From Virus to Vaccine: Projectification of Science in the VIRGO Consortium

Chapter 3

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After the Spanish flu in 1918 (40 million deaths estimated), the Asian flu in 1957 (40–50 per cent of the world population affected and about 2 million deaths), and the Hong Kong flu in 1968 (between 1 and 3 million deaths estimated), it has been assumed that another flu pandemic is likely, if not inevitable (Health Protection Agency, 2006; Kolata, 1999; Quammen, 2012; WHO, 2005a; 2005b). Risks are higher than ever, as within our modern society with its global transport infrastructure a virus that infects humans will spread even quicker than during previous pandemics (Bijker, 2006). This is why since the beginning of the new millennium, governments have been preparing for such a global outbreak, in collaboration with science and industry. In this context, the Netherlands Genomics Initiative funded an ‘innovative project’ combining academic and industrial research to develop a new vaccine against influenza: the VIRology GenOmics Consortium (VIRGO) that studies respiratory viral infections such as flu. While aiming to prevent another pandemic, this research project is also the embodiment of the increasing emphasis on innovation in research policy and the shaping of science as a manageable process, featuring strategies, roadmaps, and projects with acronyms and logos. As reflections on the meaning and impact of this ‘projectification of science’ are seldom found, this chapter will analyse the VIRGO collaboration as an example of projectification in health related research.

With important roots in traditional ‘Big Science’ projects like the Manhattan Project and the Apollo space programs, project design and management developed in fields of construction and engineering during the 1960s (Cicmil and Hodgson, 2006; Hodgson, 2004; Lock, 2003; Weinberg, 1969). As part of the New Public Management (Ferlie et al., 1996; Boston et al., 1996), the 1990s saw the project mode expanding across industries and other sectors, which is aptly described as the ‘projectification of society’ (Midler, 1995). Science has not escaped and has also become increasingly subject to projectification (Torka, 2006; Vermeulen, 2009). Collaboration predominantly takes place in a project format, which determines not only the structure of the research process but also influences the content of science.

In general, the propagation of the project mode of management is accompanied by a discourse on the project as an organisational response to the challenges of managing in a world of growing complexity (Cicmil and Hodgson, 2006; Hodgson, 2004; Lock, 2003; Midler, 1995; Sahlin-Anderson, 2002). The project's origin in modernity gives it a rational basis and a functionalist and instrumental view, focussing on time, cost, and output. But at the same time the project is presented and adopted as a new working mode in late- or post-modern societies that replaces the modern, hierarchical bureaucratic mode of organisation. Projects promise to deliver the ideal combination of a versatile and flexible but predictable form of work organisation, one that delivers controllability and adventure as well as decentralisation and accountability. However, more critical accounts on project management show that the world of projects is inhabited by dilemmas and contradictory logics. There is a gap between theory and practice and it is common knowledge that many projects cost more time and money than projected. Evaluation reports and studies provide insights in frequent cost overruns, substantial delays and under-performance. So while the project is widely adopted as an organisation format, its effectiveness as a management strategy is subject to discussion, now also extending into the realm of science.

What does the adoption of a project mode of working in scientific practice entail? Most obviously, the scientific project formalises scientific enquiry, via diverse forms of contracts: legal, financial, and technical. In addition, projects are a way of packaging inquiry more formally, through a design that considers a clearly defined problem that has a solution and a deliverable at the end. As the construction of a project proposal become the first step in doing research, the project mode of working adds an extra phase to scientific practice. Consequently, the discourse of 'the project' acts to mark out a specific time and space horizon within which the project is to be undertaken and evaluated. Thereby a separate, temporary organisational entity is created, with its own name, acronym, logo, and website, which sets it apart from other organisational entities like universities, research groups, and funding agencies. Each scientific project tells its own story; the project comes with the creation of a narrative constructed by people talking and writing about the project, for instance in project descriptions and proposals. This narrative legitimises the scientific project and contextualises it, by embedding it into broader narratives like discourses on scientific progress or societal problems. As a result, the projectification of science brings new roles for scientists, as they have to combine doing science with research management or the commercialisation of research.

