# 6 } Flow!

## New Design Paradigms for the Innovation System

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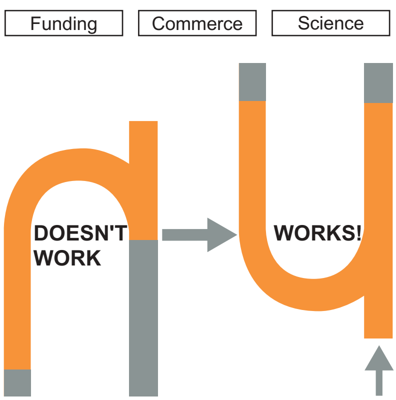
***"Sometimes it pays to simply turn the system around……***




***…. but turning the system around carelessly makes it a messy job "***

### 6.1 } BEFORE WE START

This paper has been written following an invitation by the working group Dynamising the Knowledge Chain, as part of the 'Innovation Platform' instituted in September 2003 by the Dutch government. The working group has been asked to formulate recommendations to make the Dutch knowledge chain more dynamic. One of the mayor obstacles in achieving this is the so-called 'knowledge paradox': The Netherlands has a strong position in building public-domain knowledge, yet largely fails to convert this source of wealth into economic prosperity.

The request put forward to a number of individuals consulted is to come up with 'zero-base' recommendations with respect to necessary transformations in the innovation system. 'Zero-based', for the purpose of this paper, has been interpreted as 'a green-field start; not hindered by history, existing institutions, established policies, etc '.

As always, transformations are concerned with two, separate but related, questions:

1} Where to get to?
2} How to get there?

Logic suggests that the first question should be addressed before the second question becomes of interest. Knowing 'how to get to the wrong destination' isn't very helpful. So this paper addresses predominantly the first question.[1] This implies that many issues remain un-addressed in the contents of this paper. These issues are those that will ultimately determine whether the recommendations of this paper, with respect to system design, can and will be implemented; issues that concern the determination to change, and the power to face the strong vested interests that keeps the system locked in it's current state. However important the insights in the determinants of the 'new system' may be, day-to-day practice shows the importance of the second question. There is no point in dreaming about 'the station beyond reach'. Adjusting the fine details of the current system might well be easier, and, in the short term more rewarding.

I have chosen however to take the difficult road, for the following reasons:

} Over many years, attempts have been made to improve the dynamic performance of the current system. Positive results, which can surely be claimed, however seem to fall short of the required impact on the economy as a whole, and therefore the wealth-creation required for future sustainable competitive advantage in the international arena.
} The overwhelming majority of the input to the Innovation Platform will most likely address improvements to the current system (while maintaining its basic foundations). Just another paper, and from a source less qualified to do so, will yield little added value to the platform and the working group.
} My particular field of expertise concerns the organisation of (business) systems facing extreme heterogeneity and unpredictability in their environment, and the properties of emergent systems.

'Emergent systems' is the identifier for systems that are: (business, organisational, etc) sets of interactive agents that can create meaning, coherence and continuity for themselves and their environment, by adaptation and renewal, without central planning and control.

The underlying assumption of this paper is that the innovation system is (or has largely become) such a system. I will address the reasoning behind this assumption in more detail in paragraph 2. Assuming the validity of this assumption however, it is unlikely that the organisational methods and instruments that are suitable in a predictable and rather homogeneous world are adequate to understand, design and govern modern innovations systems.

***'It takes more than a small spanner to undo a large rusted bolt: large bolts require large spanners!'***

Hence, the need was (as I have interpreted it) to come up with radically new thoughts for the future of the Dutch innovation system. And that's what you get. I aimed to write not a scientific paper, but a paper that is accessible to everyday policymakers and institutional governors. For more background and theory, see the literature listed (Attachment II).

## 6.2 } WHAT'S THE PROBLEM?

The central issue, as defined by the working group, is 'how to turn the knowledge chain, from fundamental research to marketing, into a smoothly running system'. More specifically, it defines 'smoothly' as:

- Excellence in scientific research.
- Utilisation of public-domain knowledge.
- Involvement in, and influence on, research and development, by social and economic actors.
- Minimal overlap and fragmentation in the public innovation-system.
- Minimal bureaucracy.

Apparently the existing system does not provide, or provides insufficiently, for those results. One could also reformulate the above observations by saying that the current system yields too little relevant (applied) social- and economic benefits, while being wasteful on resources: both in operational terms (overlaps) and governance (bureaucracy). Or even simpler: the system creates lots of heat but little movement. The key to this observation seems to be the weakening link between the domain of activities of the scientific community and the actors in the economic system at large. Two reasons can be identified for this problem:

- The growing importance of knowledge for economic prosperity.
- The changes in the 'ecology[2] of science' and the 'ecology of business' which are driving the two main parts of the system apart.

Let's look to both aspects in rather more detail.

