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Repertoires as Blueprints and Frameworks for the Doing of Science

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Outline

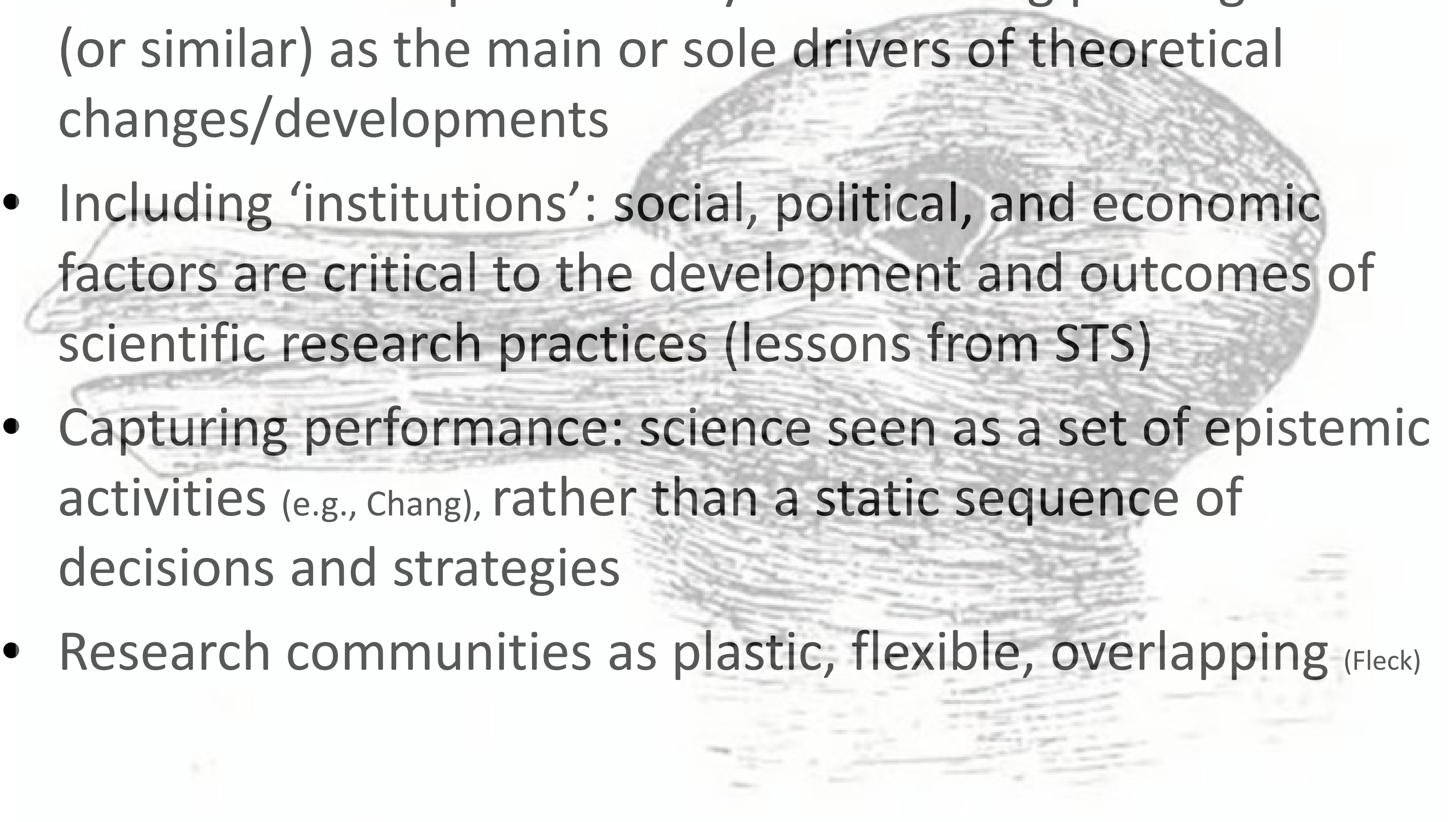
- Starting point: how does scientific knowledge develop and travel?
- Defining ‘repertoires’
- Repertoires and scientific groups
- Evaluating failure and success
- Conclusions: Lessons for ‘team science’

Our core questions

- How is scientific knowledge production organised?
- How does knowledge move from one research setting to another, and develop over time?
- What factors are in play, especially those typically neglected in (traditional analytic) philosophy of science?
- How is it possible for highly distributed, interdisciplinary collectives (such as those typically seen in contemporary ‘big science’) to produce knowledge?
- What impacts do such modes of collaboration have on the content of scientific knowledge?

