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ORDER: GOD'S, MAN'S AND NATURE'S

The Order Project: What is it?
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A talk introducing the Order Project to the members and associates of the Centre for Philosophy of Natural and Social Science, LSE

What kind of God creates a Hodge-Podge of Nature?

This for me is the underlying question of the Templeton-sponsored project 'God's Order, Man's Order and the Order of Nature.' This is a four-year project, located primarily at LSE and at the University of California at San Diego. It stretches out beyond that though so it may be better pictured as centring around an Oxford/ London axis and in the American Southwest. The project involves a team of about 30 scholars, including philosophers of physics, philosophers of biology, rational choice theorists, theologians, historians of science, historians of philosophy and more general philosophers of the natural and social sciences. Many of the names of the people on the project are familiar to the Centre here – Centre Associate Director Roman Frigg is part of it, past Acting Centre Director Eleonora Montuschi, past Co-Director Michael Redhead and me, a past Director, along with Robert Bishop and Talal Debs, who have both been Research Associates at CPNSS, the LSE Choice Group and Damian Fennel, who kicked off this project but has now left the academy to work for the UK Financial Services Administration.

The project grows out of the 'quiet revolution' in science studies.

This revolution is a revolution in the scientific world image. For the past two decades scholars in science studies – historians of science, philosophers of science and sociologists of science – have been engaged in detailed investigations of the sciences, across the panoply from physics to geology to cell biology to child welfare theory, with an emphasis on how these sciences are 'actually practiced'. Science is supposed to tell us about the world. So if we have a good study of scientific practice and what is going on in it, this should help us construct a *scientific world image*, that

is, an answer to the question: 'What is the world like when we look at it projected through the lens of our best contemporary sciences?'

When we look around us, the world we live in certainly looks a mess. Since the scientific revolution, however, a strong Western scientific tradition – not the only one but the dominant one – has supposed that, beneath this all-too-apparent mess,

lies a true reality that is beautiful, clean and thoroughly well-ordered.

This hidden reality, according to the scientific world image that has been dominant since at least the 17th century, is governed through and through by laws and those

laws are essentially the laws of physics. So Queen Physics has been supposed to reign supreme throughout the entire world.

This image survived even quantum mechanics and chaos theory. It is still alive and kicking. In quantum mechanics, despite its vaunted indeterminism, we still have totally deterministic laws for the thing that really matters, the thing that quantum mechanics is committed to, which is the quantum state. The quantum state evolves totally deterministically. You sometimes hear that quantum theory is probabilistic. That is with respect to macroscopic quantities. But quantum theory on the conventional reading says that macroscopic objects are just big, big composites of microscopic objects, all of which have quantum states. And if you know the states of two systems, then there's a quantum state for the composite; so if each of a million systems has a quantum state, so too does the composite they make up. So quantum mechanics has deterministic evolution for the quantum state throughout both the micro and the macro world. Even if you do want to talk about probabilities for something that should seem very odd from a quantum perspective, like classical macroscopic quantities, even there standard lore has it that the probabilities for these, if not their exact values, evolve deterministically. And there's no space for anything else to happen. The standard story of quantum mechanics supposes that the theory covers everything; even consciousness is really all just a matter of quantum states of the brain.

Chaos theory similarly does not undermine the image of a world governed universally by deterministic laws since it relies on the assumption that things that start out very close together can end up in quite separated states – under the rule of deterministic law. That's why I say that this scientific image is still alive and kicking.

The quiet revolution in science studies brings this world image into question. Science studies scholars have been looking at the practices and uses of science here, there and everywhere. There are scholars studying little bits of biology, little bits of economics and little bits of physics. What we have done in laying the groundwork for the Order Project is to bring this disparate work together to consider its overall lessons. We've looked at what all these scholars in various places are saying – and we see that the idea that universal laws of nature are not all they are cracked up to be is coming up here, there and everywhere.

Not many people have stood up and said: 'The overall lesson is, the laws of Nature are under threat'. People say instead, 'Laws do not provide the fundamental

mechanism for prediction, explanation or manipulation in the scientific practice I study.' So, the reason I say the revolution is quiet is that it is flaring up in many different local regions here and there but it has not so far become a unified movement. The Order project aims to see if it should and what the theological implications of that would be.