### Commerce

Economic prosperity depends on the ability to create added value, and there are three main ways to improve the added-value creation of a business system [Lit. Ref. 1]:

- Sell more ('volume')
- Work more cheaply ('efficiency')
- Provide more utility for the clients (and charge 'premium value')('differentiation')

At any level of economic system evolution (micro-, meso-, macro-), for any type of business (agro, industrial, services) the main-stream players evolve from a volume-driven strategy, through an efficiency-driven strategy, towards a differentiation-driven strategy. For most developed economies (let us say the OECD economies) most companies in most markets:

- Face a volume growth-potential that is largely insufficient to satisfy their value-creation ambitions
- Have exploited the benefits of industrial scale effects to the limits achievable within the cost structure of their 'domestic' ecosystem.
- Are facing increasingly erratic consumer-markets (heterogeneous, unpredictable and moment-specific).

New volume is sought in large new developing markets (e.g. China) and exporting labour-intensive supply-chain activities to 'lower income' countries (e.g. China). The value embedded in 'OECD manufactured' goods and services resides increasingly, not in the 'material' content of such goods and services, but in its embedded 'emotional' and 'knowledge' content. With that, not groups of clients, but the individual client, and his/her instant, moment-specific needs, become the centre focus of the value-creation process. This evolution has three fundamental consequences for the business ecosystem and the qualifications needed to survive in this arena:

- Speed in all processes. This is the driver towards new process configurations along lines of 'Mass-Customisation' and 'Mass-Individualisation' [Lit. Ref. 1].
- Agility substitutes prediction: in an unpredictable environment the speed of response to events is the only remedy.
- Fragmentation of business systems into smaller, more flexible units, acting largely independently, but in alliances (both within as well as between company structures) that act as an ecological sub-system.

Hence, value creation in OECD economies is (increasingly) founded on [Lit. Ref. 1+2]:

- Speed: The 'time-to-market' decreases and the 'half-time-value' of any product/service decreases ever more rapidly.
- No prediction: asking companies (and consumers!) for need-forecasts is increasingly irrelevant for the future.

- Fragmentation: the traditional clearly identifiable ‘partners’ in innovation disappear (as a meaningfully authoritative partner), and all businesses become behaviourally like SME’s.

### Science

If we look at the science side of the equation, the nature of the problem becomes even clearer. Where business is driven by the need to create economic added value, the scientific community is driven by the creation of knowledge. Apart from the question as to whether this creation can be adequately measured by a weighted counting of publications, there is no intrinsic reason (other than acquiring funds) for scientists to be at all interested in the needs of economic actors. It can be argued that it follows that a large part of science funding is in the hands of governing bodies that ‘merge economic, social and scientific interests’. Whereas for ‘big science’ this might well work, this mechanism does not provide for scientists and companies to work together at an operational level. It does not provide speed, agility and operational cooperation.

Apart from that, the scientific domains also fragment ever further. Whereas, 50 years ago one magazine would cover the whole field in a particular area of science, nowadays 30 different magazines may cover an equal number of specialized areas. Even in the scientific community, scientists in adjacent fields of specialization might no longer be aware of each other’s insights, or even be interested in them. So whereas business requires integration of knowledge, science provides specialisation of knowledge - specialisation which is in many cases outside the scope of interest of potential business users (at the business operating-level). To a certain extent it can be argued that there is no correlation (or that there is even an inverse correlation) between the ‘breakthrough value’ of certain research, and the business interests of the economic actors. Examples include such areas as ‘bio-computing’, nanotechnology, etcetera. In management sciences the reverse is visible: the struggle to be relevant has yielded a science that substantially moulds experiences (ex-post, through case studies) into models, and then pretends those models to have predictive value [Lit. Ref. 3]. In other words: where science demands specialisation, business requires integration. The two eco-systems become disconnected. This is visible in many large corporations that eliminated in-house science to replace it by business-unit-driven product-development, while keeping a close corporate watch on (heavily-government- subsidised) university research at a global scale.

Lastly the peer-mechanism in science doesn’t seem to help to create speed, relevance and integration. As science is measured in (weighted) publications:

- Integration becomes ever more difficult with the fragmentation of magazines
- ‘Conventional science’ is easier (and more quickly) published than ‘new science’.
- Carving up good ideas over many publications scores better that publishing in ‘one-go’.[3]

Hence, the reward system for scientists puts a premium on specialisation, conventionalism and slowness, especially for the less talented amongst them.

### The Innovation Paradox

This divide shows clearly in the current state of innovation in The Netherlands. Whereas science at large still holds an adequate position as judged by international comparison, only a very small percentage of companies (even the companies considered to be innovative [Lit. Ref. 9]) draw on the scientific knowledge accumulated in our academic institutions.

The thought that the science-business interface can (or should) be structured by governments, might well be false. The much cited Finnish model is not necessary a product of adequate public governance, but maybe only the by-effect of a single company's (Nokia's) success.[4] Where the cooperation between science and industry around Cambridge is considered to be a success in innovation terms, the role of government is largely invisible, and the funding is said to be largely of US (private capital) origin.

In any case, if the above is substantially true, the innovation system increasingly becomes a system in which large numbers of highly fragmented players, each of them driven by short-term interests, loose sight of each other. Such is an eco-system, where reaction time (to create effective cooperation) is longer than economic timescales require, and where predictability is evaporating. As there is no chance of creating effective cooperation between players that pursue their well-recognized self-interest, for when such interests lead to incompatible behaviour, the chances of organising a solution through planning, coordination and central control are deemed (increasingly) to fail.

