Transformative Science, Technology & Innovation Policy

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Defining Science, Technology & Innovation Policy

STI Policy has traditionally been seen as a multi-level effort to improve the generation of knowledge, its embodiment in new technologies, and the broad uptake (diffusion) of these technologies for the aims of improving productivity, growth, competitiveness and employment.

This traditional view remains dominant and constitutes a key component in the landscape described by the multi-level perspective as the overarching set of influences and framings governing the structure and purpose of regimes

It is important to note that the ‘aims’ listed above do not include sustainability, equity, or life satisfaction (although the employment aim is often spoken of in terms of ‘good jobs’)

STI Policy has traditionally been seen as distinct from a number of policy areas of growing interest :

1. Science policy is strongly shaped by the argument that research should be curiosity led and governed by scientists with adequate resources provided to assure the best opportunities for research are exploited.
2. Technology and innovation policy is meant to be a complement to private sector and specific government needs (e.g. health or defence) with those needs being defined by private sector actors and specific government missions

What is transformative STI policy?

Transformative STI policy is founded on a critical analysis which has three elements:

1. Societies are challenged by new developments that are either omitted or of secondary importance in traditional STI policy
2. Traditional STI policies are implicated in the emergence of some of these new developments
3. All societies have unmet developmental needs which raise questions about the adequacy of our existing socio-technical systems

The implications of these elements is that we cannot expect better outcomes from doing more of what we have been doing.

Worse, we may perpetuate and amplify some of the problems that we face by continuing to employ our existing approaches to STI policy.

Transformative STI policy is the result of rethinking the rationales, processes and desired outcomes of STI policy to address issues of environmental sustainability and human flourishing.

Idealism versus Pragmatism

The initial definition of transformative STI policy as the 'result of rethinking the rationales, processes and desired outcomes of STI policy to address issues of environmental sustainability and human flourishing' is idealistic

It sets a motivation, but does not tell us where to begin or how to proceed with the rethinking process

Worse, it risks being so idealistic that it discards useful things that we have learned from traditional STI policy and encourages naïve or ad hoc approaches that, when closely examined, either amount to authoritarian solutions or unrealistic optimism about the agency (capacity to act) of those motivated to make reform.

Pragmatically, then, we need to begin with a clear understanding of the rationales and process of *existing* STI policy with the aim of identifying how these rationales and processes might be changed.

At the same time, we need to elaborate where we want to go – i.e. what constitutes policies for 'sustainability and human flourishing.' In these remarks, I am going to bypass a discussion of ends in order to focus on means.

How to proceed? An Outline of Remarks

I. Overarching (Landscape) features that influence STI Policy

II. Three ‘Framings’ influencing STI Policy

III. Practices of STI Policy

IV. Conclusion

I. Overarching (Landscape) features that influence STI Policy (1/3)

1. Mission Oriented versus Complementary Policy

Historically, STI policy has been organised around 'missions' such as national defence, space exploration, big science (e.g. CERN) and health

STI policies have also been directed at improving the 'knowledge base' for business activities and, to a lesser degree, the 'knowledge base' for regulation in areas such as health, safety, and the environment. Hence, providing a 'complement' public and private investment activities.

Aside from missions, the issues of 'direction' of STI policy are rarely, if ever, discussed and it is generally assumed that more knowledge *and* innovation is a good thing

The latter assumption, that more innovation is better, reflects a Schumpeterian assumption that processes of competition and creative destruction will be, on net, positive (e.g. displaced labour will be re-absorbed in other productive activities and overall improvement in productivity will lead to a net gain to society)

Questioning these premises is usually seen as tantamount to being 'anti-science' or 'anti-progress'

I. Overarching (Landscape) features that influence STI Policy (2/3)

2. Division of Labour Between Public and Private Sectors

Science is largely taken to be a public enterprise – across the world different 'performers' receive differing shares of public budgets for science (e.g. predominantly universities and public research laboratories)

Technology development is taken to be principally the responsibility of the private sector who are expected to invest according to prospects of economic return and therefore efficiently determine what technologies should be developed.