The Order Project studies both scientific and theological questions. Here at CPNSS the scientific questions may be of most interest so I begin with them. There are two distinct scientific questions that the revolution poses. One is: Does Physics reign supremely and by herself or is she only part of a motley assembly? The second issue is: How far does the long arm of natural law extend? Do some things occur even perhaps just by hap?

These two questions challenge two central pillars of the doctrine of total order. The first is what I call *vertical reductionism*. This is the idea that 'It's all physics really'. The sciences are properly organized as a pyramid. At top, and least fundamental, are the social sciences. They depend entirely on the structure of the brain, which puts us in the realm of biology, which in turn is just complicated physics. So it's really nothing but physics all the way up. That's *vertical reductionism*. We should note though physics is not the only discipline with takeover aspirations. We see the same drive for example in economics in the work of someone like Chicago School Nobel-prize winner Gary Becker, who wants to use market equilibrium and rational choice theory not just to treat market transactions but to treat a host of phenomena square in the domain of sociology and psychology, like love, hate, power and family relations – everything from drug addiction to racial discrimination to youth crime and choice of spouse.

The other is what I call *horizontal reductionis*m – that every event that occurs is dictated by the laws of nature, so that whatever level you're at there is an ideal theory that covers everything at that level. Many scholars who believe in horizontal reductionism suppose that the ideal theory at a given level can be constructed entirely with concepts at that level (though of course if vertical reductionism holds, these will all be reducible to those of microphysics). Though it has been changing recently, this was the dominant approach in economics for the past couple decades. Even if economics cannot account for phenomena in the domain of sociology or psychology, nevertheless economics is self sufficient, complete in its own domain. Economics is all that's needed to treat economic phenomena – no outside lessons or outside concepts from psychology or sociology or anywhere else are required. Some

scholars allow however that to get sound regularities about effects at any particular level it will be necessary to mix concepts from across levels. Those inclined to vertical reductionism generally suppose that in principle all that would ever be needed would be concepts from 'more fundamental levels'. Whether the theories at various levels are supposed to be sufficient unto themselves or instead require assistance from elsewhere, what all these views share in common is the assumption that the rule of law at any level stretches out to cover all the phenomena at that level. That is *horizontal reductionism*. And it too has been challenged by the quiet revolution.

Consider vertical reductionism in more detail. What was assumed for a long time was that each concept from a legitimate principle in a special science like economics or cell biology or psychology would be reducible to identifiable concepts from a more basic science. For instance if you had a nice theory of irritability, so that irritability was a legitimate scientific concept, then irritability should be identifiable with concepts from a lower-down science, all the way down to physics. The canonical example involves a principle from thermodynamics, the Boyle-Charles law for ideal gases: PV = nRT. In the Boyle-Charles law we have identified macroscopic phenomenological characteristics of the gas – pressure, volume and temperature – and have established a good firm law about how they relate.

But, so the reductionist story goes, each of these classical characteristics of the gas can be identified with characteristics that are studied in a more basic science, statistical mechanics, and the Boyle-Charles law itself simply collapses into a principle that can be derived from the laws of that basic science. So you have the science of thermo dynamics of which the Boyle-Charles law is a part. But underneath thermodynamics holding it up is supposed to be statistical mechanics. The volume of a gas is to be identified with the volume occupied by the molecules making up the gas, the temperature of the gas is to be identified with the kinetic energy of those molecules and the pressure, with the impact of the molecules with the walls of the container. The Boyle-Charles law is derived as a principle relating the mean kinetic energy of the molecules with the impact and volume occupied. That's a standard case of vertical reductionism.

What I have just described is a case of *type-type* reductionism in which each concept or type from the higher science reduces to a concept lower down. You've got volume of the gas up at the higher level, something lower down matches it – the volume occupied by the molecules; you've got temperature up higher, some other statistical

mechanical concept matches it lower down; and so on. But type-type reductionism is not the only game in town. Philosophers of mind in particular have pushed a different concept, which can be called 'token-token' reductionism. There's a lot of different language for the different kinds of reduction but I like 'type-type' and 'token-token' because it makes clear that under one scheme you're identifying types but in the other you're identifying individual cases.

