Innovation, Sustainability, Development: A New

MANIFESTO

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

# The Original 'Sussex Manifesto': Its Past and Future Relevance

Adrian Ely and Martin Bell

# Retrospective

STEPS centre

## About the paper

The original "Sussex Manifesto" called for radical change in international debate and action about harnessing science and technology to development. It challenged the commonly accepted global division of labour in innovation that underlay most preceding discussion of this issue – conducted almost exclusively in terms of (i) undertaking research in advanced countries 'for' developing countries and (ii) transferring 'to' developing countries technologies available in advanced countries. Its central argument was about massively increasing the developing countries' own S&T capabilities for creating and shaping their own knowledge and technologies. It also stressed that 'systemic' changes in S&T management, organization and policy as well as broader economic and political structures would be necessary in developing countries if any increase in such capabilities was to achieve a significant developmental impact; and supporting actions would be needed in the advanced countries. This paper reviews these proposals and examines, as far as possible, the extent to which they have been realized in the subsequent forty years. It highlights continuing and new challenges now facing innovation policy, and indicates ways in which some of the original manifesto's ideas may be extended to address today's urgent problems. It then outlines additional considerations that would need to be addressed in considering the manifesto's relevance to contemporary issues about innovation, sustainability and development.

## About the authors

**Adrian Ely** is a Research Fellow at SPRU, University of Sussex and a member of the STEPS Centre. Adrian convenes the Innovation, Sustainability, Development: A New Manifesto project. His areas of interest include environmental impacts of GM crops, frameworks for biotechnology regulation, risk and uncertainty in policy-making around new technologies and innovation for sustainable development.

**Martin Bell**, Emeritus Professor at SPRU, University of Sussex, is an historian and economist. His research and consultancy interests centre on the development of innovation capabilities in Africa, Asia and Latin America – focusing in particular on their accumulation in industrial firms (including MNC subsidiaries) and their roles in the long-term evolution of both innovation systems and the structural diversification of developing economies.

## About the Manifesto project

In 1970 a radical document called The Sussex Manifesto helped shape modern thinking on science and technology for development. Forty years on, we live in a highly globalised, interconnected and yet privatised world. We have witnessed unprecedented advances in science and technology, the rise of Asia and ever-shifting patterns of inequality. What kind of science and technology for development Manifesto is needed for today's world? The STEPS Centre is creating a new manifesto with one of the authors of the original, Professor Geoff Oldham. Seeking to bring cutting-edge ideas and some Southern perspectives to current policy, the New Manifesto will recommend new ways of linking science and innovation to development for a more sustainable, equitable and resilient future.

For the all the papers in this series see:
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## About the STEPS Centre

The STEPS Centre (Social, Technological and Environmental Pathways to Sustainability) is an interdisciplinary global research and policy engagement hub that unites development studies with science and technology studies. Based at the Institute of Development Studies and SPRU Science and Technology Policy Research at the University of Sussex, with partners in Africa, Asia and Latin America, we are funded by the Economic and Social Research Council.

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IDS Institute of Development Studies
US University of Sussex
SPRU – Science & Technology Policy Research
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# The Original Sussex Manifesto: Its Past and Future Relevance

**Adrian Ely and Martin Bell**

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For further information please contact: STEPS Centre, University of Sussex, Brighton BN1 9RE
Tel: +44 (0) 1273606261
Email: steps-centre@ids.ac.uk
Web: www.steps-centre.org



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# INTRODUCTION

This background paper for the STEPS Manifesto project seeks to outline elements of a bridge across the 40 years between the original Sussex Manifesto of 1970 and ideas about a possible New Manifesto in 2010. One part of that bridge is concerned with similarities and differences in ideas about how science, technology and innovation do, or might, influence development. Another part is about continuity and change in the context for science, technology and innovation. Taken together, these lead to views about the past and future relevance of the ideas in the original Manifesto.

The paper is organised as follows. First, in Section 1 we outline the ideas and key proposals in the original Manifesto. We concentrate in particular on the Manifesto's recommendations, organising these in two groups: those that were framed in terms of quantitative targets and those that were developed in more qualitative terms. We not only highlight what we consider important, but also comment on areas where we believe the original perspectives would have limited relevance today. We then sketch in Section 2 our views about the extent to which these two sets of recommendations have been realised over the last 40 years.

In Section 3 we turn to the current context for considering the role of science, technology and innovation in developing countries. We outline continuing and new challenges, noting in particular important features of the new global context. Finally, in Section 4 we explore some of the ways in which the ideas and perspectives of the original Manifesto would need to be stretched, modified and supplemented in a New Manifesto. These centre on the idea of a '3D' agenda for innovation and development – one that gives much greater attention to *Directionality*, *Distribution* and *Diversity* in patterns and processes of innovation.

Exploring these similarities and differences across 40 years is complicated by the shifting relationship between language and concepts. Similar terms have come to be used in different ways over the 40 years, while different terms are used to refer to similar concepts. We have tried as much as possible to use terms in ways that map to the usage of the original Manifesto and its context on the one hand and to current usage, especially among the STEPS Centre, on the other. Where it seems necessary we provide a brief explanation to assist the reader in navigating through these aspects of the bridge. But also, superimposed on that, we have found it expedient in a few places in our exposition of the original Manifesto to use our own terms to simplify or summarise. We have tried to indicate clearly when we use such terminological anachronisms.

## 1. THE ORIGINAL SUSSEX MANIFESTO – CONTEXT, CORE CHALLENGE AND RECOMMENDATIONS

### THE CONTEXT AND THE BROAD CHALLENGE

The document that later came to be known as the *Sussex Manifesto* was originally commissioned by the United Nations Advisory Committee on the Application of Science and Technology to Development (ACAST) as an introductory statement for the *World Plan of Action on the Application of Science and Technology to Development*. Rejected for this purpose by ACAST, it eventually became Annex II of *Science and Technology for Development: Proposals for the Second Development Decade,* a 1970 report to the UN's Department of Economic and Social Affairs. The World Plan of Action emerged later and was

recommended to the General Assembly by the Economic and Social Council in 1973 (UN 1973). Having been described pejoratively in discussions at the United Nations as 'a manifesto', Singer et al's document later became known as *The Sussex Manifesto: Science and Technology to Developing Countries during the Second Development Decade* (1970).

With its origins linked in that way to the *World Plan of Action*, the Sussex Manifesto was concerned with identifying ways in which science and technology could be applied much more effectively to foster 'economic development'. That purpose probably seems fairly simple to current readers, but in two important respects it was a radical departure. First, economic development was identified as a historical process leading to qualitative social change, [1] and it was distinguished from economic growth in GNP per head, the frame of reference in most previous discussions of science and technology for developing countries.[2] Second, with respect to the key issue about *how* science and technology might contribute to development, the Manifesto marked an important change from earlier global discussions. Especially at the UN Conference for the Application of Science and Technology for the Benefit of Less Developed Areas (UNCSAT) in Geneva in 1963,[3] these had focused primarily on questions about transferring technologies from the developed to the developing world. In contrast, the Manifesto took off from a premise of the *World Plan of Action* - the view that 'the developing countries must have their own scientific and technological capability'.[4] But the Manifesto went beyond generalities about strengthening such capabilities, and called for a fundamental change in what it called 'the international division of labour in science'.

> From the outset, ... we reject the idea that the existing international division of labour in science is adequate for development. It provides no basis whatsoever for development; amongst other things, the less developed countries must have an indigenous scientific capability.
>
> (Singer et al 1970: para 18)

Terminology in this area in the Manifesto was looser than might be expected today. Terms like 'science' and 'science and technology' (S&T) were used almost interchangeably. In a framework that was well established at that time (e.g. in the OECD's recently produced Frascati Manual for standardising statistical surveys), these were seen as activities that provided some of the inputs, often considered to be the main inputs, for producing outputs of 'innovation' – although that term appeared very rarely in the Manifesto.[5] The Manifesto

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[1] This was not surprising. Several of the Manifesto authors were close working colleagues of Dudley Seers, and the appearance of the Manifesto in 1970 neatly split the timing of two of Seers' path-breaking contributions to the differentiation of 'development' and 'growth': *The Meaning of Development* (Seers, 1969), and his classic *What are We Trying to Measure?* (Seers, 1972). The latter identified development as a process of creating the conditions for 'the realization of human personality'; and its evaluation should therefore take account of three linked economic criteria: 'whether there has been a reduction in (i) poverty; (ii) unemployment; (iii) inequality' (p. 21).

[2] As one example see Jones (1971), The Role of Science and Technology in Developing Countries, which embeds its discussion in a framework centred on 'economic growth and technical progress'.

[3] Esha Shah, in another paper in this series, locates the Sussex Manifesto in a much fuller review of UN debates about science and technology for development – see Shah (2009).

[4] Singer et al 1970: paragraph 1. [In the rest of the paper, such references to specific Sussex Manifesto paragraphs will be located in the text in the form – Singer et al 1970; para 1].

[5] In two senses, however, the prevailing ideas of innovation reflected in the Manifesto were narrower than usually thought of today. On the one hand the process of producing innovation was seen as centred very heavily on the creation and transformation of knowledge via science and technology, giving much less emphasis, or none at all, to other contributing activities and forms of knowledge. On the other hand, innovation as the output of that process was also seen in relatively narrow terms, typically in hardware-centred notions of new products and processes, giving little attention to other forms of innovative change – e.g. in organisation and institutions.

authors were therefore rejecting prevailing perspectives that accepted as inevitable the division of the world into two groups of societies: those that engage with science and technology in a creative process that generates the technological bases of production and consumption; the others that merely use and apply some of the results of that creative process undertaken elsewhere.

From this rejection of the way scientific and technological activities were globally distributed, there followed the core challenge laid down by the Manifesto. This was about massively transforming the efforts then being made to create and strengthen the S&T capabilities for innovation in developing countries. The underlying aim of the challenge was clear: developing countries should not simply be choosers and users of 'ready-made' technologies they acquired from advanced economies; they should also be adapters, improvers and creators of the technologies they came to use in their development. Consequently, the Manifesto suggested that massive resource allocations and other efforts should be made to enable those economies to become increasingly significant innovators.[6]

That broad challenge led to a number of recommendations for action over the forthcoming development decade. These fell into two groups. One consisted of recommendations to which the Sussex group attached specific quantitative targets for the decade. The other consisted of recommendations of a more qualitative type, concerned with ensuring that the meeting of the quantitative targets would actually contribute to the reality of significant developmental gains. We review these two groups separately.

## THE MAIN RECOMMENDATIONS: QUANTITATIVE TARGETS

Three of the Manifesto's recommendations were associated with quantitative targets. Most of these were couched in terms of expenditure on research and development (R&D) activities and capabilities, but the Manifesto authors recognised that R&D constituted only a small fraction of the scientific and technological activities contributing to innovation. A wide range of others was also essential (Singer et al 1970: para 10).[7] However, the emerging bodies of statistical data about science and technology at that time had come to focus very heavily on only R&D activities, and the Manifesto's quantitative targets were somewhat reluctantly couched in that narrow framework (Singer et al 1970 para 74).[8]

### (i) Increasing scientific and technological capabilities in developing countries, so changing the global division of innovative labour

[6] This perspective was a strong emerging feature of the contemporary intellectual context of the Manifesto and its authors. This and other aspects of that context are reviewed in more detail in another paper in the New Manifesto series: Bell (2009a), Innovation Capabilities and Directions of Development.

[7] This was explained at some length in para 10 of the Manifesto. Many of the other non-R&D activities were closely related to formal research processes – such things as scientific library and information services; scientific testing and standards services; museums, zoological and botanical gardens; and geological, geophysical, meteorological and natural resources survey work. Others were more concerned with the 'application' of science and technology – e.g. design, engineering, production control, marketing, and routine medical services.

[8] The persisting importance of these statistical frameworks in shaping the policy agenda for science, technology and innovation in developing countries is reviewed in another paper in this Manifesto series: Bell (2009b), Innovation Statistics and Innovation System Models: Policy Tools and Policy-Making in Developing Countries.

The first recommendation centred on a very ambitious target for the growth of scientific and technological capabilities of developing countries over the new development decade of the 1970s.

> ... the research and development (R and D) effort of the developing countries should be increased from the present level of about 0.2 per cent of gross national product (GNP) to about 0.5 per cent of GNP (Singer et al 1970: para 5)

This recommendation was qualified as being 'a rough approximation' and it had to be disaggregated to reflect differences between developing countries if it was to have any operational meaning.

It was estimated that by the end of the decade this might amount to about 4 or 5 per cent of total world expenditure on R&D – a very large increase over the 2 per cent share of developing countries in the global total in 1970. But the aggregate magnitude of the challenge was greater than suggested by that increase. Recognising that R&D constituted only a fraction of overall science, technology and innovation (STI) activities, the Manifesto suggested that there should be a 'similar – or possibly even greater – increase' in overall STI activities. Indeed, 'expanding R and D by itself will not be economically useful' (Singer et al 1970: para 74).

### (ii) The role of aid and donors

The second recommendation centred on the need for advanced countries to provide a very large increase in aid to developing countries to enable them to build up this scale of scientific and technological capabilities over the decade. In this case the quantitative target was not couched in terms of R&D, but with reference to 'science' or 'science and technology'.

> ... the advanced countries ought to give direct, financial and technical assistance to the build-up of indigenous science in the developing countries,[with this reaching] 0.05 per cent of their GNP during the Second United Nations Development Decade, which would imply that about 5 per cent of their total aid would be for science and technology. (Singer et al 1970: para 6)

### (iii) Reorienting R&D in the advanced countries

It was also recognised that the recommended effort to build scientific and technological capabilities for innovation *in* developing countries would on its own be inadequate in orienting world scientific effort towards the problems, interests and aims of developing countries. Given the huge weight of global R&D activity that was undertaken in the advanced countries (98 per cent of the global total), the composition of the global stock of technology was becoming 'less and less directly suitable for use by developing countries'. So a reorientation of R&D in advanced countries was seen as 'essential'. The scale of this reorientation was identified in terms of a specific fraction of total R&D activity undertaken in advanced countries.

> The advanced countries should devote about 5 per cent of their total R and D expenditure to the specific problems of the developing countries during the Decade. (Singer et al 1970: para 7)[9]

No clear indication was provided about how this should be interpreted. For example, who would define such problems and how? Would they include generic global problems or

[9] The report to which the Sussex Manifesto was an annex adopted a variation of this recommendation. It also adopted the previous two recommendations (from paragraphs 5 and 6).

somehow distinguish only those that were 'specific' to developing countries? How would one identify which kinds of R&D were addressing such problems?

