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# The ethos of Systems Biology as big science

Big Science - a characteristic feature of systems biology?

How and why does it matter?

# What are the characteristic features of systems biology?

- The question targets the issue of why systems biology is worth doing
- What the ethos of systems biology is

Structure

- Ethos – formative for action
- Big science in biology
- Ethos of systems biology as Big Science

# Ethos as a normative crossover term

- Ethos: the moral character captured in defining set of features of a person, institution or practice – including aspirations

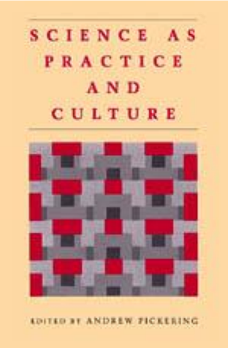
- Ethos: referring to characteristic features of a practice - crossover:
  - epistemic concern: What systems biology is as a scientific judgment – or aspiration
  - normative concern: Why systems biology is worth pursuing

Normative consern of 'academic' research (truth seeking) differ from 'post-academic' research (enabling capacity).

# Ethos – researching what gives direction to research activities.

- Ethos includes the story of our self (self evaluations) that we also communicate to others (how we want them to view us)
- Ethos is therefore formative for action (choices, directions) and collaboration structures (recruitment, enrolment)
- Ethos may be more or less articulated – more or less well argued: weak or strong
- Attempts to articulate the ethos of a practice intervenes in the practice as it targets questions of the worth of the practice
- Researching the ethos is to engage normative realities that give direction to ongoing research activities

# Investigating characteristic features of systems biology - epistemic concerns




**Science - as - knowledge**

Theoretical characteristic features

- Reductionism vs holism
- Dynamic vs static molecular interactions

**Science – as –practice**

Pragmatic characteristic features

- Work units
- Social organisation
- KM structures enabling information commons

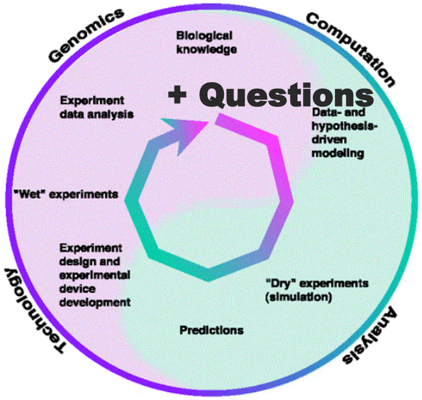
Researching the ethos of science – is to investigate scientific activity as a human practice.

Ethos focuses on particular practices – ethos of systems biology

# Systems biology as big science?

Characteristic feature -formative for action:

“**emergent** biological system properties that result from **interactions** between molecular-, cellular-, organ- and organismic-level components and structures”




What are the characteristic features of the required research systems?

How does systems biology characteristically distinguish itself from previous varieties of biotechnology research?

Seems worthwhile to note its character of being big science, and how it differs from earlier big science efforts

# Big science

- Big science inevitable?
- Social and scientific imperatives
- Ethos - and its epistemic and normative concerns

July 1961, Volume 134, Number 3473 **SCIENCE**

## Impact of Large-Scale Science on the United States

Big science is here to stay, but we have yet to make the hard financial and educational choices it imposes.

Alvin M. Weinberg

Throughout history, societies have expressed their aspirations in large-scale, monumental enterprises which, though not necessary for the survival of the societies, have taxed them to their physical and intellectual limits. History often views these monuments as symbolizing the societies. The Pyramids, the Sphinx, and the great temple at Karnak symbolize Egypt; the magnificent cathedrals symbolize the church culture of the Middle Ages; Versailles symbolizes the France of Louis XIV; and so on. The societies were goaded into these extraordinary exertions by their rulers—the pharaoh, the church, the king—who invoked the cultural and the motivations of the church builders and the pyramid builders. We build our monuments in the name of scientific truth, they built theirs in the name of religious truth; we use our Big Scie[...] to add to our country's prestige, th[...] used their churches for their cit[...] prestige; we build to placate what [...] President Eisenhower suggested co[...] become a dominant scientific caste, th[...] built to please the priests of Isis a[...] Osiris.

The emergence of Big Science a[...] its tools as a supreme outward expr[...] sion of our culture's aspirations [...] created many difficult problems, b[...] philosophic and practical. Some of [...]

**Is Big Science Ruining Science?**

The English astronomer Fred Hoyle recently set off a lively controversy by arguing against the United Kingdom's going into large-scale space research. His argument, which applies to much of Big Science, is twofold: first, that the intrinsic scientific interest of space research is not worth the money and manpower that goes into it and certainly does not justify spending more on it than on any other branch of science; and second, that wherever science is fed by too *much* money, it becomes fat and lazy. He claims to see evidence that the tight intellectual discipline necessary for science is, especially in America, being loosened. I shall touch later upon Hoyle's first point: Is Big Science giving us our money's worth? For the moment I want to discuss his [...] paraphrased [...]ing science?" [...] Hoyle's mis-[...]e, since Big [...]ic support it [...] inevitable re-[...]a journalistic [...]ich is funda-[...] the scientific [...]ritings about [...]lly separated [...]ritings, little [...] they are not

Alvin Weinberg 1961

# Big Science – large working units –
## - designed in support of a specific scientific aim

"The particle accelerator was designed primarily as an attempt to produce the 'Higgs boson' "

20 years
8000 scientist
85 countries
27 km Circumference

"Academic research"

# Big Science of HGP

Characteristic features – formative for action.