The dominant behavioural component is the individual perception of purpose of the respective companies and scientists. In this sense the innovation system can only work effectively if seen as an emergent system. It resembles a garden, more than a machine. And governance is the craft of the gardener, not the machine constructor/operator. Trees don't grow by pulling them (they might easily be un-rooted), but by understanding and guiding the energy in the system.

The problems identified in the innovation system hence identify a system crisis - a system crisis that is not exclusively a local crisis. It may just be that a combination of economic downturn, the famous Dutch consensus ('Polder') model and the history of industrial success, makes the country rather more vulnerable to these effects on the social/economic outlook. Yet, the country has been great in 'changing the rules of the game' throughout history, yielding not just world power in the $17^{th}$ century, but also great economic successes in the $20^{th}$ century.[6] 'Thinking the unthinkable, doing the undoable' seems to be part of the heritage, and might well apply to laying the foundation for a new era of prosperity.

### The Big Science Solution

One way out might be the 'big science model'**.** In this model, large sums are invested in leading science groups. It is highly discriminating in the sense that only the leading group (by international standards) is funded, and it should be started by the acquisition of a small nucleus in emerging fields of science. These basic rules might apply:

- If you're the best (by publications standards), you get the money. If not, funding is terminated.
- Any business generated around the field is welcome. No limitations are applied to combinations (and accumulation) of academic and business proceeds.

This model bets on the attraction that scientific 'centres of excellence' will have on international business. Whilst this expectation might be supported by some successes elsewhere[7], this model might not necessarily be the answer to the question posed:

- This model leads to a global 'grants' competition, where the proceeds may well be exploited outside the scope of the local value creating system, hence landing the funding country with the costs, while only marginally benefiting from the successes. The big science model might require a scale that is well beyond the national level. It might be deployed as the basis for a European quest for innovation, supplementing the national innovation systems.
- The resulting innovation might lead to 'new businesses', yet doesn't take any advantage of the public knowledge-base built to date, nor the vast number of established businesses as a base for future innovation.
- It doesn't provide a balance between scientific interest/perspective and social/ethical/environmental considerations. Biotechnology is a good example of where a leading position in science gets eroded (not necessarily unjustifiably) by social/ethical/environmental issues.
- The main issue addressed by the working group is not the lack of scientific results, but especially the lack of innovation yielded from that in the economic environment. Apparently, good science doesn't necessarily yield economic value.

If 'big science' (creating an 'attractor' in system dynamic terms) isn't the answer, the central question becomes 'how large numbers of independently acting agents can become a coherent, meaningful and sustainable system, without central planning and control'. In other words: 'Can the innovation system be seen as an emergent system, and if so, what does it take in terms of design and governance to make it work?'. This question will be the centre line of reasoning throughout the remainder of this contribution.

## 6.3 } ORGANISING ENERGY

Before we embark on the specifics of a renewed Dutch innovation-system, it is useful to outline the basics of emergent order, and systems based on these principles. In this paper I adopt a rather loose way of formulating the principles. For a more 'scientific' way of reasoning I may point to the literature list attached.

Perhaps the easiest way to understand the basics of Emergent Order[8] is the comparison between a road crossing with traffic lights (TLC's) and a roundabout. Although they serve the same purpose, the organising principles are very different.

TLC's require planning and prediction to switch the traffic lights for maximum throughput properly. For roundabouts only the peak capacity needs to be known. This TLC planning (converted in computer-program code) then instructs the users: Red = Stop; Green = Drive. Any other interpretation of the commands will lead to severe malfunctioning of the system. The control is top-down: users are supposed to obey, not to think. The roundabout situation is rather different. The basic organising principle is a 'cooperation-rule': IF there is another user on left side THEN stop. It is in a way a (visual) communication between users, applying a rule that has proven to be successful in creating (productive) order in the traffic flows. The traffic complexities are not embedded in ever increasingly complex controls from the crossings computer, but are handled by repeating the same basic rule continuously. It is complexity as recursive simplicity. While this sounds pretty trivial and easy, it is worth bearing in mind that this simplicity by no means arrives for free.

In most of Europe we used 'right priority' as an organising rule for the best part of the $20^{th}$ century - and it didn't work. Meanwhile, a working example was visible all of that time in the U.K. Furthermore, it is quite unlikely that users will find out by themselves that it takes ¾ around to make a left turn. The natural way to use a roundabout would be to go ¼ left for a left turn. It shows that even very simple emergent structures do not necessarily have simple design characteristics. TLC's work in 'batch mode': in every cycle a block of cars is allowed to proceed. At roundabouts (if within the range of peak capacity) the traffic slows down, but does not stop. It creates a more or less continuous flow.

The roundabout solution derives two of its basic advantages from this characteristic:

- The throughput performance is far superior (for most regular situations) to TLC's.
- The solution is much better aligned with users' interests (the desire to proceed), hence triggers less violation of the basic rule.

