Summary of AWT Background study 14

Room for innovation. Experience in the technical and natural sciences

Introduction

Background

This collection of interviews about innovation in scientific research is being published as a background study to the advisory report from the Advisory Council for Science and Technology Policy (AWT) about the future of the technical and natural sciences. In a review of the future of this kind, the consideration of innovative possibilities is indispensable. Innovation in the technical and natural sciences is not only of major importance for the future progress of these fields themselves, it is also the prime source of major potential applications and these are important for the future of Dutch society in general and industrial activity in particular.

In the context of the advisory report about the future of the technical and natural sciences, we did not want to spend too much time looking at the content of the disciplines in which promising or interesting innovations can be expected in the future. Other studies, such as the foresight activities of the Foresight Steering Committee, or TechnologieRadar from the Ministry for Economic Affairs, concentrate on this area. Instead of a substantial approach to innovation of this kind, this background study looks in a more general way at the possibilities and difficulties associated with innovation. Central questions are: are the innovation conditions in the current Dutch science system healthy, and can innovative ideas or approaches also take root? What are the positive and negative factors?

By innovation, we mean here not only innovation at the boundaries of existing disciplines but also innovation in the sense of the development of new, often interdisciplinary, areas of knowledge and application. An example of the importance of this second type of innovation is the striking phenomenon described by TechnologieRadar that the promising areas referred to there generally combine two or three existing disciplines. It would seem that present-day innovations in science and technology mainly result from new combinations of knowledge, and from looking at certain issues from the point of view of another discipline.

Approach

In order to establish a picture of the positive and negative factors relating to innovation, a number of discussions took place with scientists who, in the past, left the beaten path and, with demonstrable success, introduced innovations. Furthermore, a number of interviews were conducted with researchers who are breaking new ground and on whom history has not yet passed judgment.

The aim of the interviews was to establish the personal history behind innovations. What factors made a positive contribution to the innovative work

of the researcher and what factors actually got in the way? The idea is that, on the basis of the leitmotifs of those different, personal histories, the 'feel' of innovation will emerge. Our aim in emphasising the personal background was to prevent overgeneralisation and therefore occasionally gratuitous statements about openings (or cul-de-sacs) for innovation.

Our subject here is clearly innovation in a university context. We look at the individual stories of scientists employed in universities who have dealt with the conditions and methods used inside those universities. The openings for, and obstacles to, innovation in public research institutes in private R&D laboratories are only a side-issue in this collection, being discussed only to the extent that the interviewees compare the different research contexts on the basis of their own experience.

An interesting question is how we drew up the list of interviewees. The selection of 'innovators' as interviewees has, after all, a clear positive connotation which apparently applies to some of them. We adopted a pragmatic approach here by trusting our own judgment and by consulting a number of relevant actors in the field. In the end, a selection was made from the long list of names. It took into account the breakdown of innovative contributions into past and present contributions, the breakdown according to different exact sciences, the breakdown into innovation in existing fields as opposed to the opening up of new fields, and finally the breakdown into innovation which met high levels of resistance from above and innovation promoted or encouraged by administrators.

It will be clear that a complete picture of all these factors can never be obtained in a limited number of interviews. Nor was that our intention. Our emphatic objective was to acquire a feel for how innovations can be made in research. We have tried to capture the 'scent' of innovation, to take a look behind the scenes where innovators are at work. The purpose of this background study is to share those impressions with a broader public. The points made by the interviewees certainly merit more widespread attention.

It is perhaps superfluous to point out that there are of course many other scientists conducting innovative research in addition to the very small group interviewed by us. The fact that they are not represented in this collection is no reflection on their innovative qualities. Nor is it the case that inclusion in this collection constitutes a seal of approval for innovative research. The purpose of the interviews was certainly not to determine the nature of innovative research (either in the past or in the present) but to discuss factors of importance for innovation in research.

The picture established by the interviews: some leitmotifs

The interviews are personal stories about innovation. Each story merits separate reading. This does not detract from the fact that a number of leitmotifs can be seen in the interviews as a whole. These are items which are mentioned by several interviewees or which played a role in terms of furthering innovation or actually blocking it.

Individual issues

Most of the innovators we talk to are people with visionary qualities. They have the ability to abandon the usual structures and take their research in unusual directions. There are also able to focus on the long term, maintaining that focus and understanding the future potential of their innovative idea (sometimes in terms of applications as well). In figurative terms, they can see the mighty oak tree in the acorn. Some innovators are non-conformist and stubborn enough to persist with their own research lines and interests -- and to obtain financing for them -- even when those near to them think that they would be better off doing something else. In addition, a common trait of the interviewees was their considerable stamina. Even when things do not go their way or take a long time, they are able to persist with the line of their innovative research. Another trait which is not without importance is that the interviewees are often people who are highly infectious in their enthusiasm, something which also emerged during the interviews. What they had to say about the substance of their research, as well as the way they told their stories, showed that they were able to establish in their immediate surroundings a research climate of a highly invigorating and inspirational kind which drew other people to them, both from their own country and abroad. Quality attracts quality and therefore additional resources.