Philosophers of mind had a conundrum – what almost all of them believed is 'It's all brains really', just as other people believe 'It's all physics really'. But they also became convinced that states of mind can't be defined with states of the brain. So, irritability: Just as temperature is supposed to be mean kinetic energy in the ideal gas – what brain state corresponds to irritability so that whenever someone is irritable they are in that designated brain state. Philosophers of mind became convinced that they couldn't have that. The same mental state can be realised in a host of different physical states; they call that 'multiple realisability'. Nevertheless they still believed 'It's all brains really'. So instead they employ the notion of token-token identity. There may be no brain-state concept that can be identified with irritability. Still, there's always a brain state and nothing but a brain state and whatever brain state you're in, that fixes what your psychological state is. You don't have any choice. Suppose I'm in this brain state and Helen is in this very same brain state – if it means I'm irritable, it's going to mean that she too is irritable.

But you can't look at it the other way around. Roman is irritable right now and so am I but we're probably in very different brain states. So philosophers of mind introduced the idea of ' token-token' reductionism, called sometimes 'supervenience' or 'multiple realisability'. Irritability 'supervenes' on brain states; it can be realised in this brain state or that very different brain state but whenever the brain state is fixed, that's all there is to the psychological state. That's it. That fixes it. That is a reduction of a token of a psychological state to a token of a brain state.

What then about *vertical reductionism*? There's been 20/25 years of active discussion of it and opposition to it. In philosophy of mind it is still the going concern but elsewhere there's been a lot of objection to it, including a good deal of detailed work, some Templeton sponsored, on emergence. Consider type-type reductionism. When I started out as a young philosopher of science, we spent a lot of time looking for type-type reductions in the sciences. We didn't have much success. Despite a good hunt we didn't see many reductions happening in science and it proved well nigh impossible to construct plausible ones from the science available. So the claim

that one particular state of science is reducible to another began to look more and more like just a promissory note.

Then there was the work of the philosophers of mind, who said type-type reductionism doesn't work for minds versus brains. This was followed by the realisation that it might be more natural to explain psychophysical phenomena by supposing that there are genuinely different kinds of properties picked out by psychological concepts and physical concepts but that they have complex relations with each other that are mutually constraining. Cross-level interactions between the properties studied in the different domains can significantly affect the behaviours in both. What's wrong with that? Nobody wants to deny that my brain affects my psychology and it sure looks as if my psychology affects my brain. But the assumption of the reductionists is that whenever one level affects another, all the action is really down at the lower level. Once what happens at the bottom level is fixed, what happens all the way up is fixed too.

The big question is: Where are the arguments for that? A lot of us find even the sum total of offerings surprisingly inadequate: invalid, unsound or unconvincing. More generally they lack the kind of detailed empirical support one wants for a scientific claim, let alone for a sweeping meta-scientific claim that covers in one fell swoop all of the many varied scientific trades, 'their gear and tackle and trim'. [Gerard Manly Hopkins, *Pied Beauty*] It looks to us more like metaphysics than like physics.

There was also a significant movement specifically against vertical reductionism of the token-token version. One major objection was that this doctrine isn't really different from type-type reductionism. Take all the people who are irritable and consider the panoply of all the different brain states they are in. The concept of irritability can just be identified with the disjunction of those brain states. Then we have reduced a mental type – irritability – to a brain-state type – this big disjunction. So, the argument goes, if you don't like type-type reductionism, you're not going to be saved by token-token.

There was also a big movement of people who had more positive counters to vertical reductionism, defending the view that more is different; and that was across a variety of areas: in metaphysics, scientific theology, anti-individualism in the social sciences, even in physics. For example many condensed matter physicists – who study large collections of fundamental particles in interaction – like to think that more is different;

this gives the systems they study a special place in nature. So there has been considerable resistance from a wide array of quarters to vertical reductionism.

What about *horizontal reductionism*? Resistance here came a bit later on with the huge wave of discipline- and subject-specific studies. As scholars started to do detailed internal studies in the sciences, we find more and more people arguing against the indefinite extent of the rule of laws. As I noted, they don't all put it that way. But across the sciences we find scholars arguing that in their field, in the little bit of science they're studying, the basic predictive and explanatory devices are not universal laws but something else. And it turns out to be something else that has a much more restricted and local domain. So, here, there and everywhere we don't find laws playing the important roles they're supposed to.

