Chemistry between Nature and Technology

CHEMIE UND GESELLSCHAFT
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Chemical vs Natural

- “Give me something against cough... a natural drug not one of those chemicals....”

- “Chemical” and “synthetic” = unnatural, even counter-natural for the laypublic

- Why?
What is wrong with chemistry?

- How a natural science whose object is nature could be against nature?

- “Chemistry creates its object. This creative faculty akin to that of art, forms an essential distinction between chemistry and the other natural or historical sciences.

  (Berthelot 1860)
What is wrong with chemistry?
A Popular Prejudice?

- Natural vs artificial is a non-robust dichotomy

- Why wood, cotton, and wool, are seen as natural whereas nylon are synthetic? They are all processed

- Origin? coal & oil are as natural as sheep
A Popular Prejudice?

- Natural vs artificial is a non-robust dichotomy
- Why wood, cotton, and wool, are seen as natural whereas nylon are synthetic? They are all processed
- Origin? coal & oil are as natural as sheep

- Quantitative rather than qualitative difference.
- No obvious boundary, depends on many criteria+
  comparative...
- However it determines a moral threshold, a boundary for deciding what is right and wrong.
A source of chemophobia

- Natural vs artificial = a pre-modern and relative divide. Seems obsolete and irrational.
  
  - In a world saturated with technology what can be the significance and relevance of the ancient divide?
  
  - Why technophobia vs technophilia?
Chemophobia/Chemophilia polarization?

Rachel Carson, *Silent Spring* 1962, quiet nature destroyed by chemicals

Chemists’s reply: *The Desolate Year*, horrors of the world without pesticide.

**Controversy:**
- chemophobia based on the view of chemistry as a war against nature
- chemophilia became a chemophobia-phobia.

**Result:** Popular and absurd divide between chemical and natural.
Not a Temporary Depression

- Historical perspective in the long duration of Western culture (20 to 25 centuries)

- The bad image of chemistry is not a moment of crisis that could be overcome by a good marketing campaign.

- Rather one episode of a long tradition of conflicts deeply rooted in the history and prehistory of chemistry.
Cultural values embedded in chemistry

- Chemistry is not value-free: direct impact on the highly valued notion of nature.

- Chemistry blurs the nature/artifact divide:
  - as a science: knowing through making
  - as a technology: nature instrumentalized for human purposes
A long story of transgressions

A CULTURAL HERITAGE
A Western concept

- Concept of Nature is one of Four ontologies
  - totemism
  - Animism
  - Analogism
  - Naturalism
Naturalism

• Naturalism is « simply the belief that nature exists, in other terms that some entities owe their being and their development to an external principle, which is not an effect of human will. Typical of Western cosmologies since Plato and Aristotle, naturalism generates a specific ontological domain [...] it has become a « natural » presupposition which structures our epistemology and in particular our perception of other modes of identification. (Descola, Les Indiens d’Amazonie)
Aristotle *Physics* II

[A]rt partly *completes* what nature cannot bring to a finish, and partly *imitates* her.

Natural beings have an internal principle of motion and rest while artificial objects – a bed or a coat, for example – do not possess any such innate tendency to change.

‘Man is born from man, but a bed is not born from a bed.’
Roots of chemophobia in scholastic culture

- Medieval alchemy developed in a scholastic (post-Aristotelian) context

- Scholastic philosophy:
  - Natural substances have a “substantial form”
  - Nature/artificial = ontological difference
Scholastic condemnation of alchemy

- No true imitations of natural gold
- Either treachery: charlatans
- Or supernatural power: sorcerers
Alchemists vs Scholastics

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<thead>
<tr>
<th>Alchemists</th>
<th>Scholastics</th>
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<tr>
<td>Transmutation of lead into gold imitates the natural process of the ripening of ores in mines.</td>
<td>Artificial gold lacks the substantial form given by God.</td>
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<tr>
<td>Alchemical transmutation assists nature by facilitating and accelerating a natural process</td>
<td>Artificial gold cannot be identical to gold matured in the mines.</td>
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<td>Alchemy improves nature as it refines raw materials</td>
<td>No one can rival with God’s creation</td>
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<tr>
<td>Alchemy imitates the creation of nature</td>
<td>Transgression + Blaspheme</td>
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Alchemists’ Reply

1) experimental evidence:
- tests to prove the authenticity of the artificial gold made in their laboratory.

- later (17th century) analysis and synthesis to prove the identity of natural and man-made products
2) Hermes Book (13th century):
- Man-made products are both artificial and natural since they use natural agencies such as fire.