Beyond the Kuhnian response

- Shift from conceptual history: abandoning paradigm shifts (or similar) as the main or sole drivers of theoretical changes/developments
- Including ‘institutions’: social, political, and economic factors are critical to the development and outcomes of scientific research practices (lessons from STS)
- Capturing performance: science seen as a set of epistemic activities (e.g., Chang), rather than a static sequence of decisions and strategies
- Research communities as plastic, flexible, overlapping (Fleck)



So what are repertoires?

- "well-aligned assemblages of the skills, behaviors, and material, social, and epistemic components that groups may use to practice and manage certain kinds of science and train newcomers, and whose enactment affects the methods and results of research" (Ankeny & Leonelli 2016)
- Blueprints for specific ways of *doing science* that can be quickly adopted and reproduced by others
- Proposal arises out of historical, philosophical, and sociological analysis of scientific practices (descriptive) as well as reflection on when science 'works well' (normative)

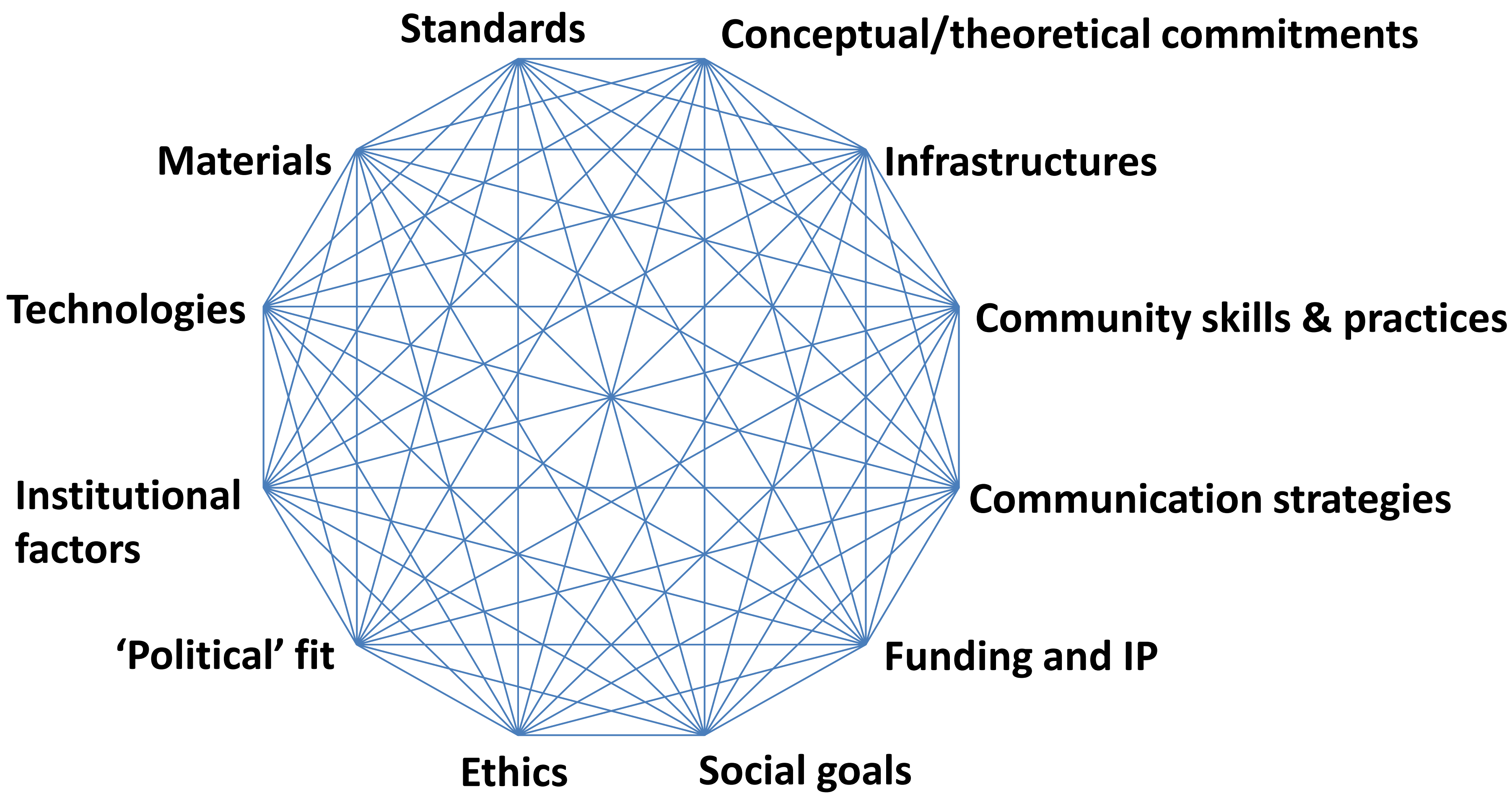
Background

- *Répertoire*, from the Latin *repertorium*
  - Etymology: “listing, catalogue, inventories” that help to find items without having been involved in collecting the relevant materials
  - Adopted by performing artists (theatre, music) in 19th c. Italy and France
  - OED: “body of items that are regularly performed” and “stock of skills or types of behavior that a person habitually uses”

- Thus term refers simultaneously to
  - the work performed
  - the ways in which it can be transmitted and reproduced
  - the unique characteristics of specific enactments of the work

Characteristics of repertoires

- Strong resonance with usage in non-scientific, performative fields: enacted through individual or group performances; each instantiation typically results in new variations (see Becker on jazz)