## THE MAIN RECOMMENDATIONS: 'QUALITATIVE' AIMS AND CHANGES

The Manifesto's other recommendations were far more detailed and nuanced than the quantitative targets summarised above. In particular, they referred to other kinds of change that would be necessary to achieve any significant developmental impact from the huge increase in expenditure on R&D activities and capabilities. These other kinds of change involved economic, institutional and political considerations that were much less amenable to quantitative measurement and targets than R&D. These more qualitative recommendations can conveniently be summarised under four headings – though the Manifesto did not use precisely this framework:

(i) The extent to which R&D activities actually resulted in some form of application in innovation – what we describe here as their 'application effectiveness', regardless of the nature of any application and its socio-economic outcomes;

(ii) The qualitative type of R&D undertaken, along with the type of any associated innovative application resulting from it – what we refer to here as the 'orientation' of R&D and in particular the extent to which it was oriented towards 'development' aims and purposes;

(iii) The broad economic, institutional and political conditions that would be necessary for application-effectiveness and development orientation;

(iv) The extent to which technology that was available in principle in the advanced countries was actually acquired and absorbed to contribute to development.

### (i) The application-effectiveness of R&D in developing countries

The Manifesto expressed deep concerns about the extent to which R&D in developing countries actually resulted in any kind of innovative application. Much of it seemed to be application-ineffective.[10] The Manifesto was emphatic about the importance of application effectiveness because any increased expenditure on S&T activities would be 'folly' if the problem was not addressed.

The source of the problem was identified partly in the low productivity of R&D activities themselves. Two kinds of organisational explanation were provided for this. Some were essentially about micro-level organisational issues – for example, research being squeezed out of university activities because of high teaching loads, or the fragmentation of research activity into large numbers of small projects. Another kind of organisational problem was more pervasive – the fact that a large amount of R&D, especially more applied R&D, was undertaken in government organisations where numerous aspects of management and coordination were commonly problematic. 'There are some serious organisational disorders' (Singer et al 1970: para 67).

Without reforms to overcome these organisational shortcomings, any additional financial resources for scientific and technological activities 'will largely be wasted'. (Singer et al 1970: para 69).

[10] One implication was that, corrected to reflect the effectiveness of R&D, its global distribution was "even more lop-sided" than suggested by the raw expenditure data. (Singer et al 1970: para 33).

But application-ineffectiveness resulted from more than low R&D productivity. In particular two other issues were highlighted: (a) the limited systemic integration of scientific and technological activities, and (b) the limited demand for innovation that was exerted on these activities. Both merit further elaboration.

(a) The limited systemic integration of scientific and technological activities:
As noted above, the Manifesto authors were clear that by focusing on R&D they were concentrating on only a small part of the overall system of scientific and technological activities that contributed to innovative change.[11] Consequently, they stressed the importance of ensuring that there was effective 'integration' and 'coupling' between research effort and the wider 'process through which this effort is translated into economic application' (Singer et al 1970: para 61). They returned again to the issue when, reflecting a very linear model of the 'system' that was dominant at the time, they highlighted that: 'There must be firm connexions between every link in the technology application chain' (Singer et al 1970: para 70).

In retrospect, one can recognise now that the Manifesto perspective on the 'system' was more limited than would often be currently emphasised, for example in the work of the STEPS Centre. In particular this was reflected in the kinds of knowledge, activities and actors encompassed by the system, as well as in the relatively linear, rather than networked, mode of interaction between them. Thus, the Manifesto's interest in science and technology was framed to include only 'modern' and 'formal' types of knowledge. The contribution to innovation made by other forms of knowledge - local, indigenous, traditional, craft, etc. - was unrecognised, or at least only implicit.

Given this focus, the Manifesto also centred its attention on formally organised R&D institutes as the key actors contributing to innovation. Even when the scope was expanded to include such activities as consultancy and extension services or activities like design and engineering concerned with "the application" of science and technology, these were clearly seen as adjuncts to the core activity – R&D. They were part of the "chain" that linked new knowledge from formally organised R&D to its application in production. Consequently, activities involved in creating and applying even 'modern' and 'formal' knowledge *independently of* any upstream R&D – including various forms of design and engineering – did not seem to be recognised, and they were certainly given no particular emphasis. Correspondingly, the organisational basis for creating new technology via formal R&D was seen as being concentrated in public organisations like research institutes and universities. These were taken as the core of the system and there was no discussion of more de-centralised forms of organisation – for example, the development of innovation capabilities in production enterprises themselves.

This bounded scope of the Manifesto's view of the 'system' was evident also in its explanation of the purpose of S&T policy. In its 'narrowest sense' this was seen as being concerned with research and experimental development. But even in a broader sense, it did not stretch very far. It was seen as encompassing not merely 'the generation of new knowledge' in R&D but also 'the dissemination and application' of existing and new knowledge throughout the economy (Singer et al 1970: para 14). In other words, beyond the creation of new knowledge via R&D (in centralised and largely public organisations), other parts of the system merely disseminated and applied what had been created. They did not play independent knowledge-creating roles. All this was totally consistent with the prevailing conception of 'science and technology systems' at the time.

[11] But, as noted above, this reflected a rather narrow science-and-technology-centred perspective on the processes leading to innovation.

(b) The limited demand on innovation activities:
The Manifesto also stressed that the limited application-effectiveness of R&D did not simply stem from the kinds of organisational problem on the supply side that are noted above. At least as important was that 'there are no pressures of demand for scientific and technological knowledge' (Singer et al 1970: para 58). Consequently, the argument was that increased expenditure on R&D, even with improved organisation, 'will make no sense at all' unless, among other things, there was a 'perceived need' for inputs of science and technology to production.

It was stressed that, given 'the way production is organised' these needs would be unlikely to materialise as commercial demand. Although some contribution to overcoming this could be achieved by close coupling between the different innovation actors so that needs and R&D were better linked in two directions, much more important would be the articulation of needs as non-commercial demands on R&D via policy and planning organisations. This non-market demand would be more effective if it was informed by long term perspective planning methods (Singer et al 1970: para 117).

There was, however, no elaboration about how such technocratic methods (at a national level) would in practice transform needs into effective demands on scientific and technological capabilities as a stimulus for more effective application and innovative impact. But in any case, such technocratic solutions to the problem of limited demand seem to have been secondary to the role ascribed to changes in deeper underlying conditions summarised behind the term: '*the way production is organised*'. We will return to these conditions after commenting briefly on another kind of problem that was seen as limiting the development impact of R&D.

### (ii) The orientation of S&T activities in developing countries

Alongside what we have called 'application-ineffectiveness', the Manifesto identified another constraint on the contribution of R&D to development. This was about what we summarise here as its 'orientation' – i.e. about *the kinds of* problems and objectives that R&D addressed and hence *the kinds of* innovation that were sought. The Manifesto stressed that these were highly variable.[12] Some orientations of R&D might contribute to development, but others might not – even though the activity was undertaken in the context of developing countries.

The extent of that contribution was seen as being strongly influenced by the weight and orientation of R&D in the advanced countries, which exercised a considerable gravity-like 'pull' on the R&D that was undertaken in developing countries, and frequently had 'a preponderant influence' on the way science was oriented in developing countries. [13] Moreover the direction of that influence would be shaped by the heavy concentration of advanced country R&D on objectives concerned with areas like defence, space exploration and nuclear power. Consequently, the orientation of STI activities in developing countries is often linked to objectives 'which are external to the countries themselves and which have little enough to do with the requirements of development' (Singer et al 1970: para 37). This was seen as a matter of considerable significance:

> The result is a phenomenon which we shall refer to as the 'internal brain drain', whereby a substantial part of the scientific work going on in the developing

[12] This concern with the 'orientation' of S&T activities was very similar to the current STEPS interest in the 'direction' of innovation.
[13] The Manifesto noted that STI-related aid activities of advanced countries may 'reinforce these contrary tendencies' (Singer et al 1970: para 37).

> countries, in addition to being underfinanced and poorly organized, is irrelevant to the environment in which it is being done. (Singer et al 1970: para 38)

But the pull of advanced country R&D was only one of two interacting forces that determined the extent of the development orientation of R&D in developing countries. The other was the strength and orientation of *localised demand*, both market-mediated or articulated through non-market mechanisms, as discussed above. It was the balance between external influence and domestic demand that shaped the actual development contribution from local R&D.

However the Manifesto was somewhat ambiguous about the nature of this 'local' demand. In some expressions, this seemed to be a fairly aggregated kind of 'national' demand that reflected a more or less homogeneous bundle of needs of a developing country as a whole. In others, the notion of development-related demand seemed to reflect more differentiated kinds of need within developing countries – a differentiation that was connected to the Manifesto's Seers-type perspective on 'development' with its emphasis on reducing poverty and inequality. This, for instance, seemed to be the implication of some of the discussion of the need for 'appropriate technology'.

This brings us back again to the underlying conditions of underdevelopment that the Manifesto summarised under the term: 'the way production is organised'.

**(iii) Conditions for application-effectiveness and development-orientation**

One powerful section of the Manifesto stressed that the various organisational weaknesses in scientific and technological activities, and the limitations of policy and planning for R&D, were only a part of the overall set of issues that should be addressed by change and reform. These were 'really only proximate causes' of the limited application-effectiveness and development orientation of R&D. Instead:

> The real causes lie deeper in the nature of *under-development* itself. In brief, many of the *structural and organizational* characteristics of the developing economies are antithetical to the application of science and technology and, by the same token, prevent the development of what might be termed a 'realized demand' for scientific and technical knowledge. (Singer et al 1970: para 51 – emphasis added)

In order to interpret that assertion and associated explanations, one has to connect them to the Manifesto's earlier distinction between growth and development. But one probably also has to look outside the document of the Manifesto itself to the academic context in which both it and several of its authors were deeply embedded.[14] For example, in this context in the late 1960s, terms like 'under-development' or the 'structural' characteristics of developing countries did not simply refer to 'under-grown' economies and their characteristics. Instead, such terms were rooted in the work of scholars like Celso Furtado, Dudley Seers and Hans Singer (the last being one of the Manifesto authors). To simplify grossly, these scholars saw 'under-development' as embedded in two kinds of structural characteristic: (i) a highly unequal position within the international economy, and (ii) a highly unequal polarisation of societies within developing countries, reflected in highly unequal distributions of not only incomes and opportunities, but also of underlying assets of financial wealth and land. Consequently, at least for some of its authors, the Manifesto's reference to 'the way production is organised' was a reference to the way its organisation reflected this dual set of inequalities.

[14] Some aspects of this intellectual context for the Manifesto are explored in another paper for the Manifesto series: Bell (2009a) Innovation Capabilities and Directions of Development.

In a similar way, the Manifesto's comments about how these structural conditions of underdevelopment influenced science and technology in particular were rooted in the work of scholars like Charles Cooper (Drafting Secretary to the group of Manifesto authors) and close colleagues like Frances Stewart and Amilcar Herrera. For them, the effectiveness and orientation of STI activities in developing countries were shaped not just by the kinds of *international* inequality in scientific and technological power that led to phenomena like the 'internal brain drain'. They were also profoundly shaped by the extreme *intra-national* inequalities in the distribution of income, assets and power. For example, the demands of a developing country for new-to-the economy product and process technologies, and also such limited demand as existed for innovative scientific and technological activities, were overwhelmingly the demands only of that country's elite, upper income groups. Possible demands from other groups were typically precluded by the structures of inequality. A glimpse of the concrete reality of this perspective is provided by the Manifesto's brief discussion of the kind of 'reorganization in the economy' that might be needed if agricultural R&D was to play a significantly developmental role:

> It may, for example, be pointless to undertake programmes on new seeds or new agricultural outputs unless there is land reform or reform of tenure systems'. (Singer et al 1970: para 119).

The Manifesto also recognised, albeit very briefly, that 'the way production is organised' reflected political power and interests. Consequently change in the prevailing organisation of production was highly constrained, not least by political power and relationships: 'Such reorganization is a slow process and political constraints may make it difficult to achieve' (Singer et al 1970 para 119).

The Manifesto also noted that questions about the way power and interests shape scientific and technological activities are not confined to areas of economic power and interest– e.g. as above, the distribution of land-holding that shapes the application-effectiveness or orientation of agricultural R&D. They may also arise in ways that are much closer to scientific and technological activities themselves. This perspective arose in connection with the Manifesto's discussion about strengthening science and technology policy institutions. At that point it offered the following caution:

> Science policy institutions must not be allowed to become merely a facade for scientist pressure groups who, under the guise of national commitment, are really mainly interested in getting more resources put into their own field of interest. (Singer et al 1970: para 60)

Perhaps it is not too surprising that the document was rejected by ACAST, the collected representatives of the world's science policy institutions!

### (iv) Access to the technology 'available' in the developed countries

Although the primary focus of the manifesto's qualitative conclusions was about strengthening scientific and technological activities in developing countries, along with their application-effectiveness and development orientation, it also addressed questions about accessing and using the stock of science and technology that was in principle 'available' in the advanced countries. This involved two different issues.

One was about accessing existing knowledge and competences in order to *create new* science and technology. This involved strengthening various kinds of 'coupling' between scientific and technological activities in advanced and developing countries (e.g. training and

R&D collaboration). This was linked to the suggested re-orientation of advanced country science and technology towards development problems and objectives. However, this course of action was seen as a two-edged sword. Although it could play an important positive role, it could also intensify problems associated with both 'external' and 'internal' forms of brain drain. Managing the details of such 'coupling' arrangements was essential to minimise these problems.

The other set of issues were about *acquiring existing* technologies for operational use in developing countries. Here various problems about gaining access were highlighted. On the one hand, much of the relevant technology was seen as proprietary – i.e. owned and often patented by corporations in the advanced countries. If access was possible at all, it could only be acquired on problematic terms – e.g. linked to direct foreign investment, with consequent constraints and difficulties. On the other hand, technology might not be proprietary, but was often available only in highly packaged forms involving high costs.

The Manifesto's response to the second set of problems consisted of several rather unclear suggestions. In part, some of the constraints on access seemed to lie within the developed countries themselves. There was a 'lack of capital and skills' in domestic companies, and this would preclude them either from collaborating with foreign companies or from using imported technology efficiently on their own. By implication, stronger skills and capital resources would reduce such constraints. In part, a solution to access problems was also seen in the somewhat optimistic idea of establishing an international technology transfer bank, perhaps under the auspices of the UN. Finally, another partial solution was seen rather dimly in the domain of S&T policy which should include 'the establishment of policies towards technology transfer'. (Singer et al 1970: para 60). What such policies should consist of was not elaborated. But one key issue was flagged as an important reason for strengthening scientific and technological capabilities for innovation in developing countries:

> In addition, of course, the ability to use transferred technology *as the basis of further innovations* – which is crucial to maintaining competitive efficiency at rising income levels – depends entirely on local scientific capability. (Singer et al 1970: para 20)

If they had elaborated on what they meant by 'policies towards technology transfer', the Manifesto authors might have turned that statement around and argued that a crucially important aspect of wider innovation policy was not just the development of local scientific and technological capability, but part of its explicit application to developing further innovation as a complement to the transfer of imported technology. However, they did not put it quite that way. But we will return to the point later as we review how the agenda of the Manifesto has been met in the subsequent 40 years.