Home base

How are innovators able to persist with their research, sometimes despite considerable opposition? Several stories make it clear that this is only possible because they had a home base and were given room in universities, in the area funded directly by government. This security safeguarded the continuity in their line of research, continuity which is awkward to establish when researchers depend on other sources of funding. When they depend on these alternative sources of funding, researchers have to adapt their research to fit in with certain programmes. As a result, the research can be fragmented and continuation with one's own lines of research can become more difficult.

Stamina

Genuine innovation also requires stamina. It is not exceptional for ten or twenty years to go by before what is originally thought of as a 'crazy' idea is proven. Lead times like this are often much too long for industry. Several interviewees therefore thought that direction or control by the commercial sector was a dangerous thing, involving a risk of control based on short-term interests or demands. Because of the longer periods of time which are inherent to innovation, a number of interviewees point out that there is little point in granting freedom of action to someone for only a limited number of years or in financing a single research assistant position. Long-term thinking is also needed in this respect. That does not mean to say that researchers should be left to do what they like for ten or twenty years. The interviewees indicate that it is quite possible to demonstrate progress by means of interim publications relating to parts of the research. This makes it possible to evaluate progress.

Other sources alongside direct government funding

It is, incidentally, striking that all the innovators we talked to have been successful, or are succeeding, in obtaining large amounts of financing from sources other than direct government funding (industry, government institutions, and so on). Several interviewees say that you need a clear base in the university (a basic fee which you can use, for example, to finance a number of genuinely free research assistant places with no dependence on peer reviews, but entirely at your own discretion), but that you then have to obtain additional financing yourself. As one interviewee put it: the first flow of funds (direct government funding) should work as a multiplier. You use the first flow of funds as the seed crop and the basis for harvesting second- and third-flow financing (government agency funding and contract research funding respectively). That first flow of funds is therefore considered to be essential for innovation, but - as several interviewees pointed out - it is important in the Netherlands to avoid falling into the trap of depending on the first flow of funds for all of your financing.

Excellent scientists

An important common denominator which emerged from the interviews was also that the interviewees did not have just one innovative idea, whether or not of the 'non-conformist' variety. On the contrary, they are simply excellent scientists with good, even brilliant, past records Generally, they have acquired their reputation in more mainstream research fields. As a result, several of the innovators interviewed advocate granting research freedom to certain people on the basis of past performance. Give people who have proved that they are good scientists the freedom to follow up their own ideas without having to submit detailed plans in advance. Reputation should be enough. Their argument here is that universities appoint professors, ideally after completing meticulous procedures. They should therefore be trusted to do good things as they see fit.

No complete freedom

Freedom based on reputation is not the same thing as complete freedom. The innovators thought it was completely normal to make appraisals of people's performance. For example, it was thought that it would be a good idea to make an objective test or appraisal every ten years. However, a few of those we spoke to pointed out that designating work as substandard -- or even excellent -- is not the usual practice in the Netherlands. Whatever the case, none of the innovators were opposed to accountability. On the contrary, they thought it was entirely normal for there to be a certain degree of accountability for basic financing and that you should be able to show what you have done in return.

Minimum required size

Another important factor in terms of innovation is the minimum size of a research group. Some of those interviewed stated that critical mass of this kind is required in some disciplines simply to achieve substantial research progress. A few others did not feel the same need in terms of size. As such, their research could be done alone or with a small group of people. Disregarding the demand or need for a certain group size based on the actual

science and turning to the more general picture, a certain critical mass has a beneficial effect on the generation of innovative openings. If one wishes to create a room for 'free' research within university groups -- in other words research which does not require prior peer approval and which is not limited by programmes from other research schools -- a certain group size is required. In larger groups, it is simply easier to create this room explicitly. In these cases, only a limited proportion of the total budget is taken up.

Innovations where several disciplines/subdisciplines meet

One of the features of many of the researchers we talked to is that their innovative activities are located in intermediate areas where several disciplines/subdisciplines meet. This sort of interdisciplinary - innovative - research finds it difficult to get a foot in the door at the Netherlands Organisation for Scientific Research (NWO). The NWO is focused -- according to the interviewees -- primarily on the mainstream of particular scientific fields. The result is that research proposals involving several disciplines have to compete at the NWO with proposals located entirely within the boundaries of the existing disciplinary communities. It is precisely because of the inevitable scarcity of resources that peers prefer to grant financing to research situated at the heart of the discipline in question. In order to 'score' with interdisciplinary projects despite this, these proposals have to be clearly superior to those for monodisciplinary projects. In addition, innovators in intermediate areas often fall between two stools: they are sent to other disciplinary communities for financing. This can be correct as such but they will be rejected on similar grounds elsewhere.