What kind of alternatives to laws are on offer in these various studies? There are a great many alternatives, from scholars explaining, 'Here's my best reconstruction of what's going on in my discipline'. For instance

- There are *ceteris paribus* laws.
- Philosophers of biology Sandra Mitchell and John Beatty in philosophy of biology argue that the relevant principles in their domain are ones that evolve. Species evolve and with them species-specific principles that are context and history dependent: where there is different history there are different laws.
- Mechanisms are also a really big game now. On a mechanistic account regularities arise from having components fixed in an appropriate way. Mechanisms can produce something that looks like laws but these 'laws' are local to the correct operation of the mechanism.
- Powers have replaced laws for a lot of people, not only as central in studies in philosophy of science but in metaphysics as well.
- Historian of science Peter Gallison argues that the most basic laws of physics theories use concepts that don't properly map onto the empirical concepts used to describe the world – even the concepts used in experimental physics. That means that the laws of basic physics theory are not covering laws after all: they do not even properly cover the experimental results that are used to attest to them. I long ago argued a similar view in *How the Laws of Physics Lie.*
- James Woodward and others argue for the centrality of principles that are invariant under human manipulation.
- There are also partial necessities.
- Institutional constraints.
- And lots more.

Scholars arguing for these alternatives to the universal rule of law include John Dupre, Peter Gallison and me; or Bill Bechtel, who is a member of the Order team, MDC (i.e. Peter Machamer, Lindley Darden and Karl Craver), and others who have become fashionable for their work on mechanisms. CPNSS Director Rom Harre has long been known for advocating powers. I already mentioned Sandra Mitchell and

John Beatty, who are joined in their emphasis on partial, local and historically-evolved laws by Andrew Hamilton, who is also on the Order Project. In the social sciences, anti-law views are found in the work of John Searle, Margaret Gilbert and our Order Project Director, Eleanora Montuschi. These are the leaders of the quiet revolution.

My own view is that it's mechanisms all the way down. You need a mechanism to get a law, but it will only be a ceteris paribus law. By 'law' I mean a reasonably reliable regularity between measurable or observable or what philosophers call 'occurent' properties. So, what's a ceteris paribus law? Here's how I argue we should think about the 'ceteris paribus' clause in ceteris paribus laws. Suppose you have a nice well-established regularity law, say, one that tells you that *y* is a function of other factors, $x_1, x_2, \ldots, x_n$:

Regularity law: $y = f(x_1, x_2, \ldots, x_n)$.

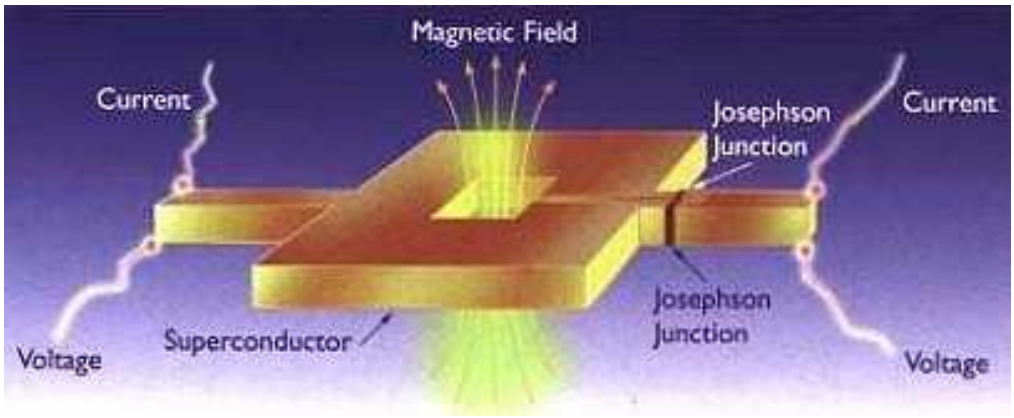
I say that laws like this are likely to hold only 'ceteris paribus'. And when is that?

This law can be relied on to hold in exactly those cases where all the factors relevant to the value of *y* are represented by one of the *x's* on the right-hand side. In a sense this is a truism. If your function leaves out something that matters to *y* in a given case, you wouldn't expect it to give you correct predictions about y in that case. If you're a real die-hard vertical reductionist, believing that it's all physics really, you think that ultimately whatever concept *y* picks out, it is reducible to some states in physics. But even physics may not be complete, even in its own domain. This is the issue of *horizontal reductionism*.