## 2. THE MANIFESTO AGENDA: WHAT HAS BEEN ACHIEVED IN 40 YEARS?

We provide here an outline of the progress made since 1970 with respect to the main objectives and recommendations of the original Manifesto, dealing first with those that were spelled out in terms of quantitative targets, and then with those that were addressed in more qualitative terms. We should stress that we do not attempt to provide a systematic analysis of all these issues over the 1970 – 2010 period. Apart from anything else, limitations in the available data preclude such ambition. Instead we merely try to explore in rough outline form whether subsequent events have moved in the directions sought by the authors of the Manifesto and, where possible, the approximate extent to which they have done so.

## THE SPECIFIC QUANTITATIVE TARGETS FOR THE SECOND DEVELOPMENT DECADE

**(i) Increasing innovative activity in developing countries and changing the global division of innovative labour**

- R&D in developing countries: up from 0.2% of GNP to 0.5%
- Share of global total: up from estimated 2% to about 4-5%

Considerable difficulties complicate the process of comparing subsequent trends of R&D expenditure with the Manifesto's 1970 baseline estimates and targets for 1980.

- The estimates for 1970 were made on a very rough basis with extremely limited data. Consequently, any subsequent differences from that baseline might largely reflect the emergence of better data coverage. However, more thorough estimates are available for 1973 and we use these for the baseline.

- The Manifesto's estimate of the developing countries' share of global R&D in 1970 was based on a global total that excluded the centrally planned economies. Care is needed in taking this approach in later years – though by the 1990s R&D expenditure in the centrally planned economies had fallen to a much lower level and its inclusion makes little difference to the shares of other groups of countries.

- It is not obvious which 'developing countries' should be included in the comparisons in more recent years. Several countries that were 'developing' in 1970 might be considered to have left that category by the later 1990s – e.g. the Newly Industrialised Economies in Asia, and perhaps China. Two kinds of comparative question might therefore be asked. One is about change in the scale of R&D in that *same group* of countries, regardless of whether they are all still considered 'developing'. The second refers to *the same type* of country to those that were 'developing' in the 1970 (i.e. the 'relatively poor' countries). We will try to throw light on both questions by separately identifying a small group of countries that might be thought to have 'graduated' to NIE or High-Income status in later years – or at least partially so in the case of China.

- We have not yet been able to identify data for the late-1970s/early-1980s, so we cannot make a rough assessment of the extent to which the Manifesto target for the Development Decade of the 1970s was met.

- There are numerous inconsistencies and gaps in the data from different sources (and even from similar sources), as well as different approaches to aggregating countries into particular groups.

We address these difficulties in a little more detail elsewhere.[15] Here we make the best we can of the data available and shown in Table 1. However, our comments – and even more the figures in the table – should be taken as only very rough indications of the broad patterns of change.

For all the developing countries of 1970 (Row C), R&D expenditure had risen very sharply from the 1973 baseline by the 1990s, and their share of the global total had trebled by 1990 and doubled again by 1999/2000 - a very substantial shift in the distribution of at least this R&D-centred element of global innovative activity. However, this aggregate picture for this

[15] See one of the other papers for the New Manifesto series: Bell (2009b) *Innovation Statistics and Innovation System Models: Policy Tools and Policy-Making in Developing Countries*. We are grateful to Elisa Arond for assistance in collecting and analysing the data presented here.

group of countries is misleading. The dominant picture is about highly uneven changes among different groups of countries that were 'developing' in 1970.

One group, the selected Asian NIEs and China (Row D) had already overshot the Manifesto target by 1990, and massively so by 1999/2000. They accounted for half of the developing countries' share of the global total by 1990, and for two-thirds by the end of the decade. Behind this path, these countries had GERD/GDP ratios that were about three times higher in 1990 than the Manifesto target of 0.5 per cent for 1980. China was well past it in 1990, and reached 1.0 per cent ten years later. This was an astonishing change given the very rapid growth of GDP during the decade, and it contrasted, for example, with the Indian level that also reached 0.8 per cent by 1990 but stayed roughly constant (0.7 – 0.8 per cent) through the decade.

The share of the global total accounted for by another group, the Latin America and Caribbean countries, had increased substantially by 1990, but then stagnated through the 1990s. Behind this, however, the GERD/GDP ratio of this group had only reached the Manifesto target of 0.5 per cent in 1990 - ten years late; and they had only crept over it to 0.6 per cent after another ten years. But that group is dominated by Brazil with a GERD/GDP ratio of approaching 1.0 per cent by the late 1990s, and the implication is that, twenty years after the end of the 1970s Development Decade, the rest of the group still lagged behind the Manifesto target.

A third group, countries in Africa, had also increased their share of the global total by 1990, though they fell back again during the 1990s. However, African R&D is dominated by South Africa which already had a GERD/GDP ratio of 1.0 per cent by 1990 – a level it has more or less maintained subsequently. The data for the rest of Africa are especially limited, but they suggest that Sub-Saharan countries and the African Arab states had GERD/GDP ratios of around 0.5 and 0.3 per cent in 1990, but that both groups of countries fell back during the 1990s to the Manifesto's 1970 baseline of 0.2 per cent.

Thus, by around 1999/2000 – twenty years after the Manifesto target date – the level of R&D expenditure of 0.5 per cent of GDP had not been reached in large parts of Asia, in much of Latin America and the Caribbean (probably all except Brazil) and in most of Africa (all except South Africa). Fragments of data for subsequent years suggest that little of this pattern has changed, except in India and some of the South East Asian countries. Hence this aspect of the challenge laid down by the Manifesto remains to be met in these countries.

**TABLE 1 GLOBAL DISTRIBUTION OF R & D EXPENDITURE: 1973 to 1999/2000**

| | 1973 | | | 1990 | | | 1999/2000 | | |
|---|---|---|---|---|---|---|---|---|---|
| | GERD | | GERD/ | GERD | | GERD/ | GERD | | GERD/ |
| | US $ Billion[1] | Share % | GDP % | US $ Billion[1] | Share % | GDP % | US $ Billion[1] | Share % | GDP % |
| ***A. Developed Countries[2]*** | ***97.3*** | ***97.1*** | ***2.4*** | ***343.3*** | **83.8** | *2.3* | ***574.8*** | ***76.1*** | *2.3* |
| ***B. (Ex) Centrally Planned[3]*** | (33.0) | (33.0) | (4.3) | *24.6* | 6.0 | - | 21.9 | 2.9 | - |
| ***C. Developing Countries (D) + (E)*** | ***2.9*** | ***2.9*** | ***0.4*** | ***42.0*** | **10.2** | - | ***158.4*** | **21.0** | - |
| ***D. 'Developing' Asia (R&D-Intensive)[4]*** | - | - | - | ***20.6*** | ***5.0*** | - | ***98.5*** | ***13.0*** | - |
| ***E. Other Developing Countries*** | - | - | - | ***21.4*** | **5.2** | - | ***59.9*** | **7.9** | - |
| Latin America & Caribbean | 0.8 | 0.8 | 0.3 | 11.3 | 2.8 | *0.5* | 21.3 | 2.8 | 0.6 |
| Other Developing Asia | 1.8 | 1.8 | 0.39 | 4.9 | 1.2 | - | 32.8 | 4.3 | - |
| Africa | 0.3 | 0.3 | 0.3 | 5.2 | 1.3 | - | 5.8 | 0.8 | - |
| ***WORLD TOTAL*** | 100.2 | 100.0 | 2.1 | **409.9** | **100.0** | **1.8** | **755.1** | **100** | **1.7** |

[1] US $ billion at PPT values

[2] This includes W. Europe, USA, Canada, Japan, Oceania, Israel. For 1973 it also includes the centrally planned economies of Eastern Europe and the USSR.

[3] For 1973 this is 'Eastern Europe (including USSR). For later years it includes the CIS (Europe) countries and the Central and Eastern Europe

[4] This includes China and a group of 'newly industrialised Economies. But no explanation is provided in the source about the composition of the latter. The group presumably includes Korea, Taiwan, Singapore and Hong Kong. It is not known whether it also includes e.g. Thailand and Malaysia.

[5] This Excludes South Africa in 1973, but includes it for 1990 and 1999/2000

Sources: For 1973 the data are from Annerstedt (1979), *A Survey of World Research and Development Efforts: The Distribution of Human and Financial Resources Devoted to Research and Experimental Development in 1973,* OECD Development Centre and Roskilde University Centre, Roskilde, Denmark.

For 1990 and 1999/2000 they are from UNESCO Institute for Statistics (UIS) (2004) *Bulletin on Science and Technology Statistics* , Issue No. 1; April.

**(ii) The role of aid and donors**

Support for indigenous S&T capability in developing countries: up to 0.05% of developed country GNP ~ 0.5% of aid;

It has proved extremely difficult to assess the proportion of international aid that is targeted towards S&T or R&D. Various organisations have tried to do so but have been unsuccessful.[16] The classification system used by most donors does not define allocations to S&T or research, usually focussing instead on sectoral categories such as agriculture or natural resources. Farley attempted a survey of the main donors in 2005 (Farley 2005). In addition to the above challenges, she found difficulties in distinguishing between (i) donor spending on R&D carried out by researchers in donor countries and (ii) spending on support for R&D by researchers from and in developing countries. Nevertheless four preliminary comments can be made.

- In the years following the Manifesto, and arguably with a significant causal contribution by it, there was a substantial change in the orientation of S&T-related aid. Until then such aid had consisted almost entirely of S&T activities executed by the capabilities of donor countries for developing countries. Subsequently there was a significant shift towards aid that aimed to strengthen S&T capabilities in developing countries. Led initially by IDRC, the pursuit of this perspective spread quite rapidly, though often only partially, to major foundations and at least some other donors.
- However, donor activities associated with S&T in general, and with strengthening S&T capabilities in particular, have remained heavily locked into a narrow perspective that in effect defines S&T as R&D. For example, Farley (2005) asked donors how they defined their activities concerned with 'knowledge, science and technology for development', and the responses indicated an overwhelming concentration on R&D. In a subsequent longer report on the study Farley examined these activities more closely in four clusters of different types of project. These indicated some involvement in activities that were not exclusively R&D, but these were relatively infrequent and often closely linked to R&D – e.g. linkages between actors within R&D centred innovation systems. (Farley 2007) This apparent scope of donor support for science, technology and innovation activities leaves out a very large area of innovation that is not based on formally organised R&D – both the STS activities supporting R&D that were stressed in the Manifesto, and the much wider range of innovation activities that are not immediately associated with R&D.
- Over the last decade, and much longer in some cases, donors have sought to focus their science and technology-related activities (i.e. largely R&D activities) specifically on objectives concerned with poverty reduction; and the more recent entry of large philanthropic donors has also taken that explicit orientation (See Brooks et al 2009).
- Associated with this has been a pervasive failure to recognise and act upon the fact that very large areas of aid activity are deeply 'technological', even though they may not be classified as such in formal records and surveys. These include donor support for the design, engineering and construction of an enormous range of infrastructure and other projects. These provide a huge array of opportunities for donor support for learning and capability building that stretches far beyond the scope of R&D. The same is true of the potential for donor involvement with strengthening the learning and capability building components of private sector projects – for example via public-private partnerships that focus specifically on those components of larger private sector projects. This potential for learning is largely untapped (See also Bell 2007).

[16] These include the UN Advisory Committee on S&T for Development, the International Development Research Centre of Canada (IDRC), and the 'Like Minded Donors'. On IDRC and the UN CSTD see Geoff Oldham, STEPS seminar, 6/2/2008, available at http://stepscentre-thecrossing.blogspot.com/2008/02/steps-seminar-sussex-manifesto.html) and personal communication, 11/6/2009. See also Farley (2005 and 2006) for a range of donor organisations.

### (iii) Reorienting R&D in the developed countries

R&D in advanced countries on the specific problems of developing countries should be 5% of total R&D

It has also proved extremely difficult to measure the proportion of R&D in developed countries that is devoted 'to the specific problems of the developing countries', and there exists no information about whether this has ever exceeded 5.0 per cent. The underlying problem is conceptual. A very large proportion of the technology that has been brought into use in developing countries over the last three or four decades had its origins, at least partially and usually after a long time lag, in R&D undertaken in the developed countries. But from how far back in time should one include the R&D that contributed to such technology? How much of that technology could be conceptually identified, ex ante or ex post, as having contributed to addressing the 'specific problems' of those countries? Beyond that, who would define these problems of developing countries and on what basis? We therefore offer no view about this aspect of the Manifesto's recommendations[17].

## THE MANIFESTO'S 'QUALITATIVE' OBJECTIVES

### (i) The application-effectiveness of R&D in developing countries

It is important to stress that achieving innovation is far from being the sole purpose of R&D. Other purposes are also important. These cover a huge range – just a few examples would include contributing to the global base of scientific understanding; supporting natural resource governance in individual countries or wider regions; or supporting the public health regulatory activities of government. Nevertheless, our focus here is on innovation, and in this respect there is a substantial basis for believing that much of the R&D in developing countries is relatively ineffective in achieving application in implemented innovation.

Generalisation about this issue is obviously impossible, and there is clearly a large amount of extremely application-effective R&D in various fields across the developing countries. However, numerous academic studies and consultancy reports have accumulated over many years to confirm that innovation-ineffective R&D is common in many R&D organisations and fields across a wide range of developing countries.

Most of the proximate causes of this that were identified in the Manifesto continue to be centrally relevant. For example,

- Enormous teaching loads continue to drive down the effectiveness of R&D in higher education (and probably also the quality of the education itself).
- Weaknesses in the organisation and management of R&D conducted in the public sector remain widespread. These are thrown into sharp relief by the cases where radical reform of organisation and management has substantially raised performance – as in the case of the CSIR in India, for instance.
- Numerous studies have also highlighted the importance of weak articulation of the innovation system associated with centralised R&D in universities and public institutes. One aspect of this weak articulation is the limited effectiveness of connections running 'downstream' from R&D to the application of its results in production.

[17] Though in connection with the orientation of R&D in developing countries, we comment briefly below on part of this issue – the substantial growth of R&D collaboration between developed and developing countries.

