running process (and in object orientated languages specifically to an object as an instance of a class).

On its functional level, the description of an operative system is a diagram. Operative diagrammatics is the physical *embodiment* of symbolic languages. A world of difference takes place when this diagram is embedded in physical matter; in computer science, *implementation* names the realization of a technical specification or algorithm *as a* program (that is: software).

Technological implementations. Human and non-human forms of embodiment under time-cricital perspective (short version)

One focus of a future *science of embodiment* leads to the analysis of time-critical signal processing both in animals and in machines, thus reactivating previous cybernetic assumptions under the specific perspective of such micro-tempor(e)alities. The core inspiration for a *science of embodiment* initiative is the acknowledgement of "the human body's unity of perception-in-action" (Mazzola); this implies the analysis of time-critical signal processing "in the animal and the machine" (encompassing both organic and electronic respectively technomathematical systems), alluding to the programatic sub-title of Norbert Wiener's *Cybernetics* of 1948. Signal processing as a topic of applied mathematics - in the neo-cybernetic sense - does not refer

to electrical engineering only, but to organic bodies as well. For example, J. D. North, in 1955, developed an "Application of Communication Theory to the Human Operator". Signal analysis (the basic archaeological level, with signals being defined as time-varying or spatial-varying physical quantities) then turns into an active mastering: operations on signals. Signals of interest range from sound, images, sensor data to telecommunication (such as radio signals). Technical media, in this context, act as agents of signal analysis: biological data (from the human body) are retrieved (and transformed) by time-varying measure media (such as sonography, electrocardiograms).

For example, the memory technique in oral poetic performances (singers of tales) relies on senso-motoric synchronisation and feedback, sometimes significantly coupled with a string instrument (Homer in Greece, *guslari* in ex-Yugoslavia). "Aucune activité de la matière ne peut échapper au rhythme" (d´Udine). Vibrating nerves, vibrating strings: "La diffusion nerveuse est comparable à la propagation du courant électrique à travers un réseau de fils conducteurs" (Marcel Jousse, Le Style oral rythmique et mnémotechnique chez les Verbo-moteurs, 1925). The subject of *embodiment* as form of *kinesthetics* epistemologically activates the assumption that both machines (technical or mathematical) and animals are governed by analogous feedback-processes. The human body in culture is coupled with such servomechanisms (such as the clock). Marshall McLuhan identified the continuous modification of man by his own technology. Man's relationship with his machinery is thus inherently symbiotic; J. C. R. Licklider in 1960 declared this man-machine symbiosis explicitely - a shift of perspective from body-centered to system-orientated *embodiment*. This requires to bring together disciplines which are usually institutionally separated in the academic faculties: humanities, engineering, cultural studies, mathematics, neuro-sciences, media archaeology.

In a way, this leads to a vote for studies of *disembodied* implementations. In a neo-cybernetic view, the media-archaeologically extended perspective liberates the term "embodiment" from its narrow restriction to organic human bodies (just as Deleuze / Guattari pointed attention to the "non-organic body") and concentrates on aspects where human and non-human forms of embodiment-in-action meet: mathematics, implemented in the physical (and organic) world, means being-in-time. The very term "implementation" tries to avoid the anthropocentric interpretation of *embodiment*. In a similar way, *instantiation* refers the idea that in order for a property to exist, it must be object or have a substance. This is not limited to human bodies; in computer science, the "instance" refers to any running process (and in object orientated languages specifically to an object as an instance of a class). Within that context, *implementation* names the realization of a technical specification or algorithm *as a* program (that is: software). On its functional level, the description of an operative system is a diagram. Operative diagrammatics is the physical *embodiment* of symbolic languages. A

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