- Can be abstracted from their specific performances, providing a ‘blueprint’ for assemblage of skills, concepts, instruments, materials, strategies, and structures required to enact particular projects
- Thus repertoires are assemblages of knowledge, social structures, methods, and tools which include epistemological, technological, and institutional elements (cf. Gilbert/Mulkay’s intepretation of repertoires as about discourse)


Standards
Conceptual/theoretical commitments
Materials
Infrastructures
Technologies
Community skills & practices
Institutional factors
Communication strategies
'Political' fit
Funding and IP
Ethics
Social goals

Example 1: From experimental organisms to model organisms

Model Organisms
for Biomedical Research

NATIONAL INSTITUTES OF HEALTH

Mammalian Models:

- Mouse
- Rat

Non-Mammalian Models:

- *S. cerevisiae* (budding yeast)
- *S. pombe (fission yeast)*
- Neurospora (filamentous fungus)
- *D. discoideum* (social amoebae)
- *C. elegans* (round worm)
- *Daphnia (water flea)*
- *D. melanogaster* (fruit fly)
- *D. rerio* (zebrafish)
- *Xenopus* (frog)
- *Gallus (chicken)*

Other Model Organisms:

- *Arabidopsis*

Other:

- Reports
- Funding Opportunities
- Process for Considering Support

- NIH Policy on Sharing of Model Organisms for Biomedical Research
- A User's Guide to the Human Genome
- Opportunity to Propose New Organisms for Sequencing
- Bacterial Artificial Chromosome (BAC) Resource Network
- Rate Setting Manual *for Animal Research Facilities*
- Final NIH Statement on Sharing Research Data
- Resource Sharing Guidelines
- What's New

We hope this web site provides you with information about national and international activities and major resources that are being developed to facilitate biomedical research using the animal models listed here. For organisms not listed, web pages may be developed in the future.

If you have suggestions as to how we can enhance the information provided, please send a message to Bettie Graham at bettie_graham@nih.gov.

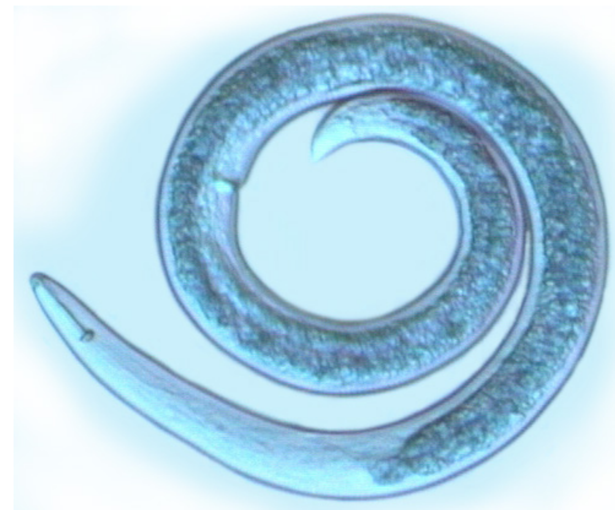
Thank you for visiting our web site.

