CITIES AS FORCES FOR GOOD IN THE ENVIRONMENT: A SYSTEMS APPROACH

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IIASA's distinctive approach to cities (and infrastructures) is outlined in a 2007 essay by Paul Crutzen (Nobel Prize for chemistry), M. Bruce Beck (control engineer) and Michael Thompson (social anthropologist), all three being at that time Institute Scholars. The essay itself was commissioned by the US Academy of Engineering's Blue-ribbon Panel, which was deliberating upon what should be the "Grand Challenges for Engineering in the 21st Century" (Crutzen et al 2007). "Cities as Forces for Good in the Environment" (CFG) was our suggestion, and we outlined it by way of a number of large questions.

- How can the built infrastructure of the city be re-engineered to restore the natural capital and ecosystem services of the nature that inhabited the land before the city arrived there, in "geological time"?
- How can this infrastructure be re-engineered to enable the city to act as a force for good, to compensate deliberately and positively for the ills of the rest of Man's interventions in Nature?
- How can cites of the Global South avoid adopting the same technological trajectory as those of the Global North? Can they, as it were, "leap-frog" the Global North by forgoing the entire human-waste-into-the-water-cycle phase, thereby ending up one step ahead?
- More profoundly, how can the engineering of city infrastructure be deployed expressly so that those at the bottom of the pyramid of dignified human development may be brought to a level where they care to engage in a debate over such a grand challenge for the century – of cities as forces for good – beyond their desperate needs of survival for just today and tomorrow?

Over the subsequent 12 or so years, a substantial body of work has evolved and been developed under this CFG rubric (much of which can be found archived at www.cfgnet.org) and it has now done two things: fleshed out IIASA's distinctive systems approach to cities and their infrastructures, and prompted some rather profound re-thinking of applied systems analysis itself. In this chapter, we will start by explaining the approach itself and then summarize what

we see to be the key modifications to applied systems analysis that that approach has now put in place.

The Distinctive Approach

Much effort, at present, is directed towards making ourselves "less bad": the UN's Sustainable Development Goals, for instance, and that framing in terms of planetary boundaries and its accompanying "safe operating space for humanity". The CFG Project, by contrast, is concerned with how we can make ourselves "more good". Putting a brick in our lavatory cistern, for instance, is one way of making ourselves less bad; taking human waste out of the water cycle completely and transforming that waste into valuable resource in the process, is a way of making ourselves more good. We provide an instance of this sort of expansive systems thinking in our 2007 essay.

> The city, continuing the large grazing animal analogy, takes in its daily grass and daily water, while we, for readily understandable but increasingly unsustainable reasons, have engineered the return of the residuals of this metabolism to the air, water and land environments surrounding the city. In the Global North, a good deal of the city's daily water is used to remove the residuals of its daily grass as wastewater so that citizens can lead healthy and productive lives, And much technological effort has been invested in treating that wastewater, not always to the better of the air, missing an opportunity to benefit the land, while not being a wholly unmitigated good for the water environment. In short, wastewater treatment in the Global North can end up shunting nitrogen into the atmosphere, to avoid fertilizing the aquatic environment, while we labour awfully energetically with the Haber-Bosch process to pull that nitrogen out of the atmosphere to produce artificial fertilizer.

We now have numerous applications of the approach (across other realms too, of course, such as energy and finance): to developed world cities such as Atlanta, Georgia, US, London, UK, and Suzhou, China in the Global North (e.g. Beck et al 2011); Kathmandu, Nepal, Harare, Zimbabwe, and Kinshasa, Democratic Republic of Congo in the Global South; along with Kanyakumari, Tamil Nadu, India and Bloemfontein, South Africa which, you could say, are somewhat betwixt-and-between the Global North and South (e.g. Beck et al 2018). There is also a project, just starting, that will be looking at four cities: Beijing, China, Vienna, Austria, Shanghai, China and Malmö, Sweden.

Our most innovative finding, we would suggest, is the existence, across all of these urban contexts, of four distinct and mutually irreducible "schools of engineering thought" (Figure 1), along with the normative insight that, in order for us to move towards "more good", each of these four schools must (a) be able to make itself heard and (b) then be responsive to, rather than dismissive of, the others. As we shift the mode of governance from *closed hegemony* (just one school's "voice" drowning out the others) to *clumsy institution* (where all four voices enjoy both "access" and "responsiveness") so the *deliberative quality* within the policy process increases and we find ourselves moved across onto transitional pathways that are socially acceptable, technologically feasible and environmentally benign.