- But perhaps more important are the commonly limited connections that run 'upstream' carrying pressures from the demands and needs of producers and consumers in the system, as well as detailed information about the nature of those demands and needs.
- Large amounts of science policy and science/technology planning have usually failed to provide effective technocratic substitutes for such demand-carrying links, even when supported by 'foresight' studies and techno-economic surveys.

In addition, the narrow scope of the STI system that was implicit in the Manifesto recommendations has remained dominant in many developing countries. This narrowness has two aspects.

- One is about *the practice of innovation*, and in particular about the limited range of actors that engage in formal R&D activities. A typical feature of the system in many countries is the very high share of all R&D that is performed on a relatively centralised basis by specialised and usually public R&D organisations – around 60 - 80 per cent, with a correspondingly small share performed by business enterprises. In the NIEs and China, this was also the situation in the 1970s and 1980s, but the proportions have been reversed since then so that they are now similar to the range found in the advanced economies – with around 60 - 70 per cent performed by business enterprises. As elaborated below, there are strong grounds for believing that application-effectiveness is much greater for such enterprise-based R&D.
- The other is about *principles and perspectives* concerned with innovation, and in particular the narrow perceptions of the innovation system that commonly frame large parts of policy for science, technology and innovation. These ideas and frameworks about innovation systems are focused predominantly on relatively centralised, specialised and usually public R&D organisations and, as stressed earlier, this framing of the policy problem gives little or no policy attention to a wide range of actors, types of innovation and forms of knowledge that make major contributions to innovation.

The Manifesto hinted at ways in which these patterns of practice and policy perspectives interacted in constraining application-effectiveness. But they drew largely on evidence about innovation activity that *did not* happen when these conditions were present, though without explicit reference to the narrow scope of the STI system. Now, supported by evidence about what *does* happen when other conditions are present, we know a lot more about these aspects of the STI system. These seem particularly important, and this suggests the need to address somewhat different core issues than only the Manifesto's core focus on strengthening R&D-related innovation capabilities.

One set of evidence about these interactions centres on the dominant organisational basis for R&D.

- The commonly high proportion of R&D that is performed in centrally organised and mainly public institutes combines with the typically high incidence of managerial and organisational weaknesses in such organisations. This combination makes a very large contribution to low application-effectiveness.
- The narrow framing of perceptions about policy for science, technology and innovation in terms of centrally organised and mainly public R&D combines with the large stakeholder community that has interests vested in the large proportion of R&D that is undertaken in that way. This reinforces the persistence of that structure.
- But a growing body of evidence is increasingly persuasive about what happens when R&D and other innovation activities are undertaken on a more dispersed and decentralised basis. The organisation and management of these activities in close contact with production commonly leads to application in innovation – typically via cumulative paths of incremental innovation. This is evident in at least three kinds of situation: (i) when R&D performed in business enterprises, not centralised institutes, is at the heart of the innovation process in both manufacturing and non-manufacturing industry; (ii) when other kinds of non-R&D

capability in business enterprises, especially various kinds of design and engineering capability, are at the heart of the innovation process but largely independent of R&D; and (iii) when farmers and other dispersed private sector actors are directly engaged in agricultural innovation, sometimes via various kinds of 'participative collaboration' with more formally organised and centralised R&D activities.

Another important set of interactions centre on the demand for innovation within the system.

- The narrow concentration of R&D in centralised and public organisations interacts with the common weakness of management and organisation in those kinds of organisation and significantly limits the pressures of demand on R&D that are articulated 'backwards' from producers and consumers.
- The narrow scope of perceptions about policy for S, T & I interacts with the common weakness of technocratic substitutes for 'real' demand-carrying links from producers and consumers, and this combination maintains and reinforces the disarticulation of the system.
- Again however, a growing body of evidence suggests that, when dispersed innovation capabilities *are* strengthened and deepened, they themselves act as both sources and channels for demand pressures on more formally organised and centralised R&D components of the system. This again arises in at least three kinds of situation: (i) when manufacturing and non-manufacturing industrial enterprises begin to engage in R&D-centred innovation, it is these activities and capabilities that generate demands for knowledge inputs from more specialised R&D organisations; (ii) even without formally organised R&D, the innovative activity of industrial enterprises that is undertaken via various kinds of design and engineering constitute both sources of demand for externally sourced knowledge, as well as channels for elaborating and articulating for R&D actors some of the technical details about such demand; and (iii) when farmers and other dispersed actors are directly engaged in various kinds of 'participative collaboration' in innovation, substantial demand pressures can (under the 'right' circumstances) be exerted on more formally and centrally organised R&D activities.

These two sets of interactions highlight the importance of two kinds of important complementarity in emerging STI systems in developing countries.

- First, dispersed innovation capability that is deeply embedded in production activities is an important complement to centralised R&D in 'supplying' innovation – both (i) by absorbing, elaborating and further developing the innovations outputs from the latter, and (ii) by innovating independently of centralised R&D. In other words, it is change in *the structure and composition* of scientific, technological and innovation capabilities and activities that is important on the supply side of the system - not just, as suggested in the original Manifesto, the stronger articulation of linkages between the components that exist.
- Second, dispersed innovation activities that are deeply embedded in production activities are also an important demand side complement to centralised R&D. Without the demand pressures that are created and articulated by these activities, the centralised and formally organised part of the supply side is substantially less application-effective than it might otherwise be. Again, aspects of the *structure and composition* of activities and capabilities are important in linking demand to actual and potential supply-side capabilities – much more than the technocratic planning processes discussed in the Manifesto.

Thus, when developing countries focus their STI policy efforts primarily on fostering the development of 'narrow' and centralised systems, they are walking on only one innovation leg. By failing to develop, strengthen and mobilise the innovation supply and demand capabilities and roles of much more dispersed and decentralised parts of the system as fully as would otherwise be possible, they are foregoing a large fraction of the potential innovation impact that might be

achieved by walking on two innovation legs. The consequence of this circumstance of 'walking on only one leg' is likely to be a *rate* of innovation that is much lower than might otherwise be achieved. That leaves open questions about the *orientation* of STI activities.

### (ii) The orientation of S&T activities in developing countries

As noted earlier, the original Manifesto was concerned about two aspects of the orientation of R&D and of scientific and technological activities. One was about the degree of orientation towards the problems and aims of developing countries, rather than those of the advanced economies. The second, somewhat less clearly, was about the degree of orientation towards the problems of 'development' - as seen in terms of a Furtado-Seers-Singer-type view of intra-country inequality and poverty being at the heart of the structural conditions of under-development.

There is no systematic evidence about the extent of either kind of orientation in contemporary developing countries, and hence only very general and speculative comment is possible. We concentrate such comment on the intra-country orientation towards issues of distribution and poverty, leaving questions about international orientation and 'internal brain drain' until the later section about accessing international science and technology. We consider two perspectives.

On the one hand, there is a considerable body of evidence that might be deemed to suggest that there is considerable 'inappropriateness' in this aspect of orientation. This falls into four categories.

- First there exist a number of studies of R&D programmes and projects that indicate a failure to address explicitly or effectively the needs and interests of poor people, sometimes despite having that general intention.
- Second, looking at the 'other end' of the problem, it is quite evident that the needs of poor people, in particular the socio-economic groups that are the focus of the MDGs, are not being met – though one must be extremely cautious about inferring that much of this failure can be ascribed to a mis-orientation of scientific and technological activities *per se*.
- Third, a number of studies make it clear that there are very few effective mechanisms and channels by which the needs and interests of poor people have come to constitute effective non-market demand that impinges on decision-making about the orientations of R&D and of innovation more generally.
- Fourth, as in 1970, it is fairly clear that there exist widespread social, economic, institutional and political conditions of the type that are likely to preclude a significant orientation of science, technology and innovation towards the needs of poor people.

On the other hand, the last decade or so has thrown up an increasing body of information showing that, in at least some developing countries, the orientation of scientific, technological and innovation activities in developing countries has changed significantly towards lower income groups in society. This is evident in the growing incidence of innovation oriented towards the needs and interests of low income groups –for instance, (i) innovation aimed at people with annual incomes in the region of $1,500 'at the bottom of the pyramid' (Prahalad 2006) (ii) 'cost innovation' undertaken by Chinese enterprises for low income domestic and export markets (Zeng and Williamson 2007) or (iii) the highly publicised examples from India like Tata's Nano automobile or Hindustan Lever's consumer products.

This evidence of a growing re-orientation of innovation is clearly *not* making a significant contribution to meeting the needs of the lowest income groups. An annual income of US$1,500 and above is a long way from a dollar a day; and the customers for Tata's Nano are far from falling into the socio-economic groups that are the focus of the MDGs. Indeed, it is precisely because large numbers

of people are *emerging from* the lower levels of poverty to constitute significant potential markets that innovation is being re-oriented towards their needs and interests.

But the evidence of this re-orientation *does* still have considerable relevance to concerns about innovation and the extremes of poverty and mal-distribution. This is because it demonstrates the flexibility of innovative activity in response to the pressures and stimuli of effective demand. It thus highlights the potential importance of finding much more effective ways to transform the needs and interests of the poorest groups in society into effective, though not necessarily market mediated, demand, and to connect those demands much more effectively to the supply side of innovative activity. In effect, the kind of re-orientation of innovation towards demand from emerging middle-income groups in some developing countries is an encouragement to go further than has so far been realised, or could be realised, by 'bottom-of-the-pyramid-type' commercial market processes. This further step is about finding other means of more fully democratising the demand for innovation – bearing in mind the common past failure of technocratic proxies and substitutes for such demand.

**(iii) Necessary conditions for application-effective and development-oriented innovation**

As noted above, it is clear that there still exist on a widespread basis in developing countries the kinds of social, economic, institutional and political conditions that the authors of the original Manifesto thought likely to preclude both (i) relatively high levels of application-effectiveness on the part of existing R&D and other innovation activities, and (ii) significant orientation of such innovation activities towards issues about inequality and poverty.

However the majority of studies that have illuminated how the presence of these conditions shape the rate and direction of innovation have concentrated on international/global conditions. In particular, much attention has been given to the ways in which international structures of power may shape innovation activity in developing countries - e.g. via (i) WTO-related governance arrangements associated with globalisation and the Washington Consensus, or (ii) the persistence of trade policy regimes for the protection of agriculture in advanced countries.

Among the studies of intra-country conditions, most attention has been given to the kinds of managerial, organisational and policy-related conditions that the authors of the original Manifesto described as merely the more proximate causes of both application-ineffectiveness in general and limited orientation towards needs and demands arising from poverty more specifically. Much less attention has been given to the kinds of conditions and contexts that the Manifesto discussed in terms of the structural characteristics of the 'organisation of production' (e.g. those concerned with the distribution of income and land ownership). Even less has been given to the significance of political structures and process that shape those aspects of the organisation of production, and hence both the rate and orientation of innovation.

Also, as far as we are aware, there has been no systematic analysis about the role of power and interests that may have more *direct* influences on the directions of innovation – for example, about the extent to which, in the words of the original Manifesto, science policy institutions have become merely a facade for scientist pressure groups who, under the guise of national commitment, have really been mainly interested in getting more resources put into their own field of interest.

Consequently we can provide little by way of a summary of systematic contemporary understanding about whether there have been significant changes since the time of the original Manifesto in the ways that economic structure and associated patterns of power and interest shape the rate and orientation of innovation in developing countries. In particular therefore, we can offer little comment about the extent to which there exists room for policy manoeuvre between the fairly evident

patterns of policy described earlier and the political constraints that would preclude significant change in those patterns.

### (iv) Access to the technology 'available' in advanced countries

As noted earlier, the original Manifesto addressed two groups of issues under this heading. One was about accessing existing knowledge and competences in order to create new science and technology. The other was about acquiring existing technologies for operational use. We follow that structure here.

## ACCESSING KNOWLEDGE AND COMPETENCES TO CREATE NEW SCIENCE AND TECHNOLOGY

There is a growing body of understanding about this issue in connection with collaboration between developing and advanced economies in activities towards the 'science-end' of the spectrum. The evidence seems to suggest: (i) a considerable increase in such collaboration (as reflected for instance in joint authorship of scientific papers), (ii) the involvement of a widening range of developing countries, but (iii) the persistence of developing countries as relatively marginal participants in the even more rapidly expanding collaboration networks of scholars from advanced economies (Wagner 2008)[18].

Thus, except in a small number of specialised areas and despite the growth of collaboration involving developing countries, there remains a huge global imbalance in the global production of science; and, if one identifies the Asian NIEs as having moved out of the 'developing' category, that imbalance may not be much less than it was in 1970. Consequently, as noted by Wagner, there remains a global challenge about 'establishing the right balance between the goals of equity (which favor distribution) and those of knowledge creation (which in many cases favour concentration)' (2008: 78).

This tension arises in a specific form in connection with major initiatives by some of the major donors (e.g. the grand challenge strategy of the Bill and Melinda Gates Foundation), or donor-supported policies to develop 'centres of excellence' in S&T in Africa (See Brooks et al 2009; Leach and Waldman 2009). In such situations, the tension seems to be seen as inevitably involving a zero-sum trade-off, with the balance often going to the apparent imperatives for knowledge creation and hence concentration. In practice though, there are opportunities to incorporate capability-building elements within such initiatives that would lay a stronger basis for wider distribution in the longer term without compromising the aims and targets for knowledge creation in the shorter term.

Almost certainly there also remains the more general 'two-edged sword' problem that the Manifesto noted with respect to strengthening international collaboration in science – the possible combination of (i) considerable gains in terms of access to knowledge and skills, plus (ii) the orientation of research towards problem areas that are of primary interest to the advanced countries, and hence the strengthening of what was described as the 'internal brain drain. Although Wagner (2008) notes examples from Vietnam and Uganda where efforts were made to establish local priorities and interests as the basis for selecting cooperation opportunities, we are not aware of any broad assessment of the extent to which increasing international collaboration in science is leading to 'inappropriate' orientations of science in developing countries. The same kinds of question about two-edged swords arise in connection with more technology-centred business collaboration in R&D in developing countries. But they too remain unanswered despite fragmentary comment.

[18] Caroline Wagner has described these and related trends as features of what she calls the 'New Invisible College'.

## ACQUIRING EXISTING TECHNOLOGIES FOR OPERATIONAL USE

From one perspective, the original Manifesto can now be seen to have been massively pessimistic about the developing countries' prospects for access to the stock of technology in the advanced countries. Over the last 40 years there has been an enormous flow of such technology in a wide variety of forms – embodied in the hardware of machinery and equipment exported from advanced economies; embedded in very large international flows of consulting, design and engineering services; carried in the form of designs and specifications made available for use via licensing agreements; and moved as human capital via an enormous variety of training arrangements.