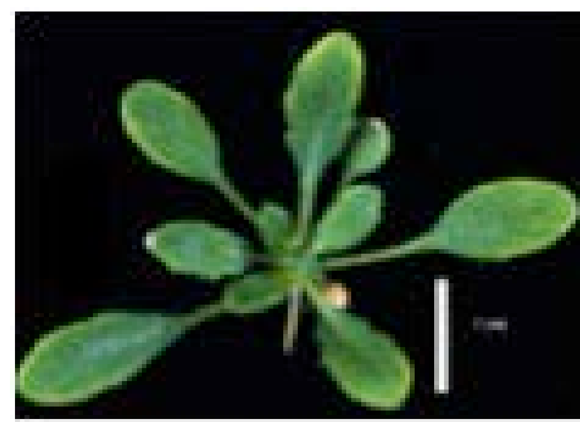
Francis S. Collins, MD, Ph.D.
Director, National Institutes of Health

Success stories: *C. elegans* (nematode) and *Arabidopsis* (thale cress)

Repertoire that allowed research community to persist beyond the completion of a specific project:

- production, use, and dissemination of standardized strains
- relevant know-how, expertise, protocols, instrumentation and (critically) large-scale data collections
- an ethos of sharing data and techniques prior to publication
- establishment of infrastructures including databases and stock centres
- the concept of a ‘model organism’ as reference for other species
- long-term, blue-skies funding (via the HGP)



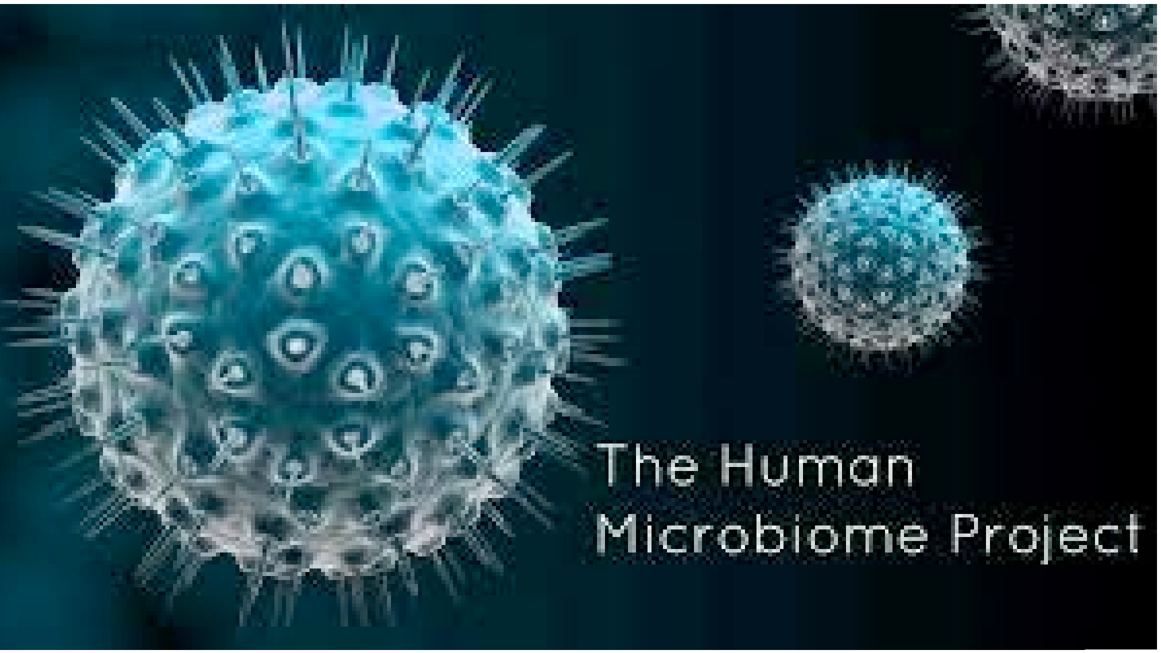


Variation on success stories: Drosophila (fruit-fly)

- Arguably the Morgan group built a shared repertoire which allowed focused research to persist beyond their specific goals
  - production, use, and dissemination of standardized strains
  - the know-how, expertise, protocols, and instrumentation
  - establishment of communication and other infrastructures such as newsletters
- Repertoire was not immediately expanded, but rather remained within (parts of) genetics until its adoption in developmental biology in 1960s

Thus note that details of what makes a 'repertoire' are highly historically and contextually contingent

Example 2: Microbiomes



earth microbiome project

american gut

Hospital Microbiome

Equine Microbiome Project

Home microbiome study

The microbiome repertoire

- Large governmental funding and related efficient publicity/PR
- Large scale (big data, big networks)
- International standardisation efforts for data and software repurposing of sequencing technologies for new intellectual goals
- Ecological conceptualisation of organisms and ecosystems as multispecies environments with unique microbial footprints
- Savvy use of social media and crowdsourcing