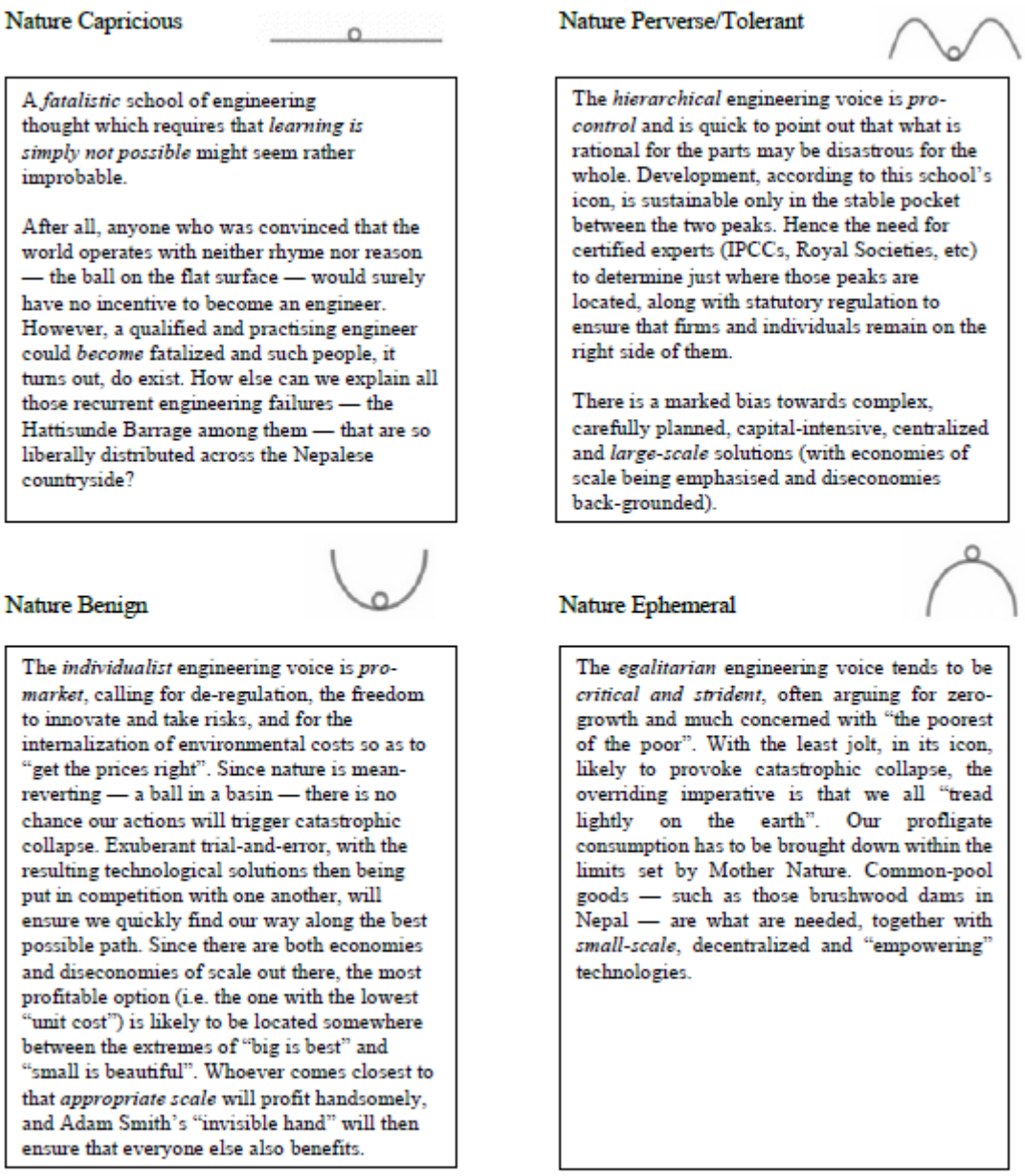

Fig. 1: The four schools of engineering thought (source: Thompson et al 2018) Note: The four "icons" are the social constructions of nature that support each of these schools, while also serving to distance them from the others.

The Re-Thinking Within Applied Systems Analysis

In engaging with cities and infrastructures we have now learned a number of important lessons, which we can assemble under three headings.

- *Anthropology for Engineers*

  Though we have made much of the need to take account of governance, it is never just a matter of "better governance" (more systematic qualitative logic) instead of "better engineering and technology" (more computational methods) or *vice versa*. The two must be melded in a mutually supportive and stimulating manner: something that is not easily done and that, we would argue, is, or should be, the USP (Unique Selling Point) of applied systems analysis (see, for example, Thompson and Beck 2017; Beck et al 2018).

- *Cities not Nations*

  One of the popular misapprehensions about applied systems analysis is an excessive focus on the global level, with the resulting inability to say anything useful about the lower levels: the system of the city, in particular, but also the household (every bit as systemic) which is where the changes in the consumption behaviour of its members – currently much-neglected by applied systems analysis, thanks to it being over-focused on the supply side – can be implemented. Wastes, it turns out, are not unavoidable; they can be designed and operated so as to generate post-consumption resources (see, for example, Thompson 2017; Thompson et al 2018).

- *Hard Thinking About Soft Systems*

  Hard systems analysis may be an idea (so strongly held to at the time of IIASA's founding) whose time has passed. Statistics (the collection of quantitative data and their quantitative analysis) have not always been the self-evident way to go. Indeed, they were tailor-made, back in the 18th century, for the centralized nation state. Not only is it that cities may be more important units of analysis than nation states, but also that qualitative evidence (narratives, storylines, case studies, "toad's eye science" and so on) may be more believable than quantitative evidence (the above-mentioned statistics) in guiding the way we make decisions. "Fewer data, more anecdotes", you might say (not unlike that slogan among patisserie-enthusiasts: "less sponge, more gunge"). So the qualitative and the quantitative need to be both re-balanced and better combined. The skills of such argumentation and analysis are anything but easy to acquire: "hard

thinking" indeed! (The framing for this – "wicked problems, uncomfortable knowledge, clumsy solutions" – is set out in Thompson 2018.)

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