The base for roundabouts is well-understood ('keep driving') self-interest, whereas TLC's require obedience to higher powers (including sanctions on violation).

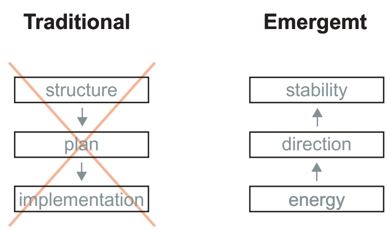
At a more abstract level, the basic difference between centrally controlled systems and emergent systems becomes visible from this example. Whereas the TLC's organise solutions, roundabouts organise energy (whilst providing a designed environment [rules, shape] in which order emerges).

### Reverse the organisation paradigm

This basic characteristic is universal for all (effective) emergent systems. It follows that this requires a complete turnaround in organisational thinking (see figure 6.1). Rather than creating a structure/organisation to pursue a problem or opportunity, subsequently make a plan, and then mobilise the energy (if needed forcefully) to implement the plan - emergent systems start from the bottom. It begins with the energy of the active players (these are the people that actually can do things).[9]

There is obviously (as with companies and scientists in the Dutch innovation-system) no reason at all why such players would necessarily want similar (or even compatible) things. This is where the cleverness and the design come in. The coherence, meaning (at system level) and continuity ate the result of the design of the 'eco-system'[10] and the interaction rule(s). These rules in fact make movement towards the aspired system benefits attractive for all players from their private perspective.

**Figure 1 Emergent organisation paradigm**




Only when this basic configuration works, does the question of the organising framework become of interest. Almost like a sailing boat: if the speed = 0 the rudder becomes obsolete. This refers to system governance, which role is quite specific and necessary, but not in a managerial definition [Lit. Ref. 4+5].

It is necessary in the context of this paper to mention two other aspects:

### Expression of purpose

As emergent systems start from the energy ('will'; ambition; self-interest) of the individual participants, there is no *a priori* reason why they would pursue similar, or even compatible goals. Indeed, this seems to be one of the problems in the current innovation system: scientists may (increasingly) pursue academic recognition, whereas companies may pursue (short term) profits. Neither is equivalent to 'innovation'[11], nor is necessarily compatible with this goal in a cooperating framework. The system's purpose is traditionally embedded in the management structure, forcing or seducing actors to act in the interest of the system's purpose. Yet if the control is insufficient to enforce this, and/or the complexity and heterogeneity of the system prevents this from being effective, the system will be 'beyond control' and is likely to become chaotic.

A measure of the system's performance is therefore required. A measure, that on the one hand expresses the overall goal of the system and its progress towards this goal, and on the other hand is a meaningful (directional) expression at the level of the individual actors. It's like playing football: counting goals is the expression of the purpose of the game but also the guiding principle in each player's behaviour. Without this expression there would be no game, and football would be a 'Brownian movement' of the ball amongst the players.

The key in designing emergent systems is to link the ambition and self-interest of the individual actor with the overall system's goal. One crude expression of this principle is: 'What you get is what you pay for'.

### Hierarchy

All systems (with the exclusion, perhaps, of the very simple systems) require hierarchy. Yet the functional hierarchy of a centrally controlled system is by default inadequate for emergent systems. This can be easily understood. As emergent systems develop order from interactions between actors, the functional hierarchy in classical organisational systems prevents this interaction (and in many cases forbids this interaction). As in such systems instructions are passed down, the actors don't have an overview of the system as a whole, and have no local expression of the system performance. Local decisions on how to proceed might therefore be very dangerous for system performance as a whole, as indeed is the case in the TLC example above.

The hierarchy in emergent systems is therefore is not a functional hierarchy, but a hierarchy of process-layers [Lit. Ref. 1], just as is found in most biological systems. Processes in these terms are sequences of steps 'from and to client'. In such a hierarchy, higher-level processes have lower (dynamic) time constants (are 'slower') than lower-level processes, and the higher-level process sets the boundary conditions for the lower process.

Converting a conventional functional hierarchy into a process hierarchy is not trivial, and is one of the central governance issues.

The above is a very brief description of some of the key design principles of emergent systems. In fact there are some 15 basic laws [Lit. Ref.1.4.5] governing such system design. However, describing these in detail would go far beyond the scope of this paper, and is not necessary to discuss a new approach to innovation in The Netherlands. The principles described above, however, do make clear that the application of the principles of emergent systems to innovation requires a fundamental rethinking of almost every aspect of the current framework of cooperation between science and commerce. This has radical implications for all concerned.

## 6.4 } THE NAME OF THE INNOVATION GAME

When we look at the Dutch innovation system from the perspective of emergent-system behaviour, one of the first aspects that meet the eye is the apparent lack of connectivity between the world of business and the world of science. Not only is there a marked difference between the (still) adequate scientific performance of the scientific world by 'peer standards' and the poor innovation performance of Dutch companies and organisations at large [Lit. Ref. 9], but also, and maybe even more indicative, there is the observation that only a very small percentage of innovating companies (measured by the product/process renewal) actually use the scientific community for their innovation [Lit. Ref. 9]. We seem to build ‘stocks’ of knowledge, but the ‘Flow’[12] is small - very small indeed.