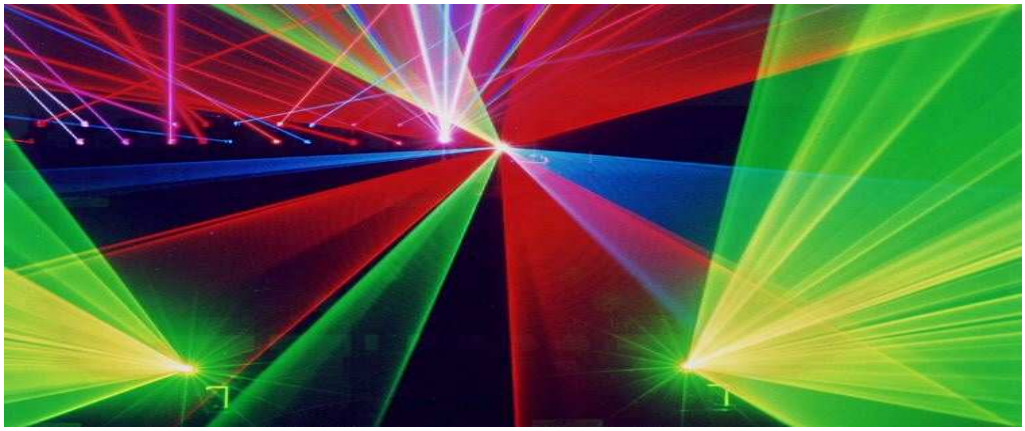
For many regularity laws in physics I believe we have good evidence that so long as all the causes of the effect variable *y* are described by one of the cause variables, *x*, in the law, the law gives good accurate predictions. That's born out by our tests, which must be highly controlled to ensure that all the significant causes can be represented by variables in the equation. How else could we test it? As I just remarked, if we suspect that there are causes at work in the situation we are studying in the world that are not represented in the equation, we wouldn't expect the law to hold in that situation. You may feel: 'But everything that goes on that can affect a physics outcome must be describable as one of those x's on the right-hand-side in some proper law of physics; it's just that we don't yet know what that law is.' That is just what I challenge.

We don't see physics being able to account for everything. Perhaps the fault is with our science and ourselves. We weak post-Lapsarians who have sinned, have bad eyes, are inattentive, it's our fault. We are not able, or not yet able, to see the full truth. Science is incomplete and a bit disordered but not the world. The answer I give to that is that we just don't know. I feel like David Hume on natural religion: If you knew the world were really well ordered under universal natural laws, then you could accommodate the apparent disorder. Human frailty is a way to do that. But it's not the most simple and natural conclusion to draw independent of the assumption that the world must be totally ordered. The failures of our current theories are one explanation of the inability of our current laws of physics to predict everything in physics' own domain. Another is that the laws of physics themselves, even in God's great Book of Nature, are ceteris paribus. They hold only in the highly circumscribed situations in which all the causes have certain nice characteristics that allow them to be represented properly as variables in a proper-looking physics law.

The world may well produce outcomes just the way our successful scientific predictions work, by co-operation among very limited principles and mechanisms from many domains, where many results are not predictable at all. To cite one of my standard examples, you need a lot more concepts than those in quantum mechanics to do the very kind of thing that provides the best grounds for our faith in quantum mechanics: produce a functioning SQUID (superconducting quantum interference device)



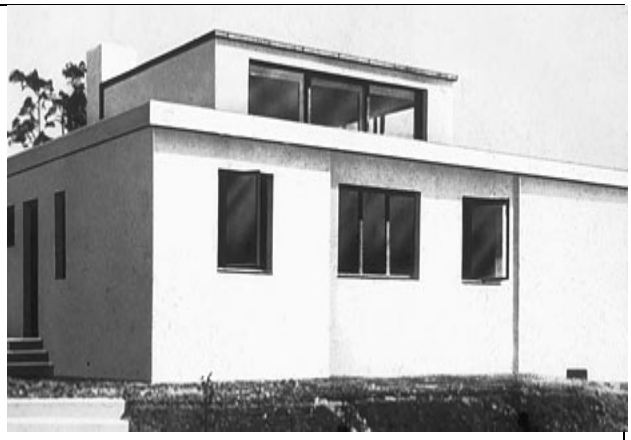
or a laser



So which is it, completeness or incompleteness? Can economics account for everything in at least its own domain, regardless of whether it can take over psychology and sociology as well? Is physics complete in its domain? These are grand metaphysical questions, perhaps best avoided. But science and society have long been in the grip of the assumption that successful science supports both vertical and horizontal reductionism. Both these are challenged in the quiet revolution. The Order Project wants to see how powerful these challenges are, what picture of Nature can be put instead of that in which Nature is governed through and through under the universal rule of law and what implications alternative pictures have for natural theology, for our image of God, of ourselves and of our responsibility for order in Nature.