Although they have been more limited that one might wish for in an ideal world, local capital and skills have obviously in many cases been adequate to acquire, absorb and use these massive technology flows. Also, contrary to an expectation in the Manifesto, access to vast areas of this technology has not always been tied to inward FDI. Indeed, FDI has been a relatively minor conduit for these flows. For example, annual flows of inward FDI to developing countries in the mid-2000s accounted for only around 10 per cent of their gross fixed capital formation. In other words, they managed to acquire technology for about 90 per cent of their investment outside the framework of FDI – with a significant part of that being acquired as imported technology.

However, from another perspective, developing countries' experience with the acquisition of technology from the advanced countries has fallen far short of one of the hopes and recommendations of the Manifesto authors. This is about the employment of innovation capabilities in developing countries as a complement to the use of transferred technology, so that the latter became a basis for further localised innovation. This was an allocation of scientific, technological and more general innovation capabilities that the Manifesto described as being 'crucial to maintaining competitive efficiency at rising income levels'. However, this important aspect of science, technology and innovation policy has been only rarely pursued and implemented effectively.

This approach to policy was pursued aggressively and fairly pervasively in the industrialisation of the NIEs like Korea, Taiwan and Singapore, and also more recently and less pervasively in substantial segments of industry in China. In all these cases the approach was necessarily implemented in large part at the level of the dispersed organisations that were importing the technology. But it was promoted and financially supported by policy initiatives. Such complementarity between technology imports and local innovation typically involved two interacting dimensions. One centred on ensuring that the *process* of importing was explicitly organised to ensure that it contributed to the strengthening of innovation capabilities in the importing organisation; the other centred on ensuring that subsequent use of the technology went beyond merely routine operation of the 'given' technology so as to include cumulative innovation and improvement (See Bell 2009a: Annex 1).

But in most other developing countries this approach has been much more idiosyncratic and intermittent, and rarely the subject of explicit policy initiatives. The development of a dynamic and creative engagement with technology has more commonly been left to emerge slowly, sparsely and sporadically, and the two dimensions of innovation-centred interaction with imported technology have not been pursued aggressively with active support from policy – neither (i) using the process of importing technology as an important vehicle for strengthening innovation capabilities, nor (ii) ensuring that continuing innovation is the central feature of using what was earlier imported.

This is therefore an important area where the insights of the 1970 Manifesto remain as important now as they were then, and possibly more important. Fostering the development of a technologically dynamic complementarity between technology imports and local innovation is a matter of considerable significance - for several reasons.

- It is an important basis for raising *the rate* of innovation and productivity growth – not just labour productivity, but also rising efficiency in the use of capital, materials and energy.

- It is an important basis for changing *the orientation* of science, technology and innovation over the longer term, and then moving as rapidly as possible in the new directions.
- It is an important basis for overcoming constraints on access to more advanced technologies (e.g. some of those associated with the life sciences) in which intellectual property plays an increased role – either via collaboration as an accepted and contributing partner in development, or by innovating around patents and other obstacles to access.

The original Manifesto suggestion that an international technology transfer bank should be established has not been heeded, at least in the particular form suggested. However, a number of initiatives since 1970 have attempted to perform a role similar to that proposed in the Manifesto, i.e. to further facilitate access to (sometimes patented) technology in the 'advanced countries'. Some of these have been concerned with agricultural technology.[19] There have been more general efforts, largely carried out under the auspices of the United Nations Conference on Trade and Development (UNCTAD) to facilitate access of technologies and knowledge to the developing world. In the 1980s, these efforts even included international negotiations around an agreement on technology transfer, however these efforts failed. More recently, international agreements such as the Clean Development Mechanism (CDM) (under the Kyoto Protocol) have introduced mechanisms to facilitate developing countries' access to specific technologies that can mitigate or recover emissions of greenhouse gases (See Ockwell et al 2009). While the CDM has resulted in a number of projects that have reduced greenhouse gas emissions in developing countries, there are still significant questions around its effectiveness in facilitating access to aspects of technology other than the artefacts themselves. A focus on the transfer/royalty-free licensing of intellectual property in some cases detracts from the wider and more difficult problem of building local innovation capabilities that will enable the technologies acquired from elsewhere to be employed, adapted and improved in local settings. Rather than generalised policies for technology transfer, therefore, more emphasis needs to be placed on specific capabilities, resource endowments, industrial structures and other conditions in individual developing country settings (including sub-national levels), as part of a more tailored approach ensuring greater complementarity between imports and the development of local innovation activities (as discussed above).

## 3. CONTINUING AND NEW CHALLENGES WITHIN CHANGING CONTEXTS

The above section analysed changes in science, technology and innovation policies and practices with respect to the context and goals of the original Sussex Manifesto. Forty years on, the worlds of innovation and development have evolved beyond recognition. We live in a highly interconnected and privatised world characterised by increasing homogenisation, combined with ever-greater interdependence. Environmental change, exemplified by anthropogenic climate change, presents the world with perhaps its most urgent new challenge, but also perhaps its least tractable based on traditional approaches of political decision-making. We have witnessed unprecedented advances in science and technology and the emergence of new centres of innovation activity, which cause us to begin to question traditional power structures in the governance of innovation systems. This section compares the context of today with that of the original Manifesto and asks what challenges a new Manifesto for today's world will need to address? In many cases we are seeing the re-emergence of similar debates to those that raged 40 years ago. In others, new and radical responses are called for.

[19] Technology transfer to the developing world has been supported by the CGIAR/Future Harvest Centres, and more recently by NGOs such as CAMBIO.

## CONTINUING POVERTY AND INEQUALITY

The first page of Amsden's (2001) book *The Rise of the Rest* distinguishes those 'backward' countries that 'had acquired enough manufacturing experience…' by the end of World War II '…to move into mid-technology and later high-technology sectors' ('the rest') from those 'that had been less exposed to modern factory life in the prewar period' and 'failed thereafter to achieve anywhere near "the rest's" industrial diversification' ('the remainder'). However, these distinctions focus on industrialisation and international competitiveness and neglect, or at best are only indirectly related to problems of poverty, inequality and social justice. It is these problems that are central to notions of 'development' as highlighted (along with employment) by Seers (1969) at the time of the original Manifesto, and more recently by Sen (1999), who has emphasized the underlying objectives of reducing deprivation and broadening choice. These more fundamental freedoms – to choose pathways towards livelihoods that are economically, socially and environmentally sustainable[20], have more recently been adopted to varying extents by parts of the UN system.

A large number of countries classed as 'developing countries' by the Sussex Manifesto[21] have since been reclassified under the current UNDP rankings either as countries of 'high human development' (e.g. South Korea, Kuwait, Mexico) or as 'medium human development' (e.g. India, Kenya, Honduras), and thus the North/South divide that framed the original manifesto is no longer valid (if indeed it ever was).[22] Despite these improvements, however, the prognosis at the beginning of the 21st Century presents numerous continuing challenges. Alongside some successful efforts to reach the Millennium Development Goal targets set by United Nations in 2001 a recent report suggests that the first goal addressing absolute poverty will not be reached:

- The proportion of people in sub-Saharan Africa living on less than $1 per day is unlikely to be reduced by the target of one-half;

- About one quarter of all children in developing countries are considered to be underweight and are at risk of having a future blighted by the long-term effects of undernourishment (UN 2008)

In addition to continuing high levels of deprivation, there exist multiple forms of evidence demonstrating that, both internationally and within (some) countries, inequality (of income) remains severe.[23] Poverty is not confined to Africa or Asia, but also exists (in varying forms) in Europe and the USA. Kaplinsky (2008) has attempted to provide an economic framework for understanding the dimensions of equality/inequality as linked to innovation, which includes inter-class, inter-sectoral, inter-generational, gender, temporal, and geographical dimensions.

Reducing relative poverty therefore extends far beyond the concerns of the Millennium Development Goals. Further to the immediate need to halve extreme poverty there is a (perhaps less urgent but still valid) need to promote sustained rises in incomes beyond the level of one or two

[20] The STEPS Centre's approach recognises different framings of "sustainability" as well as pathways through which they can be obtained, and focuses on identifying and promoting conditions under which poor people are better able to define and follow their own pathways to sustainability (See Leach et al 2007).
[21] This category included all countries outside the OECD and the Soviet block.
[22] This distinction between 'high', 'medium' and 'low' is based on differences in the country's human development index, calculated on the basis of a life expectancy index, education index and GDP index. A list of the groupings is available at http://hdr.undp.org/en/statistics/ (1 June 2008).
[23] Given the numerous dimensions of inequality, it does not make sense to characterise it in one single measure (therefore allowing a statement of overall trends), however various approaches lead to the conclusion that global inequality is huge, and likely growing. See, for example, discussions of the numerous methods of measuring and tracking changes in inequality covered in Held, D. & Kaya, A. (Eds) *Global Inequality*, Washington D.C.: Polity.

dollars per day to a level providing for variously defined livelihood needs of poorer people in different parts of the world. Necessarily, this entails a rethinking of 'development' to include progressive change towards social justice, in order to aid in the alleviation of poverty (both absolute and relative) wherever it may be. At a time in which science, technology and innovation are more central than ever to processes of wealth creation, a New Manifesto must adopt as a general objective the more equitable *distribution* of the benefits from innovation, both at the level of individual countries and between them.

## RESOURCE USE, ENVIRONMENTAL CHANGE AND THE CHALLENGES OF SUSTAINABILITY

Despite their relative absence from the original Sussex Manifesto, environmental challenges were increasingly being recognised as a global concern by the late 1960s. Indeed, at around the same time that the Sussex Manifesto was being drafted, a group of academics were being invited by The Club of Rome to produce a study that was to be published as *The Limits to Growth* (Meadows et al 1971). The authors used their World3 model to suggest that the rate of depletion of the world's resources under existing patterns of industrialisation necessitated an alternative to the growth paradigm. In response to this, researchers from Sussex criticised the evidential basis of the models and highlighted the absence of political and technological change in the book's predictions. They argued that:

> Some types of growth are quite consistent not merely with conservation of the environment, but with its enhancement. The problem, in our view, is a socio-political one of stimulating this type of growth and of more equitable distribution, both between countries and within them. (Cole et al 1973)

This focus on the content of growth – the composition of inputs (including primary resources) and outputs (including waste products) – has since risen greatly in its salience (See Arrow et al 1990).[24]

Questions around the desirability otherwise of growth/no-growth, even though they might have been caricatured as a sterile debate of the 'Tweedledum-Tweedledee variety' by the authors of *Models of Doom* (Cole et al 1973), have also continued to this day. They were recently resurrected in a report by Professor Tim Jackson for the UK's Sustainable Development Commission, which states categorically that 'the truth is that there is as yet no credible, socially just, ecologically sustainable scenario of continually growing incomes for a world of nine billion people' (Jackson 2009: 57). Pointing to the need to 'protect capabilities for flourishing' and to 'respect ecological limits' but most importantly to 'build a sustainable macro-economy', Jackson argues that 'for the advanced economies of the Western world, prosperity without growth is no longer a utopian dream. It is a financial and ecological necessity' (Jacson 2009: 12).

In addition to resource use and its intensity, the 1970s saw commentators and governments pointing increasingly to the negative environmental effects of certain industrial processes and technologies. Rachel Carson's book *Silent Spring* (1962) had appeared several years earlier, questioning much of the technological progress witnessed in the agricultural field in the USA. In parallel to the discussions around the *Limits to Growth*, scholars such as Commoner (1972) were focussing on 'ecologically faulty technology', to describe 'most of the technological displacements which have accompanied the growth of the United States economy since 1946,' as 'the new technology has an appreciably greater environmental impact than the technology which it has displaced; and the postwar technological transformation of productive activities is the chief reason for the present environmental crisis'. Today, national and international policies to limit pollution are

[24] The focus on patterns of resource throughput and minimising environmental impacts has more recently been supplemented by a recognised need to protect the resilience of ecological systems (See Arrow et al 1990).

commonplace, however we continue to be plagued by uncertainties, especially in the long-term, regarding impacts from new substances. The recognition of the uncertainties intrinsic to innovation have been reinforced by the lessons from persistent organic pollutants, halogenated hydrocarbons and other pollutants, and have led to various notions of 'precaution', including in international law (EEA 2001). A New Manifesto must address the fact that emerging technologies, including those referred as nanotechnology, synthetic biology or geo-engineering are now scrutinised not only on their potential benefits and risks, but also on the basis of their unknown and in some cases unknowable impacts both to the environment and societies.

## PERENNIAL BUT RE-EMERGING CONCERNS OVER ENERGY, FOOD, WATER AND HEALTH

Debates around supply and sustainability in the specific domains of energy, food, water and health have resurfaced periodically since 1970, however are currently enjoying a rise in political salience due to mounting evidence indicating their urgency both individually and in combination.[25] As sectors fundamental to poverty alleviation and environmental sustainability, they perhaps deserve special mention.

Energy, in various forms, is necessary to human survival and forms the basis for industrial and economic development (see Ockwell et al 2009). Whilst many finite resources may be substitutable under conditions of scarcity, a number of studies, largely from the field of ecological economics, have suggested the limits of substituting primary energy inputs (see Ockwell 2008 for a summary), and empirical studies point to specific difficulties of decoupling economic growth and energy use on the basis of energy efficiency improvements (see for example Sorrell 2007). In addition, many of the approaches to reducing resource use intensity (including recycling and industrial ecology approaches more broadly) will require still further energy inputs. The contribution of emissions from fossil fuel-based energy generation therefore means the transition to low-carbon energy systems is perhaps central to the global innovation challenge for the New Manifesto, and clearly illustrates the importance not merely of the rate or scale of innovation, but of the *direction* in which innovation (and the systems within which it occurs) must develop.

Aggravated by the changing climate, food shortages in recent years represent another perennial, but re-emerging problem for a New Manifesto. Whilst hunger still remains a vital issue across the world, the context has changed dramatically since 1970. The original Sussex Manifesto followed ten years after the establishment of IRRI, the first research centre of the CGIAR (Consultative Group on International Agricultural Research). The same group now numbers 15 and in 2004 accounted for some 34 per cent of all public agricultural R&D expenditures for developing countries (Millstone et al 2009). The demands on agriculture in today's world are being driven by a host of new challenges and trends, not limited to: increasing prosperity among huge populations, especially in Asia, demanding a higher (meat) protein diet; decreases in biodiversity; a rise in agro-fuel production, as countries search for alternatives to fossil fuels; a shortage of land as urban centres expand and populations continue to increase (which is contributing to the acquisition of agricultural land overseas by land-poor, capital-rich nations); the need to move away from carbon intensive production models; reduced diversity in an increasingly concentrated international food system; and the urgent need to manage food safety risks associated with existing and emerging zoonoses or new agri-food technologies and practices.