This chapter further explores the projectification of science by analysing how in the VIRGO consortium the project format structures research. Based on qualitative research including document analysis and interviews, my analysis combines the triple-helix theory (Etzkowitz and Leydesdorff, 1998; 2000; Etzkowitz and Webster, 1998; Shinn, 2002) and the concept of boundary technology (Gieryn, 1983; 1995; 1999; Guston, 2001; Star and Griesemer, 1998) to get insight into the dynamics of the projectification of science: understanding the project as a 'boundary organisation' that enables the connection of government, academia, and industry. By presenting the VIRGO consortium, its construction and its organisation, this chapter will analyse the ways in which the project format influences research. I will argue that the project format serves as a tool to facilitate connections in the triple-helix, through organisational structure, control and accountability, time, space, and the career paths of scientists. However, my analysis of VIRGO also indicates some clear tensions between (biomedical) research and project work and shows how the logic of science is repeatedly compromised. This opens up questions on the appropriateness and innovativeness of this form of research organisation.

Making the VIRGO Consortium

In the context of the sudden spread of SARS and the thread of H5N1 and increasing attention to the risk of pandemics, scientists have been publicly propagating influenza research and the development of vaccines, while simultaneously unfolding a research agenda. For instance, Professor Ab Osterhaus, Head of the Department of Virology of the Erasmus Medical Centre in Rotterdam, frequently appeared in the Dutch media speaking of the risk of an influenza pandemic. In an expert interview he explained his position on the importance of virology research:

> We cannot already make a vaccine against the next "pandemic" because the virus continuously changes. We do not even know for sure that it will be H5. So, what in my view should happen now is to take for example, a H5 or H9 subtype, make a prototype – a candidate vaccine that is already adjuvated – and test it with humans. However, these are very expensive studies; we are talking about a multiplicity of ten million euros. Industry will not finance this of course, because those vaccines cannot be sold as it actually is technology development and a whole new infrastructure should be developed. However, this is something that should be done right now. When starting at the moment of the outbreak of the pandemic, a year is needed before proving the safety and efficacy of the vaccination and another half a year to produce the vaccine. That means that one and a half year has passed and experience teaches us that the pandemic is already gone by then. It has already passed around. So I definitely think that now is the time to experiment with prototypes of vaccines to prove which technologies should be used to make effective and safe pandemic vaccines.[1]

With this reasoning Osterhaus eloquently created a sense of urgency. He mobilises the future in the present (Van Lente, 1993; Brown et al., 2000) and also gives his view on who should take action. He clearly points out that research should be financed by government, as industry will not perform the necessary research because there is nothing for them to gain yet. Osterhaus thereby touches on the complex relationship between science, government, and industry in

[1] Video interview with Professor Ab Osterhaus on the website of *Erfocentrum* (the Dutch national knowledge and educational centre for heredity and medical biotechnology), 24 October 2005. Retrieved 29 October 2007, http://www.biomedisch.nl/film/vogelgriepvirus.php.

innovation. In preparation for a possible pandemic, governments have to invest in public research, which eventually can lead to the development and commercial production of vaccinations or other forms of therapy by the pharmaceutical industry. This is reflected in the VIRGO project that started as an academic adventure but became a collaboration with industry stimulated by the government.

The Academic Start of the Project

On the website of the Netherlands Genomics Initiative[2] the VIRGO consortium has been presented as a so-called 'Innovative Cluster', which means concretely that the research is formulated in response to a question from industry and that industry takes the lead in the organisation of research (Folstar, 2002: 3). In the case of VIRGO, the leading company was ViroNovative BV. So when I decided to investigate the VIRGO project, I assumed that the main person behind the project would be someone from this company. However, it soon turned out that in order to get to know something about the consortium I needed to get in touch with coordinator Dr Arno Andeweg, an academic researcher who is based in the group of Osterhaus at Erasmus Medical Centre, which is part of Erasmus University in Rotterdam, a public facility. So while the coordination of VIRGO is presented as an industrial affair, it has a basis in academia.