It is recognised, however, that technology development is risky and that subsidising private investment (to the extent that it results in 'additionality of effort' in technology development) may be desirable to avoid underinvestment due to risk

Innovation (the commercialisation of knowledge and the goods and services produced with this knowledge) is even more firmly seen as a responsibility of the private sector. The logic of efficient allocation of resources stemming from private incentives is even stronger.

These views of technology development and diffusion are challenged by those who see a major role for the state in market making and shaping (e.g. M. Mazzucato and other scholars).

I. Overarching (Landscape) features that influence STI Policy (3/3)

3. Are Grand Challenges (e.g. Millennium Development Goals) Subject to Mission-Oriented Policies?

Previous and existing missions are based upon a very focussed purpose that appears to be linked to issues of political salience

For example, Kennedy's mission to send a man to the moon before 'this decade [the 1960s] is out' exemplifies this sort of political salience

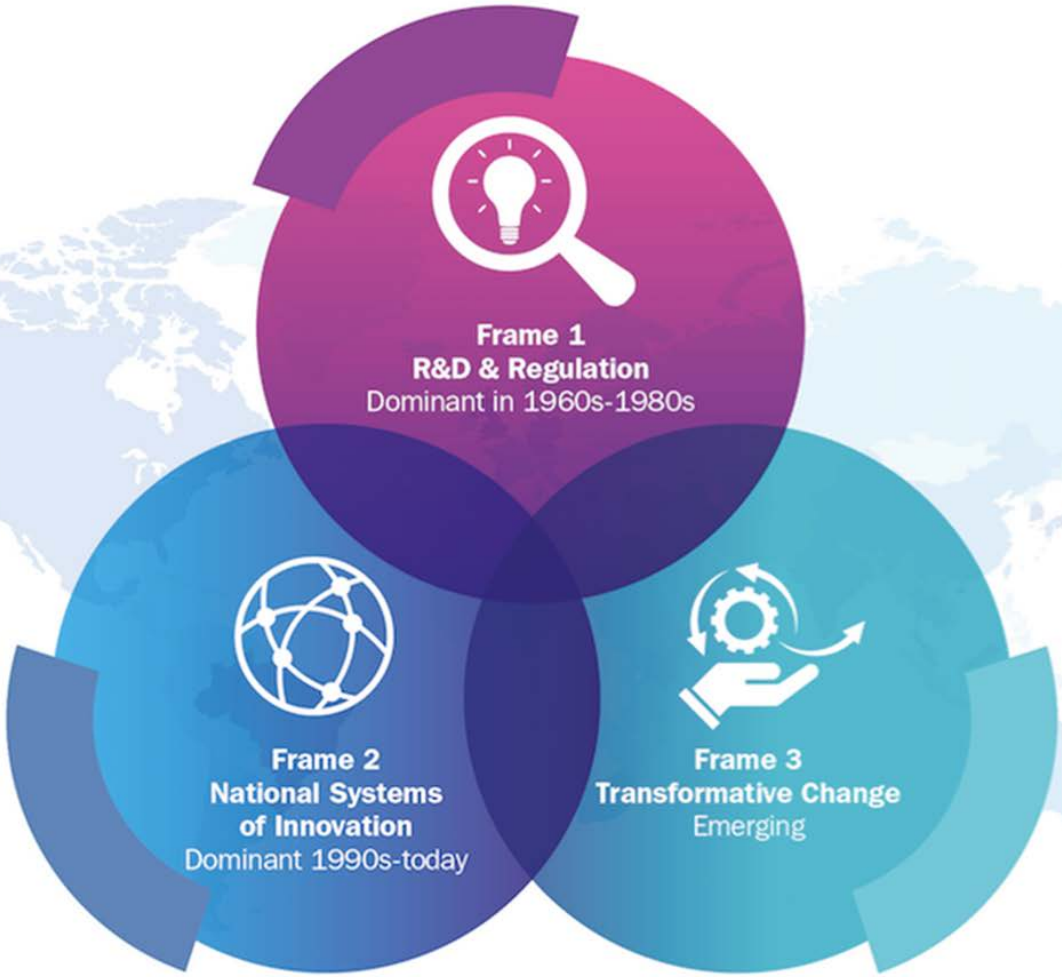
Missions are also generally aligned with a variety of existing (incumbent) interests, e.g. the contractors for the Apollo programme included the aerospace companies engaged in ICBM construction and other defence activities (e.g. IBM)