These food challenges interact closely with the perennial problem of water, again aggravated by the changing climate, as current debates focus on the need to obtain more 'crop per drop'. As the

[25] The UK Chief Scientist John Beddington has estimated that demand for energy and food will rise by 50% and fresh water by 30-40% by the year 2030. At the 2009 'Sustainable Development UK' Conference, he referred to these problems in combination with climate change as a 'perfect storm', http://news.bbc.co.uk/1/hi/uk/7951838.stm (21 June 2009).

background paper by Movik and Mehta (2009) demonstrates, while the MDGs frame the problem around the need to provide 'safe' access to the billion people on the planet who still lack it, broader issues around 'watsan' (water and sanitation) have tended to be neglected, and recent changes raise fundamental questions within the sector. International privatisation in what was, at the time of the original Sussex Manifesto, largely a public service, again raises questions over whether water should be seen as a human right or an economic good. A focus on the scarcity of water, addressed largely by technocratic approaches typical of Integrated Water Resources Management (IWRM), calls for enhanced irrigation infrastructure (including large dams), neglecting some of the social and institutional aspects of water management. Meanwhile, sanitation (in 2007 voted the greatest medical advance in the last 166 years in a poll by the *British Medical Journal*) is often neglected in international debates, with continued, severe implications in many parts of the global South for health, another sector vital to poverty alleviation.

Since the Alma Ata Declaration in 1978, which aimed to provide 'health for all' in a post-colonial world (WHO 1978), debates about the role of technology have mirrored many of those in the original Sussex Manifesto, moving from a 'transfer of technology' to an 'indigenous innovation' approach. At the same time, discussions have moved from a focus on state-led healthcare to a recognition of private and other NGO actors in wider health systems, with a blurring of the public and private in many cases. Broader changes have made the contexts acting on health innovation more diverse and more complex. Access has improved, and some of the successes in health continue to fuel debates around population that took place not long after the time of the original Sussex Manifesto (Holdren and Ehrlich 1974). At the same time, demographic changes and diseases of affluence and old age in some parts of the world are creating new economic and social challenges, especially for future generations. New channels for knowledge flows around health mark another change with direct implications for innovation. The responses to these new trends among international organisations have been multiple, but have included an increased move towards international 'grand challenge' initiatives (see Brooks 2009) (also seen in other sectors) in which huge amounts of money are invested in identifying and developing technologies seen as having an extremely wide potential for application, and an urgent need. Contrary to this trend of centralisation in the public/philanthropic domain is the spread in the sources of innovation and production of health products within firms, including to areas of the world in which regulations are less well-established. These last two issues raise questions about the governance of innovation, which are returned to in the next section of this paper.

The many challenges above may in some cases have been present (although in many cases unrecognised) at the time of the original Manifesto, however they existed within a very different social and technological context. The next two sections describe aspects of the international context of science, technology and innovation that must be catered for in a New Manifesto for 2010.

## CHANGING GOVERNANCE CONTEXTS: THE GLOBAL ORGANISATION OF SCIENCE, TECHNOLOGY AND INNOVATION

A further major contextual change since the 1970s concerns the increasing importance of the multi-country and global levels at which decisions around science, technology and innovation are taken and actions implemented. This trend towards global interconnectedness refers both to public institutions, private foundations and also the corporate sector, each with their own implications.

### Internationally Organised Science, Technology and Innovation (STI)

At the time of the original Sussex Manifesto, most important policy decisions about STI in the advanced countries were taken at national levels or 'below'. With the exception of partially global, supra-national decision-making about nuclear technology and limited co-ordination around defence-related R&D (e.g. within the NATO military alliance), the vast majority of issues involving STI

were addressed at the level of national governments. This was also the case in the field of 'development-related' STI. Key issues were largely discussed in terms of the aims and problems to be addressed by developing countries, and national governments were seen as the key actors in taking decisions about how those aims and problems were to be addressed, about how organisations should be created and strengthened to do so, and about how resources should be allocated to serve that purpose. This national-level perspective was implicitly embedded in the Manifesto. The key STI issues were discussed very broadly in terms of 'the developing countries', and it was fairly evident that the central 'audience' for the key messages in the Manifesto were country-level policy makers – with the supplementary audience of the UN being called on to play a supporting role. It was at the national level that political decision-making and co-ordinating structures, as well as systems of accountability were arranged.

Of course there were international dimensions. Multilateral agencies like UNESCO and bilateral donors played a role in the emerging domain of S&T (and occasionally 'I') for development, but they played that role primarily with respect to individual countries and in supporting and advising national governments. The work of UNCTAD, established in 1964, also impinged on the world of STI through its focus on trade. However the actual degree of international co-ordination, and indeed international law governing multilateral trade and other relations was, in 1970, still relatively limited in comparison to today.

By 1970, the international foundations were playing an increasingly significant role. For example, the problem of constraints on food production and impending famine had been identified in global terms that spanned beyond individual countries. Correspondingly, the Rockefeller Foundation had already taken steps to respond in terms of STI-related action that was organised on a 'proto-global' basis via its research centres in the Philippines (International Rice Research Institute - IRRI) and Mexico (International Maize and Wheat Improvement Center - CYMMIT). As a result of the first of these, for example, a 'globally applicable' technology - IR8 - had been created at IRRI and was already in use in rice production in countries that spanned across large parts of Asia. The application of that approach gathered pace – for example, as the global-level 'formula' was applied to medical technologies (e.g. the smallpox vaccine) and new aspects of agricultural production (e.g. generic aspects of tropical or semi-arid tropical agriculture, or to particular crops such as potatoes). The associated search for further 'globally applicable' innovation responses led to the emergence of a new set of R&D institutes with global missions (e.g. International Centre for Tropical Agriculture - CIAT, International Crops Research Institute for the Semi-Arid Tropics - ICRISAT or International Potato Centre - CIP), and a new form of organisation was brought together to provide overall governance at a somewhat more global level (the Consultative Group on International Agricultural Research - CGIAR). These efforts were largely government and foundation-funded, and did not need to rely significantly on private intellectual property.

Multinational corporations, some of which had evolved from colonial trading companies and banks, were major players by the 1970s, but displayed less potential for global reach and co-ordination than they do currently and largely worked in collaboration with their home governments to exert political pressure overseas. Although some of these firms possessed technologies otherwise unavailable to other actors, the extent to which technological capabilities and intellectual property were concentrated within the private sector was small in comparison to today.

**Current Initiatives – Global Problem Framings and Global Co-ordination**

At the supranational level, there has over the last decade been a renewed phase of efforts to identify and address development problems as framed at a global level and to organise STI-related responses to these on a correspondingly cross-country and/or proto-global basis. This has involved supranational (including UN) organisations, separate groupings of national governments, philanthropic foundations, non-government organisations and collaborations between them. In

parallel, the ability of multinational firms to organise their STI activities globally has increased fundamentally, and the increasingly private nature of innovation (largely as a result of globally harmonising intellectual property regimes) has reduced access to certain technologies in the absence of partnership with these private sector actors.

It is important to stress, however, that the connection between identifying and addressing a problem on a global basis and organising STI-related action on a similarly global basis is not always direct and clear-cut. In some cases, e.g. agriculture, where significant institutional innovations have emerged since the 1970s (and indeed beforehand) to co-ordinate agricultural R&D at the international level, the centralisation of data-gathering, problem-framing and decisions around research investment have in many cases served to exclude the perspectives of the millions of (primarily women) farmers who are looking for locally-specific innovations compatible with current livelihood practices (See Millstone et al 2009). It is also evident that the focus provided by several of the specific MDGs has prompted, or at least reinforced, global (or perhaps only proto-global) innovation activity – e.g. some of the health-related initiatives, grand challenges and the like being pioneered by the Bill and Melinda Gates Foundation, in many cases working in partnership with multinational pharmaceutical firms. In other cases, global co-ordination of innovation responses may not be evident at all. The case of sanitation perhaps illustrates the emergence of cross-country/global treatment of a development 'problem', but without a correspondingly global implementation of innovation responses. While public health in the global North benefited from the 'sanitation revolution' more than one hundred years ago, a similar revolution has not occurred in many countries in the South.

Global co-ordination in this and other areas has been piecemeal at best, and where it has emerged, has focussed on centralised science-led innovation at the expense of locally-embedded organisational forms that are capable of delivering diverse solutions built additionally on situated knowledge of local contexts.

**Current Governance Contexts and Challenges for a New Manifesto**

Governance contexts for STI have evolved substantially since 1970. In terms of public investments, the focus of political decision-making around S&T remains largely located at the national level, with conventional means for democratic scrutiny adopted as a means for ensuring that S&T investments addressed societal concerns. Within this context, however, leading scientists in their fields (through the peer-review process or as government advisors) have often been afforded a disproportionate degree of influence, considering their unelected status (see Jasanoff 1990).[26] At least in terms of R&D expenditure, the propensity for debates to be captured by an unelected scientific elite, diverting resources away from alternative forms of innovation more conducive to societal goals is as much an issue now as it was in 1970.[27] Now as much as ever there is a need to 'broaden out' the inputs to such decision-making processes in order to bring in other perspectives and avoid capture (Stirling et al 2007). While there have been efforts to further democratise policy-making around STI,[28] since the 1970s, political rhetoric at national and regional levels still downplays the open-endedness of the decisions involved around the *directions* of technological development and the essentially political

[26] In the UK, for example, the 'Haldane' principle assigns responsibility to scientists rather than politically accountable decision-makers for selecting research projects for public funding. In the USA, expert advisors have risen to hold unprecedented levels of responsibility for decision-making around S&T, and governance arrangements have had to alter in order to accommodate this shift (Jasanoff 1990).

[27] The original Sussex Manifesto stated that 'science policy institutions must not be allowed to become merely a façade for scientist pressure groups who, under the guise of national commitment, are really mainly interested in getting more resources put into their own fields of interest' (Singer et al 1970: paragraph 60).

[28] Within the representative democratic paradigm, we have witnessed the establishment of parliamentary select committees dedicated to S&T (e.g. UK). Some governments have also established organisations to experiment with participatory democratic approaches to decision-making around STI, such as the Danish Board of Technology Assessment. See also Van Zwanenberg et al (2009) background paper in this series.

nature of which *directions* might be promoted (see Stirling 2009). As public funds are limited and subject to competing claims, an openly negotiated, politically accountable approach to their allocation in the field of STI is in many ways a prerequisite to their effective use. The most basic first step in this regard (still absent in many countries) is improved transparency around expenditures on different areas of research and development (national defence as opposed to health or environmental challenges), however beyond this, a much more radical reconfiguration of the relationship between scientific experts, policy-makers and publics has been advocated.[29]

Mechanisms for anything resembling democratic governance in either non-profit, or profit-oriented spheres of international STI have either been absent or very slow to catch up with the trends towards international interconnectedness and co-ordination. National level governments remain the only level of organisation that is formally accountable for delivering public goods (and only then to current generations of their domestic electorate, rather than to those groups who might be thought of as the 'beneficiaries' of such goods e.g. populations suffering from neglected diseases in developing countries, or future generations at risk from global climate change).[30]

Furthermore, as new technologies of an increasingly pervasive nature emerge as international responses to globally-framed problems, the potential for unintended negative consequences cannot be neglected. For private and public actors alike, mechanisms for assigning liability in the event of such damage, and providing redress for those affected, are largely absent. Whilst international regulations[31] and arrangements for risk governance[32] are emerging, these continue to lag behind the upstream research process and focus on improving risk assessment for the appraisal of existing technologies. This occurs at the expense of a) developing systems that provide equitable compensation for negative impacts of which we may be ignorant at the time of introducing the technology, and b) guiding R&D in directions that reduce the potential for such ignorance or build system robustness and resilience in the event of shocks or stresses linked to technological risks.

We can predict that globally shaped and globally implemented STI-based responses to such globally framed problems will continue to emerge in the coming decades. Among the drivers for this are the global interconnectedness of food systems and the shared effects of climate change as it increasingly disrupts existing and already inadequate arrangements for meeting water needs. A New Manifesto will have to address these shifts towards global problem framings and the emerging organisational arrangements through which responses will be co-ordinated. Lessons from the past must be drawn upon in order to create organisational structures that serve broad sustainability goals into the future. In particular, several broad features of past approaches seem important – and worthy of question – in a New Manifesto.

- First, the forces and arguments for *centralised* decision-making and action-implementation have prevailed over forces and arguments for *localisation* within 'global' frameworks. The

[29] In Europe, for example, see the work of the European Expert Group on Science and Governance, in particular the 2007 report *Taking the European Knowledge Society Seriously*, downloadable from the European Commission Science and Society website at: http://ec.europa.eu/research/science-society/index.cfm?fuseaction=public.topic&id=119

[30] Similar arguments have previously been put forward in relation to foreign aid more generally – see Easterly, W. (2006) "The White Man's Burden: Why the West's Efforts to Aid the Rest Have Done So Much Ill and So Little Good" Penguin Press HC.

[31] The obvious example is that of the WTO Agreement on Sanitary and Phytosanitary Measures, however this does not provide for trans-boundary liability or redress following unintended negative impacts from technologies. Within a more circumscribed technology-specific field, the Cartagena Protocol on Biosafety to the UN Convention on Biological Diversity, is attempting (thus far unsuccessfully) to devise international rules for liability and redress following the trans-boundary movement of genetically-modified and living modified organisms.

[32] Amongst the many trans-national initiatives aimed at harmonising and improving risk governance, the work of the International Risk Governance Council (www.irgc.org) provides a good example.

perceived importance of 'co-ordination', 'non-duplication', scale-economies, close interaction among specialists, etc. has dominated. In contrast, the emerging understanding of the last decade or so about the role of geographic and organisational proximity between needs/users/markets and innovation actors has had limited impact.

- Second, the forces and arguments driving action towards *singular and generically applicable* kinds of innovation action have prevailed over forces and arguments for *diversity and multiplicity in solution-seeking*. From IR8 in the 1960s to malaria vaccines in the 2000s, the perceptions of particular kinds of problem or need have been shaped in ways that narrow down diversity and displace local solutions. This has led particular classes of technical 'fix' to be identified as the preferred innovation response – those that are scalable, generically applicable, etc (see Brooks et al 2009).

- Third, partnerships between national governments, international foundations, supranational bodies and multinational firms, whilst presenting a potent force for the mobilisation of technologies towards globally-framed problems, are still in urgent need of evolving *mechanisms for accountability*, both in terms of governing the *allocation of resources* to specific kinds of initiatives (beyond a reliance on technical expert judgements to respond to the needs of beneficiaries as defined by themselves) and in terms of *assigning liability and responsibility for redress* in the event of potential negative impacts of technological interventions.

