Priority to questions

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What is a researcher?



What is a researcher?

- Someone who identifies new questions
- Someone who can develop a strategy to address them

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What is a « simple » question?

- A question which does not require much background
- A question which does not have a simple answer
- A question which opens a new field/research area

Ex: How does heredity work?





Gregor Mendel

New field: Genetics

Contemporary example?



Explains something

Observation/frustration: Genetics is correlative



Gene

Shape

Strategy: need to look beyond the discipline

Integrating mechanics and computational modeling to be closer to causality



New field: Morphodynamics / quantitative biology

Integrating mechanics and computational modeling to be closer to causality



New field: Morphodynamics / quantitative biology

Quantitative biology can help generate other simple questions

- Extracting meaningful information from huge (and heterogeneous) datasets
- The contribution of gene network topology in regulation
- The roles of **stochasticity**
- Multiscale emerging properties
- The counter-intuitive implications of feedback
- Visualizing the **invisible**, e.g. forces
- How does robustness emerge?

A new journal for this field





Why is it difficult to generate simple questions?



We are suffering from many cognitive biases

We are suffering from many cognitive biases



KAHNEMAN

WINNER OF THE NOBEL PRIZE IN ECONOMICS

"[A] masterpiece... This is one of the greatest and most engaging collections of insights into the human mind I have read." —WILLIAM EASTERLY, *Financial Times*

1. We are conservative



It's difficult to go against established dogmas

« A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it »

Max Planck



It's difficult to abandon a scientific project





2. We have trouble with systems thinking

Braess paradox

Cathy freeway, Houston, USA

The Braess paradox applied to food security?



The Braess paradox applied to food security?







Production

Distribution

Waste

INRA2025: Produce better & Predictive biology

How to generate simple questions?



The scientist's way



A well established way to build fact-based evidence... but is it well designed to generate simple questions?

The scientist's way



The artist's way



Famous quotes



« What I do tells me what I'm looking for »

Pierre Soulages

Fine arts school: « To make in order to identify questions »

Science & society: Simple questions emerging through transdisciplinarity





nouveauxcommanditaires.eu

500 funded projects over 25 years by fondation de France (150 kE per project)

How to generate simple questions?

- Look for and take advantage of **scientific frustrations**
- Talk to the **non-experts** (no background required for simple questions)
- Acknowledge that it does not come naturally : **System's thinking**
- Promote the conditions for their emergence: Interdisciplinarity
- Open the lab to new ways to do research: citizen science, art & science

Simple and urgent questions?



Climate crisis: How to co-exist?

Australia, Jan 2nd, 2020

LAKBOGN



« Air pollution is the new tobacco » (WHO director general)

7 million deaths linked to air pollution annually

As much plastic as fish in the oceans by 2050



Ellen MacArthur Foundation, 2016 WEF

50% of the world biomass for Human use



Smil, 2013; Negrutiu *et al.*, 2020

Vertebrate on continents (in mass)



Domesticated animals 65%



Humans 32%



Wild vertebrates <3%

Smil, 2002

6th mass extinction of species



Source: IUCN

A very recent trend: the great acceleration



Steffen et al., 2007

An alert: Planetary boundaries



Revisiting positivism?

Scientific laws should explain the *how*, but not the *why*.

Auguste Comte 1798-1857



Scientific questions are not neutral

nature

Letter Published: 24 July 2013 The oil palm SHELL gene controls oil yield and encodes a homologue of SEEDSTICK and encodes a homologue of SEEDSTICK

Rajinder Singh ⊠, Eng-Ti Leslie Low, Leslie Cheng-Li Ooi, Meilina Ong-Abdullah, Ngoot-Chin Ting, Jayanthi Nagappan, Rajanaidu Nookiah, Mohd Din Amiruddin, Rozana Rosli, Mohamad Arif Abdul Manaf, Kuang-Lim Chan, Mohd Amin Halim, Norazah Azizi, Nathan Lakey, Steven W. Smith, Muhammad A. Budiman, Michael Nogan, Blaire Bacher, Andrew Van Brunt, Chunyan Wang, Jared M. Ordway, Ravigadevi Sambanthamurthi ⊠ & Robert A. Martienssen ⊠

Nature 500, 340–344(2013) | Cite this article 431 Accesses | 85 Citations | 138 Altmetric | Metrics