- They are by no means inferior to natural products. In some cases they even surpass them.

Alchemists = earliest advocates of technology in Western culture.
Dignifying artifacts

- 18th-century “facticious” products (ammonia, sulphuric acid, soda)

- Chemistry celebrated as a useful science, contributing to public welfare and the wealth of nations. Chemists were no longer perceived as dangerous people.
A Climax of Transgression

THE PLASTIC AGE
Glamorous synthetic materials

May, 1940, Nylon euphoria

Du Pont’s “Better things for better living . . . through chemistry,” as a new style of life,
Cornucopia of material plenty
The Wonderful World of Synthetics

- consumption of material goods.
- control of production, pure products
- Comfort for all: Synthetics as agents of democratization
- economic benefits *one plastic a day keeps depression away*”
- job opportunities,
- Regular supply
From properties to Virtues

- Lightness
- Plasticity (potential for indefinite change)
- Impermanence (one-use commodities)
- Clean = >
- Protecting nature: “The use of chemical substitutes releases land or some natural raw material for other more appropriate or necessary employment” (Williams Haynes, *Men money and Molecules* (1936))
Dignifying the artificial

- Plastic = major cultural value

Roland Barthes (1971) ‘Plastics are like a wonderful molecule indefinitely changing..

Connotations:
- magic of indefinite metamorphoses
- Virtual reality.
- Superficiality
A cultural Model

Plastic man
Ever changing
Superficial
Fun
Flexible
Adaptable
Convivial
Plastic accumulation

Great Pacific Garbage Patch

These patches also contain chemical sludge and other debris and the plastic can absorb organic pollutants from the seawater. Fish and birds eventually eat the microplastics and plastic pieces from small enough pieces, which humans then eat.

The plastic follows currents to the next 10 meters of the water column.

Gyre Current

An estimated 700 million garbage since in the ocean floor.

Debris ranges in size from abandoned fishing nets to micro-particles found in abrasive cleaners. Garbage from Asia's east coast takes about a year or less to enter the Pacific gyre, while trash from the west coast of North America can take up to 10 years.

10 percent of the world's annual 200 billion pounds of plastic produced washes up in the ideal

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Subtropical Convergence Zone

The wind-driven, water-draining current of the North Pacific Gyre gathers marine pollution, slowly moving it towards the center of the region and trapping it.

90% of the plastic floating in the Earth's oceans is plastic. Less than 1% of all plastic is recycled.

From the Earth

- Cotton T-shirt: 10 Years
- Coffee Cup: 100 Years
- Plastic Bag: 1,000 Years
- Water Bottle: 700 Years
- Aluminum Can: 50 Years
- Glass Bottle: 1,000 Years

Estimated Decomposition Rates
Desperately seeking natural substitutes
CREATING LIFE IN A TEST TUBE
Renaissance

- Paracelsus’s attempts at making life in a test-tube
- Faust Legend
A Literary theme
Wöhler synthesis of urea

- 1828, synthesis of organic compound
- Death of metaphysical vital force
- Dawn of a new era when chemists would be able to create organisms
A Legend

- Legend propagated by Herman Kolbe, Wilhelm August Hoffman and Marcellin Berthelot.

- Urea is an organic substance but not an organism
- Not a total synthesis (from cyanate extracted from horns)
- A product of life but was not synthesized through the same process in the organism (Claude Bernard).
- Anti-metaphysical claim <= confusion between organic and organized and between products and process.
Marcellin Berthelot 1860

Synthesis: “The reproduction of the complete set of natural compounds using the elements in partnership with only the play of molecular forces and the chemical metamorphoses that matter undergoes in living beings”.

“the chemical effects of life are exclusively due to chemical forces”.

From synthetic chemistry to synthetic biology

- **Biology is technology**

- “The genetic code is 3.6 billion years old. It’s time for a rewrite”

- Tom Knight (Silver, Life 2.0 in *Newsweek International* June 4, 2007)
Redesigning life
Again: The death of Vitalism

*Nature*, June 28, 2007:

“Synthetic biology provides a welcome antidote to chronic vitalism”

Cultural benefit: “Life is a molecular process lacking a moral threshold at the level of the cell.”
Unnatural living organisms
Chemistry struggles in the symbolic order: given the resilience of the natural/artificial divide, chemistry keeps an aura of trangression.

Chemical Synthesis = main historical target.

When chemistry is no longer the only science who creates its own object... transfer of the burden of trangression.
What next?

- How to reconcile chemistry and the Western valuation of nature?

- biomometric synthesis?

- Green chemistry?

- Cultural Values Matter......