## EMERGING TECHNOLOGIES AND ASSOCIATED OPPORTUNITIES FOR RADICAL RECONFIGURATIONS

Alongside changes in governance structures, a New Manifesto cannot ignore the impacts already witnessed as a result of new technologies and their potential transformative effect on each of the challenges listed above.[33] Much of these effects are associated with the deployment of information and communication technologies (ICTs), which were only beginning to emerge at the time of the original Manifesto.

The impact of ICTs in enabling the transfer of capital and information worldwide has undoubtedly increased the *rate* at which innovations have emerged in the past four decades. In reducing barriers to the transmission of codified knowledge, they may also have influenced the *directions* of innovation.[34] However, ICTs have also played a wider role in creating networks for positive social change. They have further potential for linking up disparate sources of innovation addressing similar goals in geographically separated socio-techno-ecological contexts[35] as well as linking micro-entrepreneurs with investors[36], producers with markets and providers with their families - all affording significant possibilities for poverty alleviation. The activities of independent electronic

[33] Geoff Oldham, for example, highlighted the potential roles for new platform technologies (information technology, biotechnology and nanotechnology) as an issue for a New Manifesto (Geoff Oldham, STEPS seminar, 6 February 2008, available at http://stepscentre-thecrossing.blogspot.com/2008/02/steps-seminar-sussex-manifesto.html).

[34] The poverty-alleviating contribution of mobile telecommunications in connecting rural producers to markets and allowing remittances from distant earners has been widely celebrated. But even despite the introduction of cheap handsets, mobile infrastructure and $100 laptops, discussions of the 'digital divide' remain. The aggregate positive/negative distributional impacts of various ICTs remain questionable.

[35] These functions are illustrated by the 'Innocentive' initiative's pavilions on food and agriculture, health, clean technology and renewable energy, public good and citizens in action, as well as their collaboration with the Rockefeller Foundation.

[36] This model has been pioneered by kiva.org

media in gathering unofficial information in times of crisis[37] or in holding regimes and (branded) corporations to account also presents opportunities for forcing increased transparency, and E-governance initiatives raise the possibility of enhanced democratization of decision-making. Lastly, ICTs can facilitate the dynamic marketisation of externalised costs (as illustrated by the rapid expansion of emissions markets for $CO_2$), potentially serving to drive investments in more environmentally sustainable technologies.

Beyond the success stories above, the more systemic (equitable and sustainable) impacts of ICTs will be contingent upon the governance regimes under which they develop. And in other emerging technologies – including nano-, bio-, synthetic bio-, etc., a New Manifesto must pay attention not only to the opportunities they present but also to the potential for winners and losers. Promotion of open approaches to innovation rather than privately appropriated models[38] will be key to widening the potential benefits of such technologies. Such approaches do, however, raise new challenges for risk regulation. New governance arrangements, including novel approaches to technology foresight and precaution, will be needed if emerging technologies are to contribute to the New Manifesto's goals of poverty reduction, environmental sustainability and social justice.

## 4. A NEW AGENDA FOR SCIENCE, TECHNOLOGY AND INNOVATION

The key role of the application of science and technology to international development was recognised by a number of other documents and actions from the same era as the original Manifesto[39], however the Manifesto's arguments, discussed in section 1 above, were absent from many. In addition, largely due to the 'structural factors' mentioned as constraints in the original Manifesto, some of the quantitative targets and many of the organisational changes it advocated were not fulfilled. Based on the discussion in section 3 above, it is clear that the international community must now redouble its efforts to take forward these arguments. The changed context in which we find ourselves also requires us, however, to modify and supplement them with a new agenda in order to address the interlinking, global objectives of poverty reduction, environmental sustainability and social justice.[40] It is important to be realistic about both the potential *and* the limits of STI in forwarding these goals. While this document focuses on these areas of policy, and tries not to stray into broader structural questions, we also recognise the importance of an extended view of innovation, including organisational, institutional and behavioural change. Thus the framing of the New Manifesto will be wider than the *science and technology policy* focus of the original.
Each of the challenges mentioned above (including the sector-specific issues related to energy, food, water and health) require the reconfiguration of entire socio-technical systems, therefore it is at the system level that we concentrate here (much the same as was implicitly the case in the

[37] As exemplified by the Kenyan www.ushahidi.com website or the work of the independent media centre/ indymedia network.
[38] Compare, for example, the open source initiative of the Biobricks Foundation (http://www.biobricks.org/) with the patenting approach of the not-for-profit Craig Venter Institute (http://www.jcvi.org) or the proprietary technologies of LS9 (http://www.ls9.com/) in synthetic biology.
[39] Including the founding of the Intermediate Technology Development Group (ITDG, now Practical Action) in 1966; UNCTAD-II meeting, New Delhi, 1968; M. Merhav (1969) Technological Dependence, Monopoly and Growth (New York: Pergamon); World Plan of Action for the Application of Science and Technology for Development 1971; IDRC – International Development Research Centre established 1970; UNCTAD-III Meeting, Santiago, Chile 1972; 'Science, Technology and Development: The role of the UNDP', paper prepared for the Advisory Panel on Programme Policy by C.H.G. Oldham, A. McKnight, R. Turner & J. Townsend.
[40] Geoff Oldham also points to globalisation, the increased importance of market economies, the growth of S&T capabilities in emerging economies and the potential roles for new platform technologies (information technology, biotechnology and nanotechnology) as additional new issues for a new Sussex Manifesto (Geoff Oldham, STEPS seminar, 6 February 2008, available at http://stepscentre-thecrossing.blogspot.com/2008/02/steps-seminar-sussex-manifesto.html).

original Sussex Manifesto).[41] These reconfigurations will need to reshape both supply and demand influences on innovation, and its contribution to development. At this system level, the STEPS Centre identifies three characteristics of innovation and development that require more conscious attention than has previously been afforded them if the above challenges are to be met:

- *Directionality* – rather than restricting policy consideration to questions over the pace, efficiency and distributional consequences of innovation in any one particular direction, focus is needed on the nature of the directions themselves – and on multiple alternatives.
- *Distribution* - distributional issues present important criteria against which large-scale directions for change might be judged. Appraising alternative directions can enhance the scope for addressing crucial issues around the distribution of risks, burdens and benefits from particular innovation and development pathways.
- *Diversity* - This provides a crucial means to: preserve context-sensitivities in a world of globalisation, harmonisation and standardisation; hedge against uncertainties associated with different options; foster more resilient and robust systems; enable accommodation of otherwise irreconcilable perspectives in plural societies; and counter and ameliorate concentration, momentum and lock-in in the dynamics of development and innovation.

Each of these will be discussed in more detail in the following section and in Stirling (2009), which, in addition to reflecting on the relevance of the original Manifesto, discusses some of the changes to be advocated in the new one.

## PROMOTING A 3D AGENDA FOR INNOVATION AND DEVELOPMENT

### (i) Directionality

Whilst productivity growth was the primary objective of development in the original Manifesto, subsequent decades have shown that whilst perhaps easy to measure, growth is lacking as an indicator of 'development', which refers to a host of other (necessarily plural and contested) priorities. The role for innovation in the current context is not merely to drive economic growth, but rather to contribute to objectives of development and sustainability, as defined by different actors, at different levels. This may include economic growth (at least in the least productive economies), but prioritises those forms of growth which are more equitable in their distribution of benefits and risks (see below for a discussion of *distribution*), and which are environmentally sustainable. The emergent *directions* of innovation have a significant bearing, along with many other factors, on the forms of development that transpire, including their material and social characteristics.

The UN Commission on Sustainable Development has produced indicators for sustainable development. Most recently, the third edition (published in 2007) contains 96 indicators, including a core set of 50 (UN 2007).[42] Notions of Sustainability are themselves subject to different framings based on actors' existing endowments and local contexts, perspectives and priorities, and are therefore not necessarily reducible to measurement by these types of indicators. Nevertheless, for

[41] Building on a broad body of literature, research in the social sciences currently points towards ideas such as socio-technical transitions (Geels, F.W. (2005) *Technological Transitions and System Innovations: A Co-evolutionary and Socio-Technical Analysis*, Cheltenham: Edward Elgar) or 'transformative innovation' (Stewart, F. (2008) *Breaking the Boundaries: Transformative Innovation for the Global Good*, NESTA) as ways to understand how these reconfigurations may occur.

[42] These are organised under the themes of 'poverty' (including but not limited to equality of income distribution), 'governance'(including levels of bribery and crime), 'health', 'education', 'demographics', 'natural hazards', 'atmosphere' (including $C0_2$ emissions), 'land', 'oceans, seas and coasts', 'freshwater', 'biodiversity', 'economic development' (including but not limited to GERD as a percentage of GDP), 'global economic partnership', and 'consumption and production patterns' (including but not limited to materials intensity and energy intensity of the economy).

policy makers' purposes, such output indicators (when appropriately informed by democratic negotiation) play an important role in guiding policy, especially when counterposed against an otherwise dominant focus on economic growth.
Whilst previous efforts have to varying extents neglected such debates of *direction*, current challenges highlight the need for mechanisms to re-direct innovation towards diverse societal goals in the short and longer term by drawing on a multitude of alternative directions of innovation. Part of this process will involve the promotion, protection and nurturing of grassroots innovations that contribute at a local level to broader sustainability objectives, thus looking beyond the traditional sources (and types) of innovation to community-led initiatives and behavioural change. To the extent that it will engage with wider governance arrangements, the Manifesto must propose those forms that facilitate the emergence and flourishing of such bottom-up approaches, eventually challenging (unsustainable) system regimes.

Thus at a more qualitative level, beyond the re-orientation of specific S&T efforts towards the problems of the developing countries (as highlighted in the original Manifesto), here we additionally refer to a re-direction of innovation and development in a way that fosters Sustainability objectives at system levels. This therefore requires attention not only to the incremental improvements that may occur as a result of the introduction of individual innovations, but the appreciation that innovation and development directions are constrained or reinforced by interactions between social, technological and environmental (amongst other) factors – including via processes variously explored in the academic literature as 'social shaping', 'homeostasis', 'autonomy'; 'momentum', 'lock-in', 'alignment' and 'entrapment'. The extent to which these processes can be predicted in detail or guided by any one actor is still debated, but their existence, and the need to afford them greater political attention, is clear.[43] In some cases they may play an important and necessary role in supporting new, desirable directions of innovation, whilst in others they may inhibit the emergence of new pathways to sustainability. The role of *diversity* (including the importance of enabling a number of different technological pathways) in mitigating the potential negative aspects of these processes is discussed further below.

Whilst extending our focus to *direction*, it is necessary to recognise the continuing relevance of the rate or scale of innovation. Firstly, without any rate or scale, *direction* is necessarily absent; therefore it is necessary to kickstart innovation in those contexts where it is extremely slow or of insignificant scale.[44] Secondly, when technological regimes are known to be environmentally damaging or wasteful of resources, the rate at which innovation can contribute to their replacement with more environmentally sustainable alternatives is vitally important.

### (ii) Distribution

Complex questions about policies to deliver growth and redistribution of income within countries were discussed in the ILO 'Employment Mission' studies in Colombia, Ceylon and Kenya.[45] Particularly in the Kenya study, led by Hans Singer and with key participation by Charles Cooper (both of whom were involved in the original Manifesto), emphasis was placed on the significance for urban and rural groups of the prevailing directions of technological change and their possible alternatives. A similar discussion has been ongoing over the contexts in which 'trickle down' might or might not emerge to reduce poverty under different forms of import-subsitution policy.
The Sussex Manifesto mentions income *distribution* and market scale as a constraint for many developing countries: 'the available technology emphasizes production on a large scale whereas the

[43] For a more detailed discussion on directionality in innovation, see Stirling (2009) background paper in this series.
[44] It is important not to confuse this with situations in which the innovation that is taking place is not easily identified or measured e.g. various kinds of informal, grass-roots, farmer-led or other user innovation.
[45] See Bell (2009a) *Innovation Capabilities and Directions of Development,* background paper in this series for further discussion on this topic.

initial markets of developing countries (even including their realistic export markets) are usually small in economic terms' (Singer et al 1970: para 43). The document emphasized that through creating specific patterns of demand, inequality itself, both at a national and global scales, serves to drive directions of innovation, not just the other way round. Increased attention to *distribution* is therefore important not only in the traditional arena of income redistribution, but also in policies focussing on science, technology and innovation, at national and international levels.

As noted above, more equitable *distribution* of benefits from innovation is only part of the story. Whilst neglecting to focus on the environmental impacts resulting from new technologies, the original Manifesto also remained relatively quiet on the *distribution* of potential *risks* of new technologies, aside from a discussion of the impacts of synthetic substitutes on the economies of developing countries' reliant on the natural resources which they displaced (Singer et al 1970: para 44-46). Subsequent years have seen great progress in social studies of risks from science and technology, with a general recognition that now, at least in the developed countries, the distribution of risks has become one of the organising themes within society. (Beck 1992) Especially in discussions around emerging technologies, where knowledge around potential negative (as well as positive) impacts is uncertain and contested, the distribution of risks both within and between countries warrants more attention than it has attracted to date.

### (iii) Diversity

Along with directionality and distribution, another characteristic of innovation and development that did not appear strongly in the original Manifesto, but currently deserves greater policy attention is *diversity*. In a world of increasing attention to globalisation, harmonisation and standardisation, diversity provides a means to preserve crucial context-sensitivities – whether these are geographical, linguistic, cultural or social-psychological. There are several reasons for including diversity in socio-techno-ecological systems as an objective for innovation policy: it can contribute to accommodating plural values and sustainability/development priorities; mitigate against undesirable lock-in in socio-technical systems and contribute to continuous innovation, thus hedging against ignorance and fostering system robustness and resilience.[46]

The political and institutional processes that shape how particular framings of system dynamics and goals come to dominate are key to considerations of *directionality*, *distribution* and *diversity*, and to the New Manifesto. A vital contribution to opening these processes to involvement by a wider constituency, including the poor and marginalised, can be made by consciously extending the focus of policy to address broader forms of 'innovation' within a more comprehensive notion of the 'innovation system' than that traditionally adopted in government policy. This extends the message of the original Manifesto, which advocated attention to institutions outside the formal R&D system, and the connections between them.