As it turns out, the research proposal was actually an idea of Andeweg himself. He has a background in biology and already began to be interested in infectious diseases during his studies. In his PhD research he focused on the Human Immunodeficiency Virus (HIV) under supervision of Osterhaus. After his graduation in 1995 he kept in touch with Osterhaus while working at several other research institutes where he became interested in genomics research, the latest development in molecular biology. At the beginning of the 2000s he returned to the group of Osterhaus: 'That is when I wanted to start this research' (interview with Andeweg,

[2] Retrieved 29 October 2007, http://www.genomics.nl.

2005).[3] Osterhaus supported him when he envisioned integrating genomics research into the study of virus infections in order to learn more about the interaction between host and virus. As a result, VIRGO uses genomics techniques to investigate host-virus interactions to improve the rational design of vaccination and other intervention strategies for respiratory virus infections like influenza.

The basic idea behind vaccines is that they prevent virus infections by artificially bringing the host into contact with the virus and teaching the host how to react without becoming ill. However, vaccines can either produce the good learning reaction or the unwanted reaction, so the crux is to know what makes the good reaction. However, until now the reaction is often a surprise:

> We now basically do not have enough knowledge about the immune response of the host in case of a virus infection. So vaccine development is still largely depending on a "trial and error" approach. If an experimental vaccine works we have a new vaccine, but if it does not work we have to try something else again. (interview with Andeweg, 2005)

Genomics research can contribute to the understanding of the host response to a virus:

> With the new genomics tools you can at every moment – this is like the time-axe within the black-box – and at each stage see which genes are turned on and which are turned off. With the new tools you now have the ability to look with a very high resolution into what exactly happens within the host and what happens if you change something in the virus or in the vaccine. (*Idem*)

This type of research gives better insight into the reaction of the host and can eventually rationalise the design of vaccines.

The new research approach had a slow start as Andeweg first had to work on ongoing projects, and only had little time to work on his own ideas. Only when a European project was

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[3] Interview with Dr Arno Andeweg, Coordinator of VIRGO, Department of Virology, Erasmus Medical Centrum, Rotterdam, the Netherlands, 29 April 2005.

granted, he secured part of it to start his own research, albeit on a small scale. However, soon he realised he needed a large-scale approach:

> Genomics is big and technology development goes fast, so you actually cannot do this on a small-scale. This means that you need to realise, and this is my experience, that with only little money and little manpower you are always behind. And although it has your interest and it has potential, you will not be able to follow. (*Idem*)

Consequently, he tried to build a collaboration and to acquire more money. First, he became part of a larger effort within the Erasmus Centre to become a ‘Centre of Excellence’ specialising in infectious diseases within the then newly established Netherlands Genomics Initiative (NGI). Unfortunately, the proposal was not selected due to a lack of focus: ‘That was not very surprising because they involved more and more groups to fulfil the requirement of a very large multi-disciplinary centre. Everything may seem fit in the end, but if you do not take care, you lose your focus’ (*idem*). When the NGI came with a new call for research proposals Andeweg decided to give it another go and wrote his own proposal. However, the research proposal needed to be aligned with the goals and requirements of the call of the NGI.

The Netherlands Genomics Initiative

The VIRGO consortium is one of the projects of the Netherlands Genomics Initiative (NGI), a special agency within the general Netherlands Organisation for Research Funding that was set-up in response to the ‘genomics revolution’ and developments in biotechnology. Following the lobbying of scientists and policymakers and the advice of a special committee, a political debate concluded that the Netherlands’ genomics infrastructure was in need of a ‘substantial reinforcement’ (NGI, 2001).[4] With the support of five Dutch ministries – involved with, respectively, education and research, health, economic affairs, agriculture, and the environment

[4] In 2001 the Wijffels Committee produced the report on ‘knowledge infrastructure genomics’, commissioned by the Ministry of Education, Culture and Science.

– the NGI was founded in 2001 with a budget of €188.8 million to stimulate and coordinate the genomics knowledge infrastructure in the Netherlands.