- Epistemic concern: potential of sequencing the genome

  Characteristic features:
  - large scale technological facilities designed to achieve the goal
  - biology becoming a "computational analytical science" – facing challenge of bridging a gap between "real world" of biology and precise "logical" nature of computing (Lander).

- Normative concern: the projects' capacity to empower other sectors (future health, food supply economic welfare ..)

  Characteristic features :
  - ELSA studies: HGP promised to make a difference for the daily life of citizens that were not necessarily judged as desirable

National Research Council report (1993). "National collaboratories",
Cook-Deegan, Robert. 1995, Lander et.al. 1991. "Mapping and Interpreting Biological Information," Commun. ACM 34(11):33-39.



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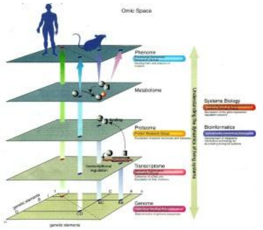
# Big Science of post-genomics

## Characteristic features - formative for action



- Epistemic concerns: "emergent biological system properties that result from interactions between [..] components and structures"

  Characteristic features

  - *Building infrastructures* (biological material, raw data, knowledge databases). Biobanks, MGED or Gene-ontology concortium, EBI …
  - *Alignment of local laboratory practices* that are to feed into and rely on shared common resources (including adjusting to new way past scientific achievements are represented and finding new ways to ensure reliability )
  - *Computation and biology*. Augmenting the brain, restructuring traditional ways of storing, sharing, communicating, assessing and mobilize knowledge
- Normative concerns: Practical outcomes of projects

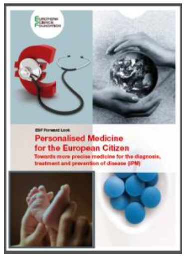
  Characteristic features

  - Context driven – post-academic: Alignment of research, industry and politics
  - ELSA studies by default

Friend & Norman Nat.biotek (31) 2013 297pp

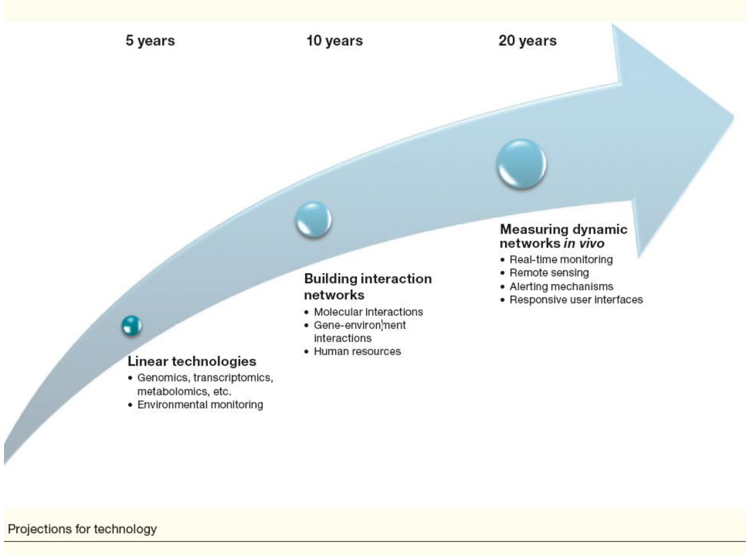
# Context driven

Medicine – possible formative role in building of infrastructures




"A defining feature of personalised medicine will be its capacity to **integrate complex information** from multiple data sources and to generate a usable output to **support the health of individual** citizens." (ESF- report)

PM vision -
prospect of progressive capacity
to utilise biological
information




Link biomarkers to treatment → In silico models of individual patients

# Characteristics features of big science

**Physics**

- One big work unit
- Centralised
- Clear scientific formative aim
- Self-contained as science
- Theory driven (academic science)
- Philosophy of ‘eternal’ questions

**Biology**

- Multiple, flexible large and small work units
- Decentralised
- Multiple formative scientific and social aims
- Convergence of sciences
- Context driven (post academic science)
- ELSA of urgent matters

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# Puzzling feature of natural science

- The smaller the object of study
  - the larger the experimental systems tend to become
- The bigger the structures
  - the more political it needs to be to fulfil normative requirements: why is it worth pursuing – really.
- The smaller the objects of study
  - the more the world has to be transformed, socially, materially, economically, politically in order to acquire knowledge about the objects.

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# Ethos of systems biology as big science

- Large resources: Demand larger mandate from society
- Large collaborative structures: alignment of ethos of various practices - become 'socially robust' all by themselves?
- Empowerment: Make available common resources locally (everywhere)
- Vulnerability: scientific risk of standardisation and alignment
- Power play: what gets the key role of being the motor for  biotechnology (like PM) – giving directions to the work of building the biotechnological "machines to make the future"