The quiet revolution gives new reasons to think that the world is quite possibly a hodge-podge. The Order project wants to know: To what extent is that conclusion plausible on the basis of our best scientific world images? But then, this raises queries about the nature of God if we think of God as the creator of this universe, and sustainer of it, taking an interest in it. What kind of God is it that prefers a muddled undisciplined world to an orderly, universally law-governed universe? Or,

prefers this **to this**



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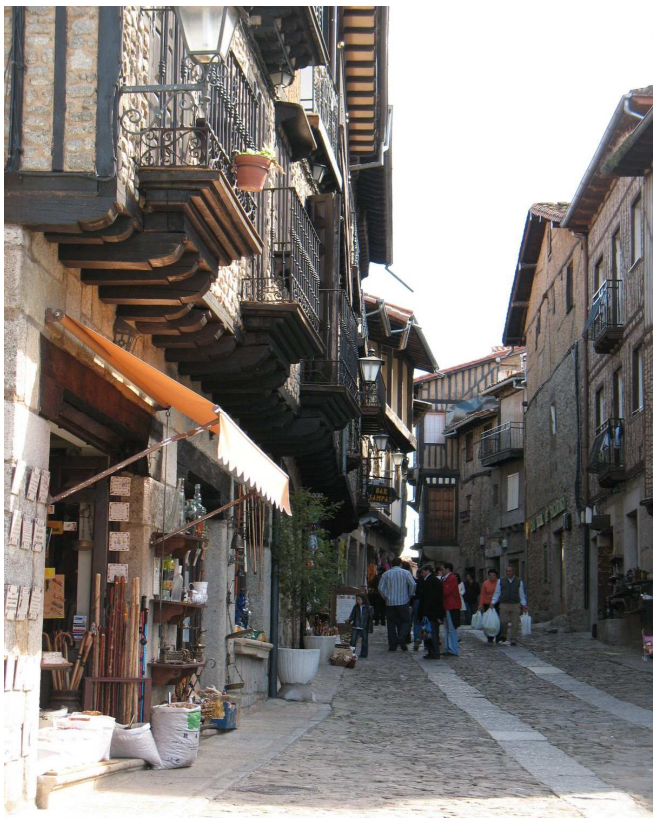

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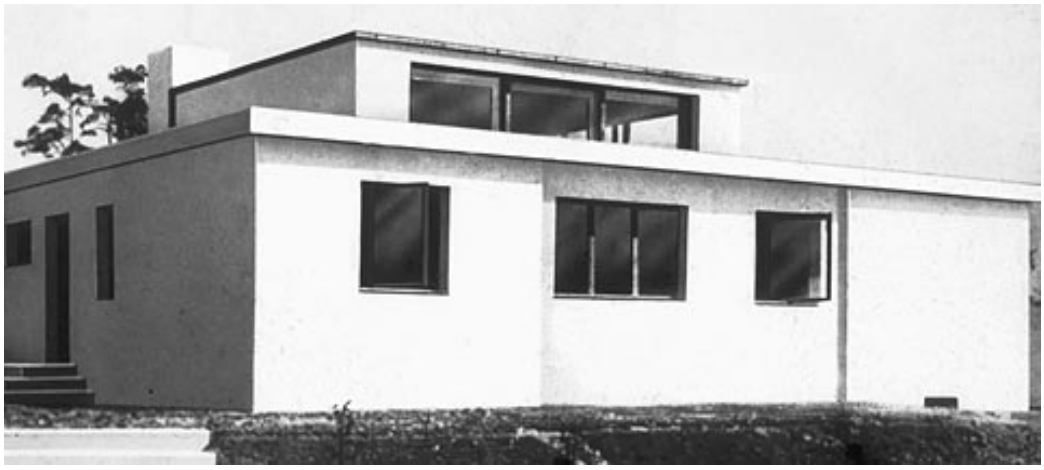