The first activity of the NGI was the creation of a strategic plan (2002–2006):

> The Netherlands Genomics Initiative heads the decision-making process for the selection and stimulation of both existing and new research activities. It primarily supports an integrated approach, from fundamental research up to and including ultimate application and attention to societal aspects. Significant emphasis is also placed on the education of young people and the positioning of genomics in social, national and international spheres. (NGI, 2001: 3)

The strategy revolved around the word ‘focus’: on excellency, on social awareness and accountability, and on innovative potential. It was put into practice via an integrative approach consisting of 12 lines of action, most importantly the creation of ‘Genomics Centres of Excellence’ dedicated to fundamental research.

[insert figure 3.1 here – portrait]

Figure 3.1 Overview of NGI activities in 2004

Source: Image courtesy of Netherlands Genomics Initiative (NGI, 2005b).

The creation of ‘Innovative Clusters’ only took place later, after the establishment of the Centres of Excellence. ‘The idea of the creation of Innovative Clusters emerged within the Initiative itself, because in the Centres of Excellence industrial participation was missing’ (interview with De Geus, 2005). Since the commercialisation of research was experienced as a difficult process, the NGI developed a valorisation policy to realise innovation in the life sciences, and the Innovative Clusters formed an important part of this policy. By explicitly giving industry the lead in research, the Innovative Clusters are the materialisation of new insights in innovation theory that picture innovation as a cyclical process, instead of a linear development from academia to industry (Berkhout, 2002). The Innovative Clusters were not financed by the NGI, but from BSIK funds – a funding programme that supports the transition towards a knowledge economy with revenues from the old economy: the exploitation of natural gas.[5] Under supervision of the NGI, seven proposals devoted to the life sciences were prepared and submitted to the BSIK programme. Of this so-called 'NGI omnibus proposal' six proposals were successful – amongst others the VIRGO consortium – and they were granted a total of €86 million of the BSIK funds.

While the NGI was originally established for a period of five years, efforts to prolong the initiative with another five years started towards the end of this period. In the first five years the NGI has built a network of genomics research in the Netherlands:

> We have been able to make some changes. Parties are starting to organise themselves, take their responsibilities and this can only be understood as the result of our actions […] We have effectively stirred things up. (Interview with De Geus, 2005)[6]

This view was confirmed by an international panel of experts during the mid-term review, which also brought the issue of continuity to the fore: 'The panel was impressed by what has been achieved, but also expressed the view that more work will be required to achieve the desired and intended objectives' (NGI, 2006: 32). Based on an overview of results over the period 2002–2007 and a new strategy for the period 2008–2012 supported by industry (NGI, 2005a; 2005c; 2005d), the Dutch government decided in September 2007 to award the NGI €271 million for a second phase (NGI, 2007a). In these last years the NGI has concentrate especially on maximising the economic and societal value of the research as presented in the NGI Business Plan called 'Munt uit Genomics', which translates as 'Capitalising on Genomics' (NGI, 2007b).

Building an 'Innovative Cluster'

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[5] BSIK is an abbrevation of 'Besluit Subsidie Investeringen Kennisinfrastructuur' which translates into 'Decision Funding Investment Knowledge Infrastructure'. Retrieved 2 November 2007, http://www.senternovem.nl/bsik/algemeen/-index.asp.

[6] Interview with Dr Bernard de Geus, Project Coordinator, Netherlands Genomics Initiative, The Hague, the Netherlands, 16 March 2005.

The Netherlands Genomics Initiative has played a crucial role in the building of VIRGO. After the decline of the first Rotterdam proposal for an NGI Center of Excellence in which Andeweg and his research would have had a place, Andeweg decided to try it with the support of Ab Osterhaus when the NGI came with the new call for proposals for the Innovative Clusters: ‘it gave me the space to do what I was convinced of together with Osterhaus as a motivating factor’ (interview with Andeweg, 2005). Working on the research plan took much time, and included discontinuing experimental work and working weekends:

> Setting up a research project is a big investment for a researcher and a research group, so you have to be able to find the time to actually participate in the competitions that enable you to scale-up your research. Personally, I created that time by more or less putting my experimental work on halt when my lab-analyst went on maternity leave. So I did not have to be in the lab that often and I could dedicate myself entirely to the research proposal. (*Idem*)

Based on previous experience, Andeweg made sure he kept his plans focused and therefore decided to concentrate only on respiratory viruses: the influenza virus, the Respiratory Syncytial Virus (RSV) and the human MetaPneumoVirus (hMPV). These targeted viruses are different enough to provide the necessary variety, while also being related. In addition, Andeweg did not organise meetings with collaborators during the writing process, but mainly communicated via email or bi-lateral meetings. Only after designing the research proposal were other research groups selected to be part of the research project.