Fundamental problems with socio-technical system change (the deep transition problem) are the complexity of the challenge (not easily amenable to politically salient messages) and the conflict with incumbent interests (investors in the current socio-technical system who might be displaced)

It also may be questionable whether the 'political will' to mobilise society for major new missions already exists or has to be constructed and whether this 'will' can be mustered given the lack of a blueprint for achieving desired outcomes

II. Three ‘Framings’ influencing STI Policy

The regimes that have arisen within the landscape partially described in the previous slides can be productively analysed by thinking of three evolving frames of reference governing STI policy



Note: The slides in this section are co-authored with Johan Schot and based on our paper, the first of the suggested readings for this session.

R&D & Regulation: Frame 1

- **Dominant in 1960s-1980s**
- Market Failures
- R&D produces economic growth, driven by productivity growth & public welfare
- R&D leads to competitive advantage & national prestige
- Markets lead to externalities & need regulation
- Emphasis on uncertainty & long term gains

The Market Failure Approach [Nelson (1959) and Arrow(1962)]

- Market failure arises when the expected private return from some types of research is lower than the social return. In this situation, private firms cannot be expected to invest in or invest 'enough' in these types of research. It is called 'market failure' because the market cannot succeed in delivering the socially desirable level of research.

- The production of knowledge is subject to market failure because:

  - Appropriability problem implies that producers will not be able to capture (appropriate) all of the benefits of producing knowledge, thus they will not produce as much of it as would be socially desirable

  - Markets are missing – markets may not exist to deal with the uncertainty of knowledge investment
    - For example, venture capital firms usually wish a firm to have patents or specific technologies that can be kept secret before they will invest in them – initial exploration is someone else's problem

R&D & Regulation: Frame 1
The Focus & Actors

Focus:

- Knowledge production, R&D, breakthroughs, high-tech, novelty

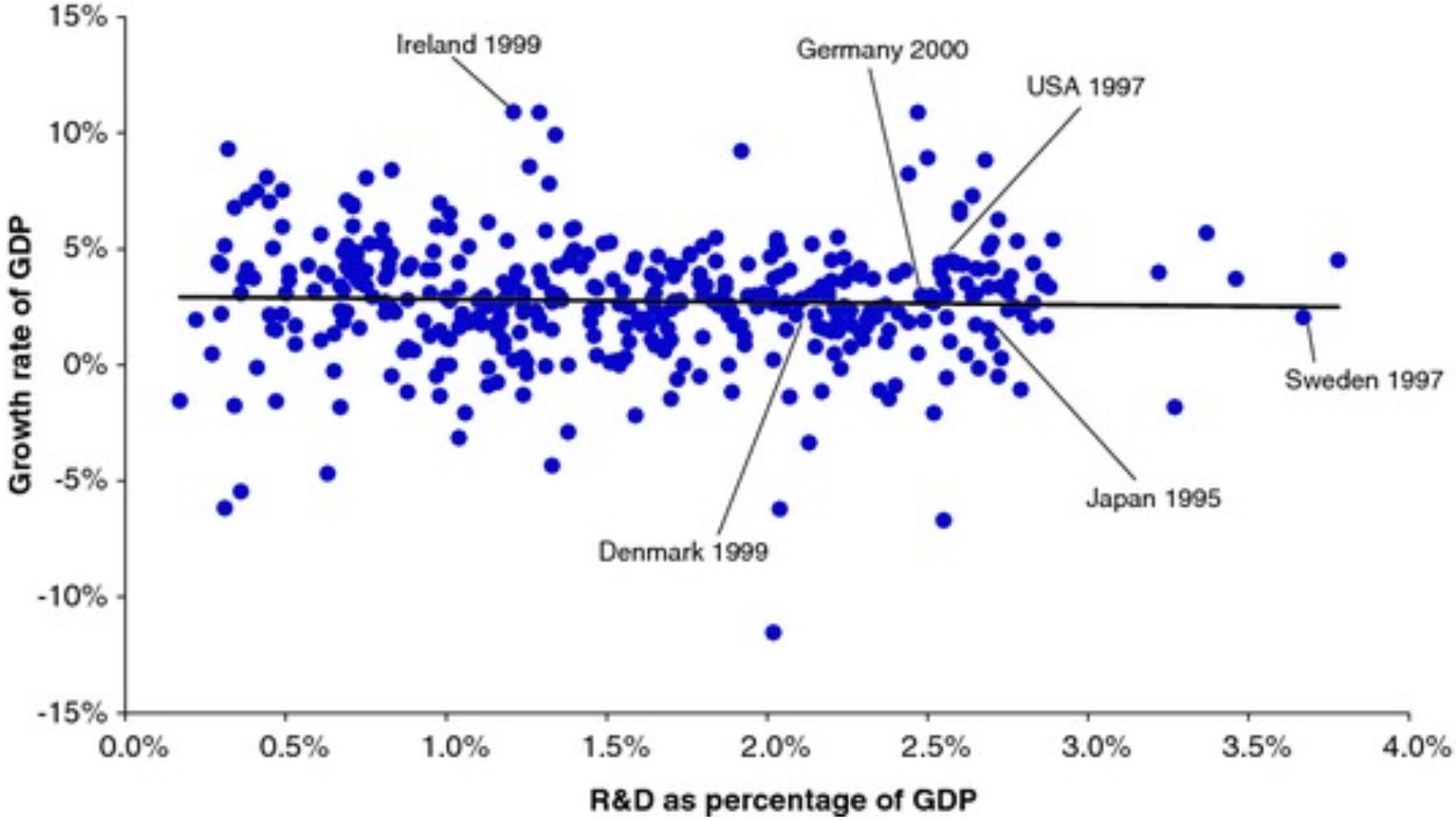
Innovation Actors:

- Government & Market actors with a tendency to prioritise large firms
- Experts, scientists, inventors, engineers

R&D & Regulation: Innovation Model

Disappointment with the First Framing

No apparent relationship between growth rate of GDP and the amount of R&D as percentage of GDP



Expenditures on R&D and economic growth in 29 OECD countries 1981–2000.
Source: OECD, Statistical Compendium on CD, 2002:2

National Systems of Innovation: Frame 2

- **Dominant 1990s-today**
- Systems Failures
- R&D & learning (by producing, using and interacting) produces economic growth, public welfare & competitive advantage therefore national prestige
- National, Regional & Sectoral Systems of Innovation
- Entrepreneurship/role of business