This therefore suggests that a further increase of the pile of stocked know-how is unlikely to yield more innovation in the Dutch context. It is therefore difficult to see how, by merely pumping more cash into the scientific community, the innovation performance will improve. From that perspective the 700 million euro extra funding that has been granted to the scientific community at in the current government coalition and marked the starting point for the ‘Innovatieplatform’ might well yield more science, but will be unlikely to contribute to innovation.[13]

With the worlds of science and business drifting apart (as argued before, see chapter 2), the only way out is to radically increase the interactivity between these two worlds - not at management level, but at operation level. If we want ‘flow’ (of know-how into business) then we should focus on that, and not be primarily concerned with scientific evolution. There’s plenty in stock for the years to come, and more can always be bought on the world market, where there is plenty of knowledge for sale. However, as business does not grant academic recognition and scientists don’t boost next quarter profits, in the current configuration there isn’t a great deal to be traded/exchanged between these actors.

### Science euros

In the existing system configuration businesses are taxed, part of this tax is labelled by government for science funding, and then re-distributed amongst scientist through a increasingly complex arrangement of ‘bodies’ in the form of first and second tier funding streams for academics.[14] There is a radical need for this system to be dismantled. In order to change it, however, direct interaction is required to achieve flow and emergent order. The (admittedly radical) way of achieving this is to label 28% of VPB at company level[15] as ‘science euros’ (SE’s) and allow these to be spent with scientists at (certified?) institutions of academic research and development. This would provide a playground in which academics could only finance their academic aspirations by convincing businesses to grant their SE’s to them, and seduce business to involve academia to the maximum in their quest for innovation and renewal. SE’s not spent would fall back (as general tax income) to the government (not to be spend on R&D funding!). A true ‘market for innovation’ would emerge with price elasticity to success and failure, and with a very strong incentive for all players to innovate and become successful (and pay taxes in The Netherlands).

One could argue that this might kill any perspective of fundamental research, yet this is highly unlikely. For university acting in this innovation market, fundamental research is equivalent to the development of its future ‘know how’ product. Just as businesses invest in product development, so it is unlikely that properly operating universities will not do so too. And if not: when they have sold out the current stock of know-how, the party is over. So be it!

Another objection could be that many businesses will not know how/where to spend their SE's, hence being incompetent to play this game. If this is at all true, many of them will find their way soon, and those who can't, have no concept of innovation. Their SE's will fall back to the community at large to do other useful things with - and rightly so!

In addition, such an assumption itself could be considered as utterly patronising, as it questions the basic ability of businesses to develop their business, by knowing or finding out what's good for them. If this concern were to be true, the innovation of Dutch businesses can and should be considered a hopeless case, and the current quest for innovation had better be terminated altogether.

The biggest single problem to be anticipated is the breakdown of the current 'innovation cartel' between the large companies on the one hand and the large academia on the other hand. Without doubting in any way their good intentions, they have everything to loose in a world in which a gentleman's agreement on how to organise and distribute science, research and development funding is not adequate anymore. Strong opposition is thus likely to be expected in defence of 'the old boys' game'.

***'The problem in changing large complex (organisational) systems is often that part of the problem is sitting at the decision table.'***

### Knowledge productivity

A genuine conceptual problem is, however, how to ensure (from a system governance point of view) that the funding is used for real innovation. If justification is found at the inputs of the science process, we might soon see all expenses being booked as science expenses, including the university catering, security, etcetera. This is something reported to happen in the WBSO scheme with corporate expenses, and similar behaviour has been demonstrated in the healthcare funding. A nightmare-like bureaucracy is looming along this route. In fact, how do we know whether innovation occurs in the first place? This question is (in emergent systems design) in fact the question into the 'expression of purpose' as previously discussed.

Successful innovation is an expression of turning know-how into (economic and social) wealth. If, for a moment, we just concentrate on the economic wealth (i.e. the ability to add economic value), knowledge productivity becomes a true measure for successful innovation. Already, from the works of Solow etcetera, we know that the increase of productivity can only be very partially explained by capital and labour inputs into the economic process. A large proportion of growth (~2/3) is unexplained from the perspective of resource-productivity and has been called 'Residue'. It is widely assumed that this 'Residue' is driven by technology, know-how and ICT. Zegveld [Lit. Ref. 6] showed that such 'Residue' can also be defined and measured at the micro-level of the economy (that is on the level of the individual company), and demonstrates large differences in the ability to generate ‘knowledge productivity’ and the underlying corporate mechanisms [Lit. Ref. 7]. ‘Knowledge productivity’ might hence provide an excellent expression of purpose (EoP) for the new innovation system.

In the following way this EoP could/might be embedded in the system design[16]: to improve the effectiveness of the system, but also to express the differences in the contribution to innovation between large companies (with a history and track-record of innovation) and other companies who will need to develop this capability as yet in the decades to come.