Moreover, Andeweg had become well aware of the importance of the presentation of the project and he made the proposal readable and attractive for the evaluators. He made sure, for instance, to include diagrams in the research proposal.

[insert figure 3.2 here – portrait]

Figure 3.2 The schematic presentation of the application of genomics tools in research on the virus-host interaction

Source: Image courtesy of Arno Andeweg, VIRGO.

> I learned from the EU project in which I participated that they like pictures. This is simply what works and it is not artificial as I also like to think along these lines. When people have to read lots of this kind of paperwork [he flips through the elaborated research proposal], then it is important that you show with nice diagrams how the structure is built. (Interview with Andeweg, 2005)

Finally, Andeweg and Osterhaus baptised the collaboration VIRGO: a contraction of virology and genomics which also indicates that the research has not been done earlier.

In February 2003 the VIRGO research proposal was submitted and in the following months reviewed by several organisations:

> From February till the summer numerous organisations have taken a look at it, from the Netherlands Bureau for Economic Policy Analysis to the National Institute for Public Health and the Environment and SenterNovem for economic-societal factors and of course the purely scientific review as well. (*Idem*)

The VIRGO team had to present the proposal four times in a row to different organisations, but it was worth the trouble. In November 2003 their efforts were rewarded with a grant of €10.8 million (NGI, 2003: 11).

But what about the participation of industry? When asking Andeweg about this, he acknowledged that the requirements for VIRGO were quite different from the requirements of the academic Centres of Excellence of the NGI. Most importantly, industry needs to be the leading party in an Innovative Cluster. Consequently, the VIRGO consortium put forward ViroNovative, a company that is dedicated to the human MetaPneumoVirus (hMPV) which was discovered by Osterhaus's group in 2001. This discovery resulted in the establishment of a new company that is located in the same building as Osterhaus's group, only two floors higher:

> This company is a spin-off of our group. So that was easy, as Ab [Osterhaus] is the scientific director of the company. We could perfectly combine the two so as to find a good solution. And we all work both above and here below anyway. This good "internal" public–private collaboration, then, provided the

> foundation for the expansion of public–private collaboration in the innovative cluster. (Interview with Andeweg, 2005)

According to Andeweg, the NGI knew that ViroNovative was not really the leading party behind the consortium, but this was not a problem as VIRGO is one of the clusters with most commercial ties.

Industrial involvement in VIRGO has indeed taken shape but only after the academic start of the project. This means that industry was not involved in the formulation of the question – as required by NGI – but Andeweg says about this:

> It depends on how you define what a question is. Pharma in general and Solvay [one of the participating companies] in particular, have a great interest in better vaccines, so there is a demand. It is only that they did not ask us explicitly to do this using genomics tools. (*Idem*)

Nevertheless, industrial parties became seriously involved in the research collaboration and contributed €3.3 million to the project (Boekholt et al., 2007). The industrial partners had different aims: ViroNovative wanted to exploit its IP position further by developing knowledge for marketable products for hMPV intervention strategies while Solvay Pharmaceuticals was interested in the development of knowledge for a new generation of human influenza vaccines. Next to ViroNovative and Solvay, Intervet took part in the project aiming to develop knowledge for animal vaccinations. The different orientations of the companies involved enabled them to build on the same knowledge without competing with each other.