National Systems of Innovation: The Focus & Actors

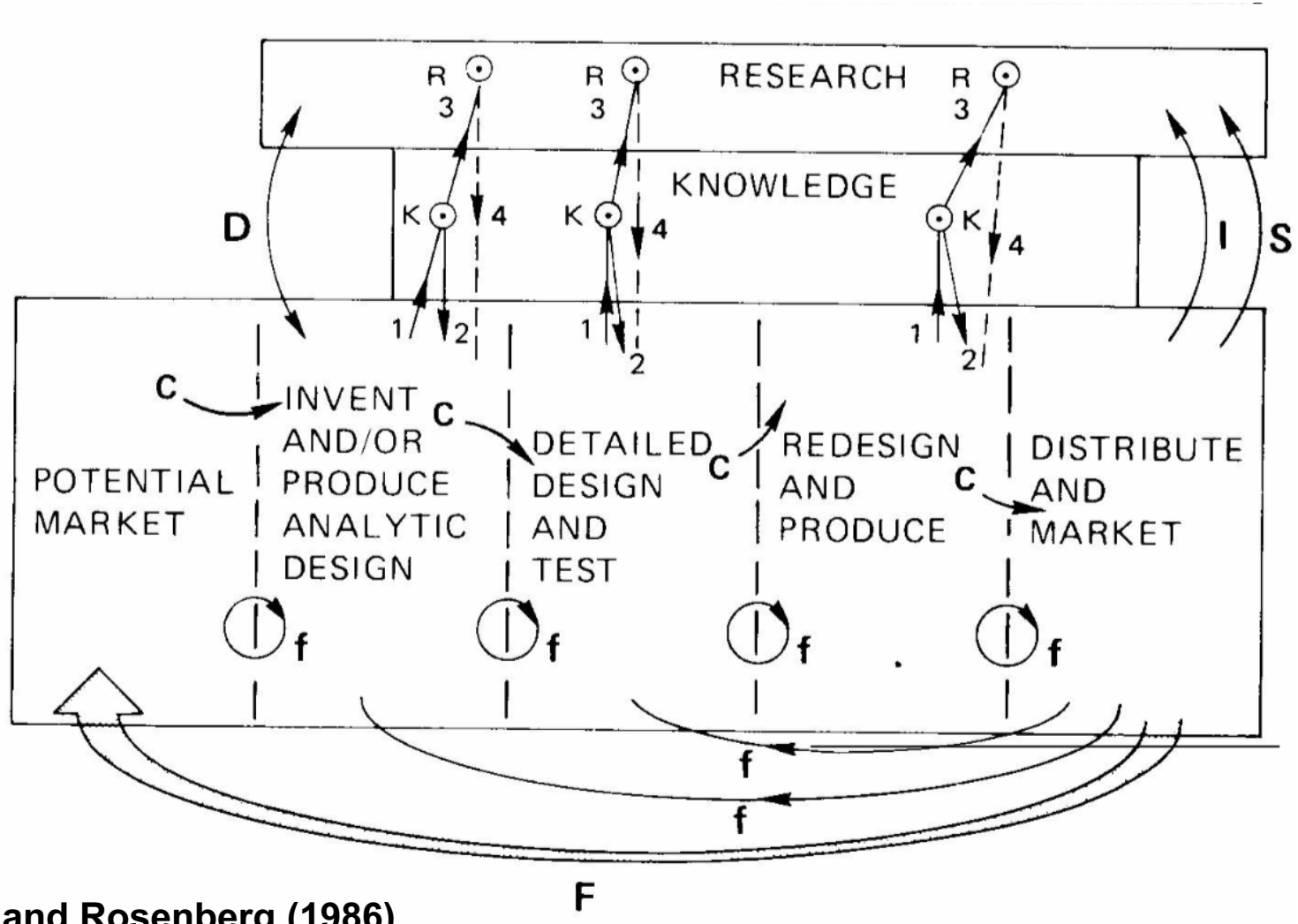
Focus

- Product & process innovation, knowledge production, R&D, incremental innovation, hidden innovation
- Introduction of idea of path-dependency, technical change is cumulative & collective & focused (directionality)

Innovation Actors

- Market actors, SMEs, entrepreneurs, universities, governments, users, networks, intermediaries, public-private partnerships (civil society?)

National Systems of Innovation: Innovation model



Kline and Rosenberg (1986)

Transformative Change: Frame 3

- **Still emerging**
- Social & environmental needs failure (e.g. inequality & climate change)
- Explicit recognition R&D & innovation - do not automatically lead to human welfare
- Need to distinguish between good & bad innovation
- Regulation is necessary but not sufficient for addressing societal challenges
- Need for Transformative Change/Sustainability Transitions