Or disturbingly, it seems even **this**

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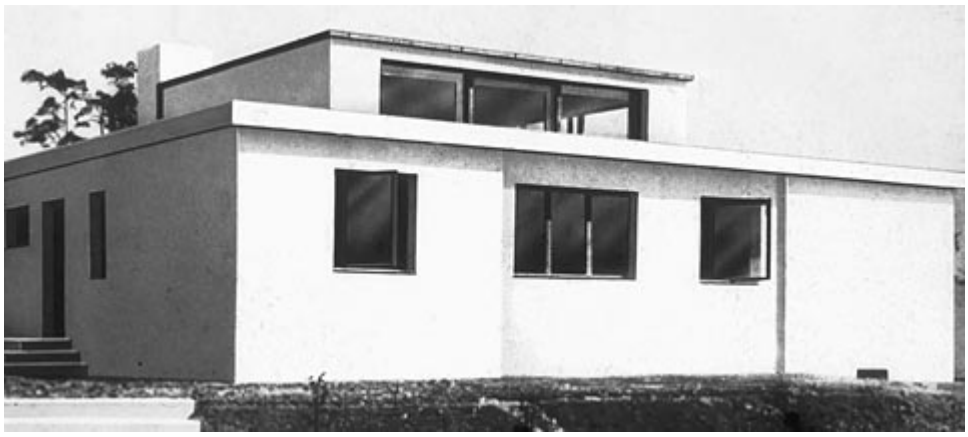


That's the fundamental kind of question we study on the theological side. And to spell out in slightly more detail: Do these new scientific images of the world give us new views about what counts as perfection? If you believe that God is perfect or created the world to be a reflection of His own perfection, then what should we now think of as perfection?

In particular consider the poem *Pied Beauty* by Gerard Manley Hopkins:

> 'Glory be to god for skies of couple-colour as a brinded cow;
> … rose-moles all in stipple upon trout that swim;
> Fresh-firecoal chestnut-falls; finches' wings;
> Landscape plotted and pieced— fold, fallow, and plough;
> And áll trádes, their gear and tackle and trim'

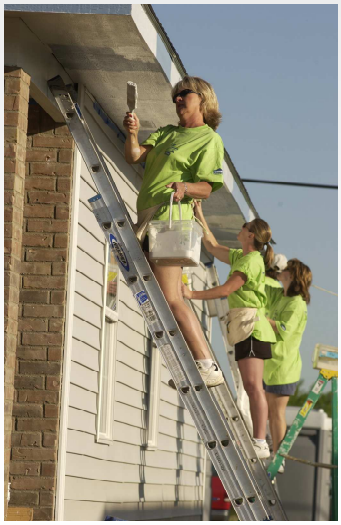
Pied beauty is a very different image of perfection than that of the clean, tidy, well ordered lines of 'Bauhaus' architecture. So the quiet revolution invites us to ask what counts as perfection or, perhaps, it gives new doubts about just how perfect the Creator is. This leaves us with queries not only about God, but also it leaves us with queries about ourselves and about our role in Nature. If you believe that order is desirable and the order of Nature is incomplete, is it our job to work to complete it? If so, what should count now as order? Beauty?

Queries about us

- Is it our job to build order?

What kind of order –

What counts now as Order? Beauty? Perfection?



- How do we manage?

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We have two quite different images of beauty and the aesthetic ideal in Manley Hopkins versus the Bauhaus; what we would be aiming for in the two cases would be very different. So, what counts as order, beauty and perfection? And finally, how do we manage? A part of our project is devoted to this last question as well, especially the researchers from the Choice group with their work on how we build social order and those from philosophy of physics and biology studying the types and sources of natural order.

Concluding, these are the big questions we are asking:

- Are universal laws – the kind we've had with us since the Scientific Revolution – all they're cracked up to be? Much recent research suggests not. But if not laws, then what? Are any of the candidates now on offer good enough: mechanisms, ceteris paribus laws and the like? Of course there's no need to think that there is one model of governance that fits all sciences but do any of these notions really make sense without universal laws to underpin them?
- Is the world really dappled, independent of what our science looks like?
- If it is, what then of God?
- And finally, what of us and our mission in the world?

These are the questions the Order Project is going to be working on in the next four years.