Scientific questions are not neutral

« Accurate genotyping for enhanced oil yields will optimize and ultimately reduce the acreage devoted to oil palm plantations, providing an opportunity for conservation and restoration of dwindling rainforest reserves »



Singh et al., 2013 Nature

A dissonance in the scientific community



Ínría

1 Obje	ectif stratégique d'Inria : construire un leadership scientifique, technologique et industriel	
dans et	par le numérique, en France et en Europe	
1.1 Ma	aintenir l'excellence scientifique	
1.1.1	Rendre plus efficace et plus fluide le processus de création d'éauipes-proiets	
1.1.2 sociét	Favoriser la prise de risque scientifique, notamment à travers la réponse aux grands défis de la é et l'interdisciplinarité	1
1.1.3	Renforcer le soutien au développement technologique	
1.1.4	Renforcer l'impact des moyens incitatifs avec des décisions prises au bon niveau	
1.1.5	Renforcer l'ambition européenne d'Inria	
1.1.6	Se concentrer sur quelques partenariats stratégiques au niveau international	
1.1.7	Renforcer l'attractivité d'Inria pour garantir la qualité des recrutements scientifiques	
1.1.8	Veiller à une meilleure prise en compte de la politique d'établissement dans les processus	
d'évaluation		
1.2 Renforcer l'impact économique d'Inria16		
1.2.1	Passer à l'échelle pour la création de startups technologiques	
1.2.2	Donner la priorité aux accords bilatéraux avec des partenaires industriels français et avec les	
entreprises développant une base d'emplois en France et plus largement en Europe		
1.2.3	Développer une offre d'Inria en matière de formation continue sur les technologies numériques. 18	
1.2.4	Inscrire un objectif ambitieux d'impact économique dans certaines des actions internationales 19	
1.3 Co	nstruire une organisation efficace et sereine19	
1.3.1	Renforcer le sentiment d'appartenance à l'institut et améliorer le fonctionnement collectif 20	

Promote scientific risk-taking,
through the response to the
great societal challenges and
through interdisciplinarity »

La Fabrique des Questions Simples



https://simple-question.org/

Trends in Plant Science

CellPress REVIEWS

Feature Review

Flowering Plants in the Anthropocene: A Political Agenda

Ioan Negrutiu,^{1,*} Michael W. Frohlich,^{1,2} and Olivier Hamant^{1,*}

Flowering plants are the foundation of human civilization, providing biomass for food, fuel, and materials to satisfy human needs, dependent on fertile soil, adequate water, and favorable weather. Conversely, failure of any of these inputs has caused catastrophes. Today, human appropriation of biomass is threatening planetary boundaries, inducing social and political unrest worldwide. Human societies are bound to rethink agriculture and forestry to restore and safeguard natural resources while improving the overall quality of life. Here, we explore why and how. Through an evolutionary and quantitative analysis of agriculture, and bridging plant and Earth sciences, we anticipate the advent of a research and policy framework, integrating plant science in all sectors: the economy, local and global governance, and geopolitics.

Highlights

Our civilization depends on a triad encompassing soil, water, and food biomass, all of which ultimately depend on plants.

A retrospective view of evolution highlights unique attributes of flowering plants that allow the production of biomass that supports modern civilization.

Through excessive human appropriation of biomass, while ignoring crucial plant needs for soil and water, this renewable







The central role of plant scientists in the anthropocene







Paradigm shift #1: Time & matter

Use matter to save time

TOWARDS

Use time to save matter



Ex: Zero pesticides, durable resistance

Paradigm shift #2: growth vs. degrowth



A society of growth based on real or artificial scarcity

TOWARDS

A sober society based on abundant and complex interactions

Ex: Agroecology, predictive biology

Paradigm shift #3: optimization vs. adaptability



Improve performance thanks to process optimization

TOWARDS

Build our adaptability on the system's weaknesses

Ex: Multi-stress/multi-performance

Paradigm shift #4: Food production

Use the ecosystem to increase production

TOWARDS

How production feeds the ecosystems

Ex: Phytoremediation, Bio-economy, Ecosystem services

In short: a shift in our scientific questions



From performance...

to resilience



Take home messages

- Free up your questions!
- Interdisciplinarity, System's thinking, and Citizen science to the rescue
- We are facing an existential crisis which requires creative research, more than ever