Let us assume company A with a knowledge-productivity index (e.g. 5 year moving-average of Zegveld’s TFP factor) $R_A$ and a weighted average for the whole population of companies in The Netherlands being $R_{ttl}$. When the nominal value of SE’s in a particular year is $SE_A$, the real value of SE’s in that year for company A might be calculated as $R_A/R_{ttl} \times SE_A$. The implication will be that companies with a proven track record of turning knowledge into economic value have a stronger position on the innovation market that companies that don’t have (as yet) this status. Such a mechanism might also be applied to the SE’s value, which falls back to the government when not spent by the individual companies. This amount also could be *pro rata* distributed to companies based on their R-factor.[17] This might draw (international) companies into the game that for reasons of fiscal optimisation don’t pay any (or only little) VPB taxes in The Netherlands.

Does this mean that the whole current system of intermediate organisations (ranging from NWO to the GTI’s) will disappear? Yes it does, at least with respect to their current *modus operandi*. And it should, if only to increase radically the speed of the system, and reduce its managerial complexity and bureaucracy. It is however conceivable that new players will come into the field, or might well develop from the current intermediate institutions. Whereas the operational interaction will largely take place between the basic actors in the system, higher-level processes will develop in a process hierarchy. Such processes could concern alliances (e.g. at branch /sector level) that pool SE’s to achieve R&D synergy, systems of scientific brokers/market makers that lubricate exchange processes in the innovation market, etcetera.

Superficially they might even look like resembling the current institutions. There is however one big, and determining, difference: their existence and power is vested in the choice of the individual companies and academics, and they are paid directly by them. If there is no business: there is then no work, and no existence. Whereas currently GTI’s are largely focussed on their own continuity of existence, in the new situation they could derive this only from effectively contributing to the increase of knowledge productivity.

One last issue might be of interest in considering the outlines of a new innovation system. Research into the design aspects of emergent systems shows a relation between the complexity/order of a system and its environment. Expressed in terms of thermodynamics, an ‘entropy continuum’ should exist on the interface between the system and its operational environment.[18] Such entropy can be expressed mathematically as a function of connectivity and concentration of its network-topology [Lit. Ref. 8]. It basically implies that a more complex, less orderly, environment, requires a more complex/less orderly system. A less orderly system has (in network morphology terms) a higher connectivity and/or a lower concentration than and orderly system. This is the basic explanation of why businesses become more networked and less hierarchical in sophisticated economies. Also from this perspective, a shift from central planning and control to interactive dynamics as organising principle is in the end unavoidable. The vision and guts to change the rules of the game (and with that shaping the new game), rather than stretching the conventional solution beyond its limits, might well pay off handsomely. No guts, No glory! This could well be by far the most important innovation: ‘Innovate innovation’.

***‘The only innovation required is the innovation of the innovation system.’***

One way of looking at such a perspective is the analytical way, which has been the basis of the above reasoning. Another way is through closing the eyes, and imagining such a world. In attachment I such attempt has been made for your further imagination.

## 6.5 } CAN WE? WILL WE?

What will stop us from implementing the SE’s methodology? In the previous chapter some likely counter-arguments have been mentioned already:

- the risk to fundamental research (incompetent university behaviour),
- incompetent company behaviour,
- vested interests of mayor players and institutions.

As argued, I do not support these views, and in any case, they can be overcome. It is true that the devil is often in the detail, and designing a system that will work will require more (intellectual and design) effort.[19] However, enough is known about the fundamentals of emergent system behaviour to make such ambition achievable.[20] Obviously, turning the switch, say on 1 January 2005, will destroy the current system overnight, and it might well not restore from its ashes. Some kind of gradual evolution, creating a learning environment for players and governors is required. This might be done in several ways:

- Starting with ever greater parts of the 2nd tier money flow, with preserving the 1st tier, and its inherent link to education intact for the time being[21]
- As the innovation issue is not linked to all domains of science equally (e.g.

technology and management sciences might be more relevant than oriental languages and cultural history), priority could be given to relevant scientific domains.

- Companies could be (temporarily) presented with a choice between the existing system (that is: the government/NWO/etcetera invests their SE's in science) or they decide themselves.
- Alternatively, SME's could (e.g. in cooperation with MKB Netherlands to help organised the transfer) opt for the SE method, whereas large companies remain (for the time being) in the old system.
- Etcetera.

Caution should however be exercised with respect to the migration path. Experience shows that maintaining dual structures causes a disproportional increase of the complexity costs (e.g. bureaucracy) of the system, especially where the old and new systems interact. Thus, the benefits of the new system might well be eroded by the added complexity. For the time, and to the extent, that the old system remains, it should be prevented from interfering with the new system (this might strongly influence the migration path) and the old system should be forced to shrink but ultimately vanish. Many arguments will be put forward by the beneficiaries of the past why this can't be done. Some of these arguments might even be true. But the bottom line is: 'Because it can't, it should'[22]: things that can (be done in the old system) don't create real change. Breaking down the old institutions (or force them to transform) is the single biggest migration risk.

