1. Hacking’s Central Point

The debates between constructionists and their critics are old philosophical debates that will probably not be settled anytime soon (if ever).

- **Fate/Contingency**: How inevitable are our current and future situations?
- **Nominalism**: Does the world have an inherent structure?
- **Rationalism**: Are we fundamentally guided by reason or something else?

2. Contingency

2.1. Contingent ideas

Pickering: “quarks are constructed” = the idea of quarks was not inevitable.

- More precisely, “there could have been a research program as successful (‘progressive’) as that of high energy physics, in the 1970’s but with different theories, phenomenology, schematic descriptions of apparatus, and apparatus, and a different, and progressive, series of robust fits between these ingredients” (72).

A research program is a series of theories and methods. Research programs are progressive if and only if they're:

- **Empirically progressive**: successive theories make new predictions not covered by their predecessors, while retaining most earlier corroborated predictions;
- **Conceptually progressive**: successive theories regularly produce new concepts with rich and simplifying structures; and/or
- **Technologically progressive**: successive theories produce more effective technologies than their predecessors.

Otherwise, a research program is degenerating.

A research program is successful only if there is a robust fit between:

- **Theory**: A set of lawlike statements that we typically think of as the “core” of a theory (e.g., F = ma, E = mc²);
- **Phenomenology**: the interpretation and analysis of the experiments that mesh theory and data;
- **Auxiliary hypotheses**: More mundane hypotheses about experiments, e.g., instruments, etc.; and
- **Apparatus**: the actual material instruments that are used to obtain experimental data.

2.2. No Predetermination

“At any stage in research, it is not predetermined what will happen next.” (73)

For Hacking, the No Predetermination Thesis is an empirical claim about the past, present, and future history of science, about the ways in which scientific research programs will develop.

2.3. “Alien science”

Weinberg: any alien race that had as developed a physics as our own would be committed to the same laws of physics as we have, e.g. Maxwell’s equations.

Hacking’s replies to Weinberg:

- **Small problem**: If computers had been discovered earlier in our development, we could have bypassed the analytic mathematics upon which Maxwell’s equations are founded. We would not have had the analytical tools to infer Maxwell’s equations, but would have accomplished everything that is entailed by them.
- **Big problem**: deducibility, translatability, and equivalence are not transparent ideas. Claiming that Maxwell’s equations are deducible obscures the fact that in physics, a lot of mathematical innovation must occur to make certain claims deducible from others. In other words, there is a lot robust fitting going on… and there are other, unrealized robust fits.
- **Curious problem**: Even when certain theoretical laws are empirically equivalent, they suggest different research problems, laws to conjecture about, uses, goals, and understandings in a research program.
3. The Convergence Objection

3.1. The Objection

C1. If the approximate truth of \( p \) best explains scientists’ convergence on \( p \), then \( p \) is inevitable.

C2. The approximate truth of \( p \) best explains scientists’ convergence on \( p \).

C3. \( \therefore \) Scientific ideas are inevitable. (From C1, C2)

3.2. Hacking’s Response to the Convergence Objection: Big Picture

1. Convergence is small-scale, big-scale, or unique-and-ultimate.
2. If convergence is small-scale, then C2 is false.
3. If convergence is big-scale, then C1 is false.
4. If convergence is unique-and-ultimate, then is false.
5. \( \therefore \) Either C1 or C2 is false. (From 1-4)

3.3. Small-scale convergence

1. If convergence is small-scale, then scientists converge on how a theory, phenomenology, set of auxiliary hypotheses, and apparatuses robustly fit with each other.
2. The approximate truth of theories, phenomenology, etc. does not uniquely predetermine scientists’ convergence on how they robustly fit with each other.
3. If \( x \) does not uniquely predetermine \( y \), then \( x \) is not the best explanation of \( y \).
4. \( \therefore \) If convergence is small-scale, then C2 is false: the approximate truth of theories, phenomenology, etc. does not best explain scientists’ convergence on how they robustly fit with each other. (From 1-3)

3.4. Big-scale convergence

1. If convergence is big-scale, then scientists converge on a single answer \( p \) to a question.
2. If scientists converge on a single answer \( p \) to a question, then they could have converged on a different answer \( q \).
3. If scientists could have converged on a different answer \( q \), then \( p \) is not inevitable.
4. \( \therefore \) If convergence is big-scale, then C1 is false: even if the approximate truth best explains scientists’ convergence on a single answer to a question, the answer need not be inevitable. (From 1-3)

3.5. Unique-ultimate convergence

1. If convergence is unique-and-ultimate, then scientists converge on the one and only answer to a question.
2. If scientists converge on the one and only answer \( p \) to a question, then there could still be many different historical trajectories to their convergence on \( p \), with science being very different at each step of these historical trajectories.
3. If there could still be many different historical trajectories to \( p \), with science being very different on each of these historical trajectories, then everything but \( p \) is not inevitable.
4. \( \therefore \) If convergence is unique-and-ultimate, then C1 is (nearly) false: even if the approximate truth best explains scientists’ convergence on the one and only answer to a question, then everything but the answer need not be inevitable. (From 1-3)

4. Nominalism

4.1. Constructionists as nominalists

Nominalism is the denial that the world has a knowable inherent structure; rather we classify kinds of entities in that world according to our own conventions and interests.

Nominalists still allow for constraints, e.g., theories, apparatuses, etc.—in other words, our research programs place important constraints on how we classify the world—but our choice of research programs is not predetermined by the inherent structure of the world.

4.2. Traditional argument for nominalism: Ockham’s Razor

1. The inherent structure of the world is superfluous to our explanatory needs.
2. If the inherent structure of the world is superfluous to our explanatory needs, then the inherent structure of the world does not exist.
3. \( \therefore \) The inherent structure of the world does not exist. (From 1-2)
4.3. Critics of constructionism

Critics of constructionism are often *inherent-structurists* who claim that certain classifications “cut nature at its joints.” This is, at the very least, a kind of structural realism.

5. Explanations of Stability

5.1. Stability

In physics, there has been about a century-worth of science that is cumulative and stable. Compare this to the developments of the early 20th century, in which relativity theory and quantum mechanics could be seen as radical shifts in physics. Why has physics been so stable in the past century?

5.2. The Debate

Social constructionists typically offer *external* explanations of this stability, i.e.,

- They cite factors (e.g., interests, the challenging of many authorities) that are not part of the content of the theories to explain why theories have had such a successful track record for so long.

Their critics typically think that the stability is explained by “the good reasons produced by the research.” (91)