Academic and industrial partners also agreed on being complementary. The academic partners remained to have primarily academic goals: the development of new knowledge about host-virus interaction on which future research can be build. However, coordinator Andeweg also acknowledged the importance of academia and industry working together, as it is important that academic research on vaccines has an outlet to companies. Moreover, the group of Osterhaus has a long-term tradition of cooperation with industry to supplement governmental research funding which is ‘not always abundant’. The other way around, vaccine companies depend on public research as they are often not able to perform fundamental research themselves. The industrial partners therefore hope to acquire new fundamental knowledge through academic projects that can be further developed into marketable products. Jeroen Medema from Solvay Pharmaceuticals explains how VIRGO contributes to vaccine development:

> The VIRGO consortium is of great importance for vaccine producers. First of all, we do not have the capacity to carry out that kind of fundamental research ourselves. Our strategy is to monitor what is going on in universities and elsewhere and then jump on the bandwagon, preferably before it accumulated speed. That means we try and pick up new concepts at an early stage and develop them further through clinical trials, registration and market introduction. We expect VIRGO to feed our pipeline of new vaccines and medicines. (Medema cited in NGI, 2005e)

This quote confirms the importance of the collaboration for industry. Medema especially expected to use the VIRGO research to improve vaccines and reduce the time that is needed to develop a vaccine.

In short, the analysis of the formation of VIRGO shows how the research project is actually an academic collaboration that turned into a public–private collaboration led by a company due to the requirements of funding policy. The result was the VIRGO project proposal in which actors brought their different goals in line by combining fundamental research with industrial goals for application.

Organising the VIRGO Consortium

In the case of VIRGO the organisational structure of the project makes visible how academia, government, and industry have become entangled. First of all, the project has been connected to the Dutch government via its funding sources: the Netherlands Genomic Initiative and the BSIK funding programme, a collaboration between six Dutch government departments, including the Ministry of Education, Culture and Science which is responsible for the Innovative Clusters of the NGI. However, the monitoring of the BSIK programmes was delegated to SenterNovem, an agency of the Dutch Ministry of Economics Affairs that stimulates innovation. As a result the

VIRGO consortium has been officially tied to two funding programmes and three government organisations. Moreover, the requirements of the funding organisations have connected the academic partners to the industrial partners in the collaboration.

The Project as a Triple-helix

The VIRGO consortium consists of research groups from four universities and three pharmaceutical companies. Next to the spin-off company ViroNovative (that has now become part of the American company MedImmune), Solvay Pharmaceuticals has been a long-term partner of the virology department in Rotterdam regarding research into human influenza and Intervet, specialising in animal pharmaceuticals, was already involved in genomics research, notably related to poultry. The academic partners involved in VIRGO are colleagues of Andeweg dispersed over four Dutch universities, specialising in virology, theoretical biology, medical microbiology, veterinarian medicine, pulmonary medicine, immunology, paediatrics, neurology, and bioinformatics. As all partners were already connected to the group of Osterhaus in some way, the VIRGO project solidifies already existing connections in its organogram.

[insert figure 3.3 here – portrait]

Figure 3.3 Partners in the VIRGO consortium

Source: Image courtesy of Arno Andeweg, VIRGO.

Within this organisational structure, the research was divided into 10 so-called 'Work Packages': 'Of each WP we elaborated on the participants, the goals, the approach, the detailed approach, the milestones and the responsibilities' (interview with Andeweg, 2005). Each Work Package performed a specific part of the overall research plan and studied, respectively: host-virus interactions in target cells (1); mouse models (2); non-human primates (3); chickens (4); and humans (5) (Johnston et al., 2007). Other packages were dedicated to vaccine research (6); transcriptomics (7); proteomics (8); data storage, analysis, and mining (9); and the modelling of immune gene-interacting networks (10).

While the Work Packages were performing the research independently and each has its own research leader, they were related to each other through the overall aims of the research and the fact that they also build upon each other's work. For instance, the cell and animal studies were performed to find basic mechanisms of host-virus interaction that may also take place in humans. Therefore, Work Package 3, which uses non-human primates for experimentation, explicitly built on the work within WP 1, 2, and 4 in which respectively cells, mice and chickens were used as a model. WP 6, which performed research on vaccination, again built on WPs 1 to 4. In addition, WP 7 has been dedicated to technology development and standardisation for all projects and partners in the consortium, which is crucial for making data compatible. Finally, WP 9 and 10 integrated the data from all the other research efforts and built models.