### Courage and determination

As the transformation can (in technical terms) probably be done, the only remaining thing that stops us from doing it is the issue of political/governmental courage and determination. As said in the introduction, there are probably easier and safer ways to achieve some short-term improvements. Yet, as the underlying analysis in this paper is true, it just stretches the lifetime of already inadequate solutions. It's the equivalent of a more sophisticated traffic control computer on the TLC's described. But the solution (metaphorically) isn't a new computer: it's abandoning the computer altogether.[23]

In the current system the complexity costs might well prove to be already very substantial. Not unlike the national health system, where already is an estimated 50% of the funding is used (hidden in everyone's tasks) for control, coordination and administration. Only in the freeing up of this energy in itself is a major step forward taken towards useful output.[24]

***'Let's turn the 'democracy of talking' into a 'democracy of acting'.***

So the key issue is: are we serious about innovation as the future of our national prosperity? If so, let us use our historically proven strength to change the rules of the (international) game. A game with very substantial first-mover advantages indeed!

## 6.6 } ‘FOR INSPIRATION AND ENJOYMENT’

### The InnoBucks Fairy Tale

In the remote north-western area of Euria lies the idyllic country Polderland: a country with an impressive history of international trade and marine business, of knowledge development and exploitation. For some time however, things had not been what they used to be. Apart from growing unemployment, and eroding self-confidence, a problem had been developing in the commercial deployment of new scientific insights in Polderland’s companies and institutions. While ‘knowledge-economy’ and ‘innovation’ were on everyone’s lips, it didn’t get far beyond a verbal pastime. It was not that knowledge was in short supply. In the national academia the fruits of long-time scientific endeavour where literally piled up. But their commercial application had somehow been increasingly stagnating. And all this was despite the numerous activities and plans to specifically improve the deployment of science in commerce: but, for unknown reasons, it didn’t work. Everyone had own ideas about the nature and causes of this problem. In general much talking, coordination, and orchestration were underway. Lots of energy was spent on what others should do. Many new structures were created in order to flood ever more funding to the players concerned - to the extent that the new profession of ‘subsidiologist’ was about the only craft growing in the Polderland economy. But all this was without much in the way of tangible results. Or at least, there were not enough to keep pace with neighbouring countries. The country was on the brink of desperation.

Somewhere in the deep south of the country, a bunch of lunatics had thrown themselves into the science of complexity and emergence. The basic thought behind this theory is that uniform concepts, centrally structured and implemented, are inadequate for modern multifaceted societies. The economy is not a ‘traffic-light controlled crossroad’, where high-level managers can force participants to behave in the interest of all. In their view, a roundabout would be a much more compelling model of a modern society. Players interact with each other in a direct way, and with the use of some very simple interaction rules, an effective and smooth flow of traffic ‘emerges’ from this interaction. However: how can you turn the knowledge economy into such roundabout? What kind of interaction rules could lead to a continuous stream of renewal in business? And why would players want this in the first place? There were many questions that looked very hard to answer at the outset.

One of the complexity-scientists had a brain wave. Based on the ‘basic laws of emergence’, one should put all the initiative with those who can really do: at the operating levels of the companies and the academia themselves. The primary problem was not the availability of know-how (that was literally piled up in the scientific institutions) but the lack of a ‘flow’ of knowledge. In contemporary management-speak: it is not the ‘stock’ that is of interest - it’s the ‘flow’ that matters. And if the flow runs, competent players will automatically top up the stocks (the incompetent might not do so and might fail. But then: who cares?). The idea was simple:

All companies together would pay annually 12.000[25] million EuroBucks in profits tax, and 3380 million EuroBucks would flow back to companies and institutions through a myriad of arrangements to boost innovation. That's 28 %[26]! Replacing this forest of rules and systems, we would give all companies back this 28% of profit tax in the form of InnoBucks. With these InnoBucks they can do what they want, but in the end InnoBocks can only be converted into EuroBucks by institutions of science certified with the Treasury. And that's all we would do!

At first glance the idea looked too stupidly simple to work. Many of the parties concerned raised severe objections. Ranging from 'This will kill all research' to 'we can no longer govern the direction of innovation or take initiatives to develop promising new fields of science'. However, due to a miraculous set of circumstances the idea was experimentally deployed. And the result was mind-boggling. How one simple interactive rule changed the world:

In the first instance nothing much happened. Many, especially smaller, companies had no idea whatsoever of how to use the InnoBucks. And, especially in the first few years, many simply vanished. However, the academia quickly organised their hunt for InnoBucks. Scientists in the end also simply need to eat. Rapidly however, new initiatives surfaced. One organisation started collecting all InnoBucks from bakeries, with the promise to deliver something useful to the sector. After a period of grief and mourning, the organisations that used to distribute the money in the old system, became active on the InnoBuck market. Collecting InnoBucks offered them the only chance for survival. It has to be said that many of them proved considerably less successful than the new aggressive 'BuckHunters'. Many thus died a silent death in just a few years. At the academia massive energy surfaced, initially in 'cashing' their existing base of know-how. Sometimes successful, sometimes not. Rapidly, however, academia started new programmes dedicated to the development of specific knowledge in new areas of application. Institutions that failed to do so soon lost ground, and saw their InnoBucks stream dry up. They ceased to exist, or (in many cases) were absorbed by their more successful colleagues. The start was difficult and messy, but the governors withstood the temptation to intervene. As patterns of success started to emerge, their concern diminished. One of the most important indicators of success was the growing tendency of companies to supplement the InnoBucks with 'own funds' to speed up results. After 5 years the flow of knowledge[27] proved to have grown dramatically, and started to spin real economic benefits in terms of high added-value export growth and employment. For the first time in a decade academia were expanding. One of the deep concerns at the outset was the complete collapse of fundamental research. The first few years this risk indeed proved to be real. Academic governors however realised soon that the termination of long-term investments would slaughter the golden cow. Rapidly they changed course and apparently with success.[28]
The model now started to attract positive attention in other countries. Remarkable is the rather spectacular growth of R&D projects conducted in Polderland for foreign organisations. Starting at a meagre 700 million EuroBuck in 2001, the 2000 million border has recently been passed. From enquiries it shows that

'the possibility to engage in long term effective business partnerships' and the 'business relevance of long range research in Polderland' are the most important reasons for foreign clients.

'The Poldermodel' is no longer synonymous with 'talking rather than doing' but with, to use a famous local expression 'Niet lullen maar poetsen'.[29]

A fairytale? As yet. but if we want.........
.......................................we will happily live ever after!

## 6.7 } LITERATURE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## 6.8 } NOTES

1 Emergent Systems have strange habits. One of them is 'Path dependency'. This implies that the traditional separation between 'goal' and 'path' is less applicable in such organisational issues. To a certain extend 'the goal is the path' or the 'path is the goal'. In that sense this paper addresses both.

[2] The term ‘Eco-’ in this document does not refer to environmental issues or aspects. It is used to identify the relevant environment in which a unit of business/organisation operates.

[3] As one reputed academic said: ‘Writing a book is suicidal’.

[4] E.g. the Finnish HUT has yielded only 35 FTE’s employment from 11 start-ups. The bureau for Entrepreneurial Services has about the same number of employees! This in comparison with Nokia: ~60 k jobs, 25% of them in R&D (Lit. Ref. 10]. As can be said for MicroSoft, Philips, and many other ‘classics of innovation’.

[6] Schiphol and KLM; Philips, DAF, ASML, Unilever and Shell, Offshore Construction, Agro, etcetera.

[7] e.g. the microelectronics initiative IMEC in Leuven; Korea and Taiwan seem to be betting on this approach in order to proceed to higher levels of added value creation.

[8] Other terms, largely describing the same principles are: complex adaptive systems, interactive order and self-organisation. The term ‘Chaos theory’ is preferably avoided as it points to the chaotic aspects of such systems, whereas we are primarily concerned with alternative methods to generate coherence, continuity and meaning/purpose.

[9] This as opposite to people that can talk about what other people can/should do.

[10] E.g. the physical configuration of the roundabout in our example.

[11] And might indeed well be pursued at the expense of innovation!

[12] Of this knowledge into market applications.

[13] Unless this is an implicit choice for the ‘Big Science’ model. In that case however, the injection is far insufficient, and the system rules largely inadequate to yield the aspired ‘top of the league’ status.

[14] According to CBS figures in 2001 the VPB taxes amounted to 12 billion euro, while 3.4 billion euro (28%!) flowed back into science funding.

[15] For non-profit organisations something equivalent might be thought of.

[16] It is likely that a system of ‘two-dimensional accounting’ [Lit. Ref. 1] is better for the innovation system. The other axis would then be the scientific output, measured in weighted publications. For simplicity reasons this is not further elaborated in this paper.

[17] One word of caution is in place here. Interactive systems have complex dynamics. One of such complexities is lock-in. More study and (experimental) simulation s required to develop such mechanisms further before they could be deployed. The above sketch only serves the purpose of illustration.

[18] In qualitative terms this is also known as ‘The law of requisite variety’

[19] Some of the open issues are referred to in the footnotes of previous pages.

[20] It would be a good example in itself of deployment of science for business!

[21] 3th tier financing(contract research) and EU funding are kept outside the SE method.

[22] In Dutch: ‘Het moet; juist omdat het niet kan’.

[23] Not to mention rearranging the Titanic deckchairs.

[24] Complexity costs can be seen as the friction caused by the mismatch between planning and control and the heterogeneous, erratic reality. Such costs are difficult to identify, as they are part of everyone’s task and day-to-day activities. A very recent and striking example is found in the observations of the ‘Onderwijsraad’ that concluded that none of the additional funding over the past 20 years has been converted to (higher) education! ‘Deregulation’ however will only have very limited effects. Complexity costs mark a system failure/crisis. It’s not an issue of ‘less rules’ but one of ‘new mechanisms’.

[25] CBS, 2001.

[26] for an overview of R&D spending in Polderland: see at the bottom of this article.

[27] This was measured by the now famous ‘Zegveld Knowledge Productivity Index’.

[28] Apart from one university. That busted after two years, a unique event in itself in Polderland.

[29] This means something like ‘Doing in stead of talking’.