Other cases

- Coral reef research (Ankeny & Leonelli 2019)
- Clinical trials
- Pre-clinical research (e.g., pharmacological *in vivo*)
- Freudian analysis
- ‘Big’ particle physics
- Oceanographic surveying
- Science in the making: synthetic biology, big data analytics

Transferability and variability of repertoires

Same investigator/group can employ a **variety of repertoires** at any one time, depending on projects

Analogy: Franchising

- Model for how given business can be established, organised, and enacted, and implemented widely
- But unique enactment at each site (‘value added’)
- Serious financial stakes: considerable investments in materials/technologies; technological lock-in; business models for publishing and patenting; public-private partnerships
- Power of franchise goes beyond economic value: epistemic, institutional, and affective aspects

Repertoires and groups (1)

- Research fields emerge when a given community adopts a certain repertoire in a stable and long-term manner
- Communities with successful repertoires share abilities to align components of their work which they control, with broader components over which they have much less control
- Disciplines are broader, and typically encompass several repertoires (though the ethos, values, and general goals characterising a discipline will make some repertoires more appropriate than others)

Repertoires and groups (2)

- Importance of repertoires in instantiating, shaping, strengthening, and disrupting social relations within science
- Not all repertoires are associated with a stable/coherent research community (e.g., microbiome, often used as tool for funding without a shared ethos/identity)
- Existing repertoires can foster the emergence of a research community
- Research communities can also emerge in association with the birth of a repertoire (e.g., model organism communities)
- Research communities can have indirect or one-to-many relationship to repertoires (e.g., synthetic biology ‘community’ and the variety of repertoires therein)

How? practices and normativity

- Barnes: practices as “collective accomplishments of individuals concerned all the time to retain coordination and alignment with each other to bring them about” (2001:33)

- Rouse on normativity as essential to practice understood as a temporally extended, recurrent pattern of activity: “a practice is not a regularity underlying its constituent components, *but a pattern of interaction among them that expresses their mutual accountability”* (2007:48; see also Lewendon-Evans 2018)

- Repertoires encourage and stabilise a specific kind of normativity, which becomes the basis for communication and collaboration among scientific groups and associated stakeholders over an extended period of time

When do they fail?

- Failure/success are evaluated with respect to epistemic as well as ethical and social goals
  - Example: mice researchers tried and failed to adopt model organism repertoire because in conflict with highly commercialised, proprietary biomedical regime of knowledge production
- Collaborative projects typically do not result in substantial shifts in researchers' habits (or repertoires)
- Failure to establish a repertoire typically results from lack of alignment among (and/or knowledge and reflection about) components of a repertoire and accompanying boundaries and constraints
- Alignment is not only difficult to generate, but also maintain
- Repertoires are not easy to export, and not just a matter of technology

Marks of success

- Repertoires can allow acquisition of funding swiftly and efficiently
- But also impose serious constraints such as potential conservatism and hesitance to pursue original, alternative paths (similar to Kuhn's 'normal science'): they can create blind spots and canalisation
- Many creative and innovative scientific initiatives grow at the margins of, or in outright opposition to, the most long-lived repertoires
- Repertoires have significant consequences in terms of reputation, visibility, and resources

Lessons from repertoires for exploring ‘team science’

- Research fields emerge when community adopts a certain repertoire in a **stable and long-term manner**
- Communities with successful repertoires share abilities to **align** what they can control with that which they have less control over
- Using repertoires to study practice of science helps us to more critically assess **what ‘success’ involves**
- One benefit of repertoires is their flexibility: can be used across multiple fields, often are deliberately constructed to avoid committing to any specific subfield (thus exploit interdisciplinarity)
- But adoption of repertoires **unavoidably creates strong commitments** which can act as constraints to future integration and innovation (and may canalize the way in which science is done)

Why adopt the concept of repertoires?

- To encourage those who study and practice science to reflect on a wide range of research practices and behaviours—including how and when these factors do (or do not) align—thus highlighting the significance of political economy for accounts of the epistemology of scientific practice
- To broaden our view of what 'counts' as scientific work and workers (including administrators, technicians, funders, and other 'non-scientists') whose skills and expertise contribute significantly to the enactment of research repertoires
- To facilitate deeper and more accurate understanding of the relationship between individual research contributions and collective practices and norms

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Thank you! and questions

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