Transformative Change: The Focus & Actors

Focus

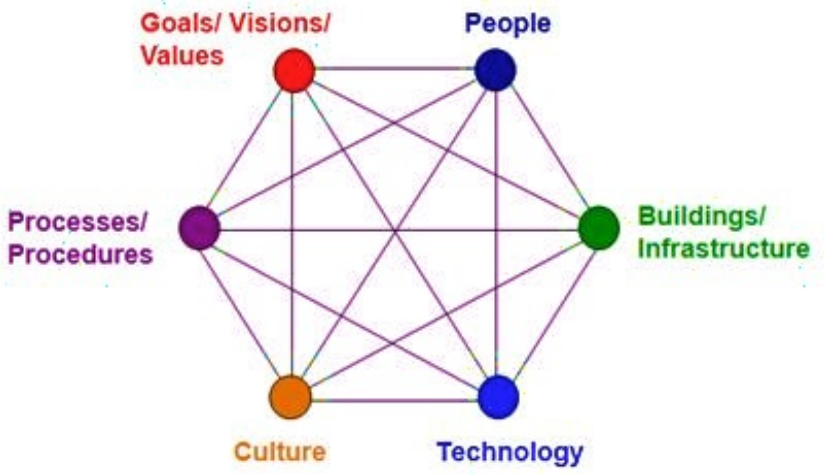
- Socio-technical systems
- Inclusion, broad social participation, informal economy, grassroots innovation (for functional reasons, and for political reasons)

Innovation Actors

- All actors can be innovative, including users-consumer, civil society, marginalised populations

Transforming innovation: Innovation Model

Multiple and overlapping models emerging:



III. Policy Practices

Each of the framings produces particular practices and activities

The practices of the first two frames are shaped by their technocratic character so ideas such as cost-benefit analysis, investment multipliers, and prospective returns are widely employed.

In the third frame, the objectives are long term transformation with great uncertainty about short and medium term returns. This raises major challenges to extending and building both private and public support for third frame activities.

The third frame involves experimentation because we do not have a blueprint for achieving the goals of socio-technical system change and because experimentation is a way to build confidence and enlist support for the disruptive (challenging incumbent regimes) aspects of third frame activities

The third frame also suggests *ex ante* deliberation of issues of directionality and consequence which requires new understandings of foresight which we call 'anticipation' to differentiate its function and process from Foresight type activities.

Frame 1 – R&D & Regulation: Policy Activities

- R&D stimulation (subsidies, tax credits, procurement, mission oriented programs)
- Intellectual Property Rights
- Improve knowledge base
- Education Policy on Science & Engineering
- Science for Society Communication
- Foresight & Technology Assessment

Frame 2 – National Systems of Innovation: Policy Activities

- R&D, IPR, Education Policy, Foresight, Regulation
- Spaces for interaction on various levels, for example technology platforms
- Use of demand stimuli, e.g. procurement
- Building Regional & National System of Innovation
- Ability to absorb knowledge, e.g. capability building, skills development
- Programs to stimulate entrepreneurship, incubators

Frame 3 – Transformative Change: Policy Activities (1 of 2)

- Building transition arena's: supporting diversity & opening up for alternatives, pathways to sustainability
- Building on social innovation, inclusive innovation, frugal innovation, pro-poor innovation
- Setting up large scale societal experiments & scaling-up (use or creation of intermediaries) Strategic Niche Management
- Enhancing anticipation, adaptability, reflexivity capabilities

Frame 3 – Transformative Change: Policy Activities (1 of 2)

- Constructive Technology Assessment & Responsible Research & Innovation (participation)
- Bridge Science/Engineering & Social Sciences & Humanities in Education system
- New institutions for coordination between various policies, integrating of STI into other policies (energy, housing, agriculture, healthcare, transport, and city policies); seeking policy mixes
- Technology forcing, through regulation and/or procurement

Conclusion

It seems highly unlikely that the challenges that our societies face in the 21st century can be addressed without a further evolution of STI policies

The direction of that evolution, what we call Frame 3, is very much a work in progress as it involves efforts to rethink the process and outcomes of the first two frames which still dominate policy practice and will continue to be relevant in the future

It is a worthwhile debate to consider the extent to which some of the goals for Frame 3 can be accomplished by 'mission oriented' policies drawing on the first two frames of thinking

Ultimately, however, Frames 1 and 2 lack a mechanism or process for enlisting social support and building from the ground up approaches that are more democratically governed

It is also worthwhile to debate whether the types of activities and practices in Frame 3 can deliver outcomes in time to meet some of the challenges we now face and how Frame 3 looks from a developing and middle income country perspective where growth may be a more urgent priority