Disregarding the question of these financing problems, the interdisciplinary approach can generate a number of additional awkward issues. The only way to compete well with monodisciplinary research is to be extremely good in all the disciplines one covers. Researchers are expected to be able to compete with the top flight in all the disciplines upon which a line of research is based. "And that's the way it should be too", is the explicit view of most innovators. You cannot be allowed to hide behind an interdisciplinary approach as an excuse for poorer quality in subareas. Incidentally, some researchers stated that interdisciplinary research sometimes gets in the way of scientific recognition, for example in terms of numbers of publications and citation scores. Researchers with interdisciplinary activities often publish in a wide range of journals associated with the various disciplines they make use of. Since scores are generally based on monodisciplinary areas, a considerable proportion of their publications and quotations are often missed.

Innovation through the NWO has little chance; if financing is provided, it is short-term

More broadly speaking, the interviews made it more than clear that innovation based on NWO financing -- and not just in interdisciplinary research -- has little chance of success. Given the current methods and criteria for assessment, the interviewees did not believe that this could be expected. An example of one important guideline used to assess proposals submitted to the NWO is that the applicant must already have published extensively on the subject. This is, by definition, impossible with highly innovative research. And since status plays an important role, it is awkward for young researchers with innovative or 'hare-brained' ideas to get a foot in the door. Several of the

interviewees thought that the NWO was conservative and cautious in its approach: in effect, it only grants applications when it is already clear what the result will be. In itself, this approach is not condemned: In this way, the limited financial resources are deployed as well as possible. In other words, most results are achieved. However, the relationship with innovative research is an uneasy one.

Another inherent drawback of the current approach of the NWO referred to by the people we talked to is that NWO financing is short-term in nature. Trainee researchers are appointed for four years, after which it is uncertain whether the NWO will continue to provide financing for a line of research. NWO research programmes are also generally short. The drawback or risk here is that, if researchers want to qualify for NWO financing, they must continuously be initiating new lines of research or be working on finding places for their existing lines of research in ongoing programmes. This does not benefit research continuity.

Open culture

An open and stimulating culture in the research group and research environment is highly important for innovation. A culture of this kind has to be created deliberately and is expressed in a range of ways, claim the interviewees.

- Stimulate creativity by means of 'cross-fertilisation' between disciplines. This can be done by asking staff, for example after receiving a doctorate, to work on an associated area instead of continuing along the path set out by their previous research.

- Creativity should be given explicit opportunities by encouraging staff to ask good 'awkward' questions and teaching them to look at their own work and other people's work critically. This should be embedded in a positive culture: people should not get their heads chopped off the moment they stick their necks out but be given space so that they can make mistakes, and dare to do so. What matters is accepting the fact that people will never achieve something new without mistakes. There is of course a difference between stupid, reprehensible mistakes and complex, unforeseen and unexpected mistakes.

- Create a dynamic working environment in which a lot is going on, where people hear new things, where there is also a high level of involvement in what colleagues in one's own group are doing and in which people sympathise with, and make contributions to, other people's work. This also means that physical proximity is important, so that people can pop into one another's offices, have a cup of coffee together etc.

- Encourage outward thinking. This requires extensive and open communications with other people both within the country and beyond its boundaries. This can be done by, for example, visiting congresses and giving presentations.

- And finally: a ban on internal, closed recruitment procedures. When there are vacancies, people from outside should always be involved.

Several of those we spoke to claimed that internal procedures are innovation's death warrant.

The Netherlands and the international arena

Finally, the innovators we interviewed were also asked to compare the situation in the Netherlands with the situation abroad. What is better elsewhere and what is, relatively speaking, positive in terms of encouraging innovation? The main positive factor in the Dutch situation was referred to on several occasions: the relative higher level of basic financing from direct government sources and the resulting security and continuity. In the USA for example, scientists lack basic financing and security of this kind. In the USA, people have to fight much more for resources and the research climate is much more competitive.

The negative factors referred to in the Dutch situation are:

- the lack of 'free' resources. The problem is not so much that there is too little money but that there is a lack of freedom in how it is spent. In the Dutch university situation, everything has to be approved by a range of bodies. This results in delays and also contributes -- in part wrongly -- to distributive justice;

- a certain level of over-programming in research. All present-day research has to be embedded in programmes which also change from time to time. The interviewees are not opposed to research programming as such. However, they warn against the pendulum swinging too far, with harmful effects on research innovation.

- the current trends towards the professionalisation of management, among other things as a result of the MUB (Modernisation of University Administrative Structure Act). Some interviewees are decidedly negative about this and state that professionalisation results in harmful and undesirable control tendencies.