## WIDENING THE POLICY FOCUS OF 'INNOVATION' AND 'INNOVATION SYSTEMS'

### (i) Redefining innovation?

The definition of innovation traditionally used by economists dates back to Josef Schumpeter. Whilst invention has in the past been thought of as 'an idea, a sketch or model for a new or improved device, product, process or system', this has traditionally been conceptualised by economists as becoming an 'innovation' only on the point of application, when it leads to a commercial transaction and the invention is actually exploited to lead to economic change (Freeman and Soete 1997). The New Manifesto requires a broader definition that recognises innovations that contribute to poverty alleviation or environmental sustainability (with or without an associated economic change). These

[46] 'Robustness' and 'resilience' here are understood as used in Leach et al 2007: 6.

may emerge through open-source collaborations which do not involve monetary exchange or from inventions that reduce costs that are currently external to the economy (e.g. waste/emissions reductions that are not reflected in economic change).

### (ii) Widening the policy conception of the innovation system – the key role of incremental innovation and diverse forms of knowledge

On the basis that 'The government sector accounts for most remaining scientific and technological activities in developing countries' (Singer et al 1970: para 67 (b)), the original Manifesto focussed on the inadequate scale of innovative activity that was organised around central, publicly-funded activity (in R&D and S&T services). Rather than highlighting R&D in state or donor-funded laboratories delivering radical innovations, a large body of research has subsequently pointed to the importance of incremental innovations in delivering gradual increases in productivity, in firms and not-for-profit institutions, between them (in production/supply chains), and at the level of national systems. In the industrial sectors, these have largely emerged through improvements in innovation capabilities associated with engineering and design (see Bell 2009a).

Positive, incremental innovation (rather than that directly accessed from outside) has also played an important role in African agriculture (Ochieng 2007). The vital contribution of formal education and other ways of building innovation capabilities can allow farmers to experiment with existing agricultural knowledge, tools and practices in different ways, incrementally improving productivity or other characteristics. Francisco Sagasti has argued that '... more than three-quarters of the world's population relies on indigenous knowledge to meet their medical needs, and at least half relies on traditional knowledge and techniques for crops and food supplies. As about one-third ... does not have access to electricity, all modern technologies and production activities that depend on this source of energy are out of their reach.' (Sagasti 2004: 54). Policies therefore need to address the fundamental role of informal types of knowledge in providing a basis for incremental innovation, and to focus on promoting the complementarities and potential synergies between these and more formal (science and technology-based) knowledge.

### (iii) Complementing technology imports with indigenous innovation

A basic sub-component of the widening of attention in innovation policy takes place at the international/national levels and involves increased attention being paid to the development of technological capabilities in developing countries in order to allow indigenous innovation, rather than a focus on their access to innovations emerging from elsewhere. This was one of the central messages of the original Sussex Manifesto but is still yet to translate into some of the mainstream reports on science, technology and development even today (see Bell 2009a). The complementarity of indigenous and imported innovation needs to be re-emphasized in today's context as it enables directions of innovation to be set in response to local needs, thus potentially providing a more equitable distribution of benefits from that innovation. In addition, stronger local innovation capabilities can help to increase technological diversity within and across international borders, both through generating new technologies locally and through allowing local traditional knowledge to be used and connected to other innovative activities, rather than simply being outcompeted by imported technologies.

Rather than assuming that technology imports (e.g. through foreign direct investment) automatically deliver knowledge flows and build local innovation capabilities, a key role for innovation policy is to maximise the potential flow of skills and experience so that local actors can not only continue to use foreign imported technologies but also adapt, develop and improve them within the local context. This is discussed in greater detail in Martin Bell's (2009a) paper in this series *Innovation Capabilities and Directions of Development*.

The New Manifesto must incorporate lessons in this area that have emerged since the 1970s and, in providing guidance to governments in developing countries, emphasize the importance of building local capabilities that are complementary to technology imports.

### (iv) Enabling bottom-up/grassroots innovation to flourish

At least in some sectors there has been an increased recognition of the role of entrepreneurs, groups and networks developing niche innovations that either respond to local needs (for which markets are small) or global needs (for which markets are absent or at least not economically viable due to externalised costs within the current economic system) (Smith 2004). The role of these grassroots or sub-altern groups in bringing new technologies and practices into dominant socio-technical regimes is vital.

As illustrated by lessons from studies of agricultural innovation in the 1970s and 1980s, farmers in developing countries play a major role in the production and adaptation of innovations. Rather than being passive users of the technologies, they in fact consciously shaped them for their own benefits. In line with the increasing attention that has been paid recently to 'user innovation' in the information technology and other industrial sectors (Von Hippel 2005) there is a general need for the inputs of those traditionally conceived of as the end of the chain to be strengthened and supported. Networks to promote learning, exchange and use of local knowledge between grassroots innovators as well as to protect their intellectual property from exploitation from outside have an important role to play.[47] In many cases, this will require new and different ways of allocating venture capital. Bottom-up innovation can also be facilitated by various micro-credit models (including those mediated by the internet) for small-scale entrepreneurs.[48] More generally, the need to widen the attention of policy so that it reaches the grassroots requires a political commitment to protect and nurture these forms of innovation, sometimes in the face of powerful economic interests.

### (v) Organisational and behaviour change as innovation

Lastly, there needs to be an appreciation of organisational and behavioural change (rather than just innovation in the form of products and services, as was the focus of the original Manifesto) as an important contributor to poverty alleviation and environmental sustainability objectives, including but not limited to its impact on market demand (e.g. through 'ethical consumerism').[49]

Organisational innovations, creating new networks, incentive structures and practices have been shown to have had important impacts in industry but are still largely under-appreciated in innovation policy in the public and private sectors. The urgency of the energy and climate threats mentioned above is driving communities to self-organise to produce 'energy descent action plans' in preparation for forthcoming declines in fossil fuels, leading to urban experimentation with approaches such as car clubs and local sustainability planning (Seyfang 2009). The New Manifesto must point to the now common appreciation of these organisational innovations for system transitions, and the role that governments can play in facilitating learning, networks as well as integration of sustainable practices with conventional approaches (Smith 2007).

Beyond the messages of the original Sussex Manifesto, the question for today's context, therefore, is how public policies and governance arrangements can act to strengthen these wider components of the innovation system, and to ensure the complementarity between the more established areas of government interest (formal R&D, public sector institutions and firms) and those fields traditionally

[47] See for example the activities of the Honeybee Network.
[48] See for example Kivo – a web-based microcredit initiative.
[49] For a discussion relating to behavioural change in the energy field, see for example Martiskainen and Watson (2009).

conceived as further 'downstream', whose contribution is now increasingly recognised. Firstly, this involves increased attention to, and inclusion of a wider range of actors than previously apparent (including firms, industry and labour groups, technical experts from multiple disciplines, but also civil society and individuals with experiential, 'lay' knowledge and a direct stake in the forms of innovation that emerge) in innovation governance. Secondly this involves an understanding and appreciation of the multiple networks and models through which innovation is organised and emerges, especially those not driven by traditional market demand.

## THE DRIVERS FOR 3D INNOVATION - CONVERTING NEEDS INTO DEMAND

The original Sussex Manifesto stressed that 'the "need" for science and technology may only be perceived if one takes a long-term, perspective view of development because many R and D projects take a long time to give results' (Singer et al 1970: para 117). In developing countries, the Manifesto argued that such 'perspective planning methods' to identify 'needs' must be 'used in much greater detail than is normally done'. Extending from this is the requirement for policy tools to convert *needs* into *demand* acting on innovation, whether through planning (as was the focus of the original Manifesto), market or other mechanisms.

Within the current structure of the capitalist economies, STI investments respond to markets' ability to pay, rather than to potential utility for users. This necessarily leads markets to allocate insufficient resources to STI serving the most urgent needs of the poorest. As well as the absence of any utility-weighting in aggregate demand, investments are most likely to serve large, homogeneous markets, generating a bias against heterogeneous local conditions in which many poorer individuals live and work. In addition, costs externalised within existing economic systems (such as those associated with the production of greenhouse gases) lead to market failures, which are linked to an absence of investment in STI to mitigate the generation of public 'bads'. Based on these arguments, it is clear that mechanisms must be identified and experimented with to convert *needs* not provided for in current systems into *demands* that act to steer innovation in more sustainable and poverty-reducing directions. Ideally these would be systemic rather than based on one-off initiatives, however as here we are not engaging with debates over the desirability or otherwise of current forms of capitalism, we are limited to discussing models that can work within current structures.[50] To this extent, it may be worth focussing on the roles that governments can play in affecting market demand, the role of other actors in affecting non-market demand (and driving innovation through other ways), and the potential contribution that the STEPS Centre can make in making recommendations around these activities.

### (i) The role of government policies in affecting prices and altering market demand

Significant contributions to driving innovation towards specified development or sustainability objectives (as measured by indicators at a system level) can be induced by a change in relative factor prices, as originally proposed by Hicks (1932) in his *Theory of Wages* but more recently demonstrated empirically with respect to changing resources (e.g. energy) prices (Jaffe et al 2002; Vollebergh 2007), or environmental policies to internalise currently externalised costs. An example would be the fundamental contribution to incentivising a transition towards lower carbon socio-technical systems that would be provided by a global price on carbon emissions, for which the Copenhagen talks later this year are of paramount importance. Beyond taxes or standards, other economic tools at governments' command, which may be used to incentivise innovation serving

[50] Whilst it is difficult to imagine an alternative economic system under which utility is maximised, components of systemic changes to foster environmental sustainability might include an international transition towards a no-growth, knowledge-based economy focussed on contraction, convergence and dematerialisation, incentivised by a dynamic system that assigns costs to material (factor) inputs *and* to waste outputs in a way consistent with their respective scarcities and the public 'bads' associated with their use.

poverty-alleviation needs, include advanced market commitments, government purchasing practices or, in relation to patented products, laws for compulsory licensing or differential pricing (which themselves further access to, rather than incentivise investments in 'pro-poor' technology *per se*).

However, these economic drivers for change are not enough, given the urgency of the problem. As pointed out in Rosenberg's early discussion of 'inducement mechanisms and focusing devises' in sha ping the direction of technological change, economic incentives are an underdetermining factor, with specific directions also constrained by prior technological change (Rosenerg 1969). More recent lessons from studies of socio-technical transitions point to broader changes that are needed in order for system transitions to occur (including cultural, industrial, scientific, and technological changes as well as those relating to market preferences, policy and governance reforms). In addition, they highlight the importance of bottom-up innovation and the accumulation of sustainable green niches (Smith and Seyfang 2007) in reconfiguring dominant regimes. The central message from this literature is not necessarily one of specific policies, but rather of governance arrangements or approaches to policy-making.

### (ii) The role of charitable foundations and aid in creating non-market demand

The choices (e.g. around funding priorities for research) of non-profit organisations, charities, philanthropic foundations and other donors have a direct impact on the ways in which needs for innovation are brought to bear on innovation actors via non-market mechanisms. Here, the processes through which needs are connected to decisions about innovation are extremely attenuated by the multiple levels and functional specialisations in the overall organisational arrangement for centralised action and decision-making. The demands of clients and 'users' of the innovation process gain little traction on decisions about the types of innovation undertaken and the kinds of solution that are sought. Even if connected channels existe between needs and decisions about innovation activity, they typically run through multiple stages of interpretation and specification at which various kinds of interest group and 'expert' perceptions impinge on the communication and articulation of the basic signals about needs. Consequently, as discussed above with respect to globally co-ordinated STI initiatives, the 'appropriateness' of the directions of innovation pursued within such global innovation arrangements has frequently been questioned. In particular, such questioning has commonly centred on the extent to which the directions are adequately oriented towards poverty reduction at the lower end of the income distribution.

The reliance on expert assessments of need, whilst serving an important role in prioritising between different claims on limited resources, may make assumptions about, or downplay the importance of value differences between different beneficiaries. Especially where sums to be invested are large, e.g. in prize funds, advanced market commitments, etc., quantitative assessments of quality-adjusted life years or alternative measures of benefit are often used to compare the expected returns on different investments. Closing down on unitary measures of value in this way necessarily downplays the different kinds of (incommensurable) benefits that can be obtained from supporting a diversity of investments, representing a limitation in the outputs of such assessments. Alternatively, scientists may be asked to make decisions about which high risk research to fund based on their own personal judgements as to its utility and chance of success.[51] In either case, the focus on knowledges 'upstream' in the innovation system and the relative absence of innovators, users and other stakeholders in the decision process can present a weakness. As such, it is necessary both to broaden out the inputs to appraisal of such STI options, and to open up their outputs.

[51] See for example an interview regarding the high risk ventures funded by BMGF. http://www.scidev.net/en/features/q-a-tadataka-yamada-and-wild-science-ideas.html

### (iii) Broadening Out and Opening Up Appraisal Approaches to Promote 3D Innovation

The STEPS Centre defines social appraisal as 'social processes through which knowledges are gathered and produced to inform decision making and wider institutional commitments', such as policies or investments around science, technology and innovation. Appraisal of different options for linking needs to demand requires *reflection* – drawing on numerous knowledges in order to understand the systems in which institutional commitments are to be made, and *reflexivity* – an acknowledgement that any body of knowledge thereby constructed in appraisal will be conditioned by the ways in which it has been produced (Stirling et al 2007). In general, rather than closing down on unitary forms of knowledge and perspectives on value, '3D' innovation can be facilitated by an opening up of the knowledges included, the perspectives engaged, the methods employed, the options compared, the effects considered and the uncertainties explored in appraisal. Although these approaches may seem more burdensome than simple aggregative, quantitative techniques, they are necessary for addressing the challenges of sustainability and development, and for providing accountability to beneficiaries and wider publics around the directions of innovation set by powerful actors.

While these appraisal approaches are relevant in certain instances, in the majority of cases, choices over policies by government, let alone innovation investments or activities by individuals in firms or on farms are not subject to formal forms of appraisal but are made up instead of 'innumerable decisions about technology' which 'are inseparable from similarly innumerable actions' (Bell 2009a). In these instances, the contribution made by the New Manifesto needs to focus on the above-mentioned frameworks to drive innovation in more desirable directions, and on governance arrangements and conditions set by policy that empower those responsible for these innumerable decisions and actions to determine their own pathways out of poverty.

From the discussions in sections 1-3 above, we can see that the original Sussex Manifesto was in many ways a document before its time. Many of its central messages are as pertinent today as they were 40 years ago, and the benefits of following its recommendations are evidenced by the changes that have taken place in certain parts of the world. Other aspects of its analysis and prescriptions are still relevant in addressing new challenges associated with a changing global context and new emerging threats. However, these also need to be extended, adapted and supplemented with an agenda including *directionality*, *distribution* and *diversity*, as described in section 4 above. Obviously, the institutions through which these ideas might be put into practice will vary based on the context in which this takes place, and new lessons will be learned along the way, leading to reconsideration and improvement of these proposals. In an increasingly dynamic world, it is far easier to look back over 40 years of history than to project the continuing relevance of the Sussex Manifesto, or its extension to encompass a 3D agenda, 40 years into the future.

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