Next to the individual management of the Work Packages, an overall management structure of the VIRGO consortium was set in place, consisting of a governing board, a general assembly and a steering board. The governing board reported to Senter and the NGI, while in the general assembly decisions about the project were taken. Each WP had a representative in the general assembly who represented one of the participating institutions at the same time. The steering board, in turn, was responsible for daily business. It was formed by Andeweg (as coordinator) in dialogue with Osterhaus (as official head of the project) and supported by a half-time secretary while some people with business experience were involved too. In addition, the project made use of the experience of an officer of the Technology Transfer Office of Erasmus MC to allocate IPR. Finally, legal and financial matters were outsourced to experts, respectively to the legal service of Erasmus MC and an outside accountancy firm.

VIRGO thus shows how the different domains of government, academia and industry have been tied together in an organisational structure of various layers. First of all, the core of the VIRGO consortium consists of academic and industrial research groups. Around this centre, government agencies are in place, as well as financial and legal support. Secondly, the project itself has various organisational levels. While at first sight the 14 different research groups all seem to collaborate, it turns out that the research is actually divided into 10 Work Packages in which specific groups work together. These groups are connected through the research results and via the management of the project. It is only on the management level that actors from all the different organisations come together. This structure binds the different domains together in a new organisational entity that forms the backbone of the research: the VIRGO project that enables the different societal orderings to connect and overlap.

Control and Accountability

Next to structuring the research and its governance, the project format deals with control and accountability of science. When talking to scientists in charge of a research project, you can be sure that they get started on 'bureaucracy' at some point, a term that scientists use to cover the things they certainly do not like: policy procedures and the pile of paperwork that comes with it. Originally bureaucracy does not have a negative connotation and it can also be argued that bureaucracy is the protector of freedom in scientific collaboration as it defines the participants' rights concerning data (Shrum et al., 2007). And although it is nowadays very much part of a career in science, for scientists, bureaucracy is often a major cause of frustration and the direct enemy of valuable research time (Parker et al., 2011). In this respect Andeweg is exemplary as he prefers government just handing out a bag of money without restrictions:

> Sometimes I wonder what happens if you just give researchers money and a direction of research and let them do their job. Of course things will go wrong, but the question is whether more things will go wrong? At least it would mean that more money is spent on research as now the costs for the whole apparatus are quite substantial, not only at the policy side, but also at the academic side. (Interview with Andeweg, 2005)

In this light, the need for an NGI was even questioned by scientists. For instance, the prominent Professor Piet Borst, former director of the Netherlands Cancer Institute, claimed:

> Already before the establishment of the NGI, excellent research in genomics was performed in the Netherlands. Researchers only needed money to be able to perform world-class research, but they did not need orchestration. They know themselves which research directions are promising. They needed help, not interference or extra bureaucracy. (Borst, 2004: 46)

From a scientific perspective the new NGI initiative with its elaborate strategies, fancy brochures and network meetings seems a waste of money, because it is the research that counts and that is where the money has to go.

A different perspective, however, also shows a different world. From a policy perspective De Geus from NGI states that the regulations and paperwork that come with the funding of science are simply essential:

> The Netherlands Genomics Initiative is viewed as quite bureaucratic indeed, but this is all but true. Yes, we do have some rules people have to adhere to. But when we ask for reports of progress we want to know only about the general progress, not the details. Rather than lengthy reports of progress, we want concise ones. Accountability is the real problem, however. People just don't like to be accountable, especially scientists. But accountability is not a strange thing to ask for. When I award a research grant of some 16 million [Euro], I would think I'm entitled to know what happens with the money. […] We are talking about public money here that should be accounted for. (Interview with De Geus, 2005)

On a European level, Dr Jacques Remacle, who is working for the part of the Directorate General for research that specialises in functional genomics, adds that the need for accountability increases together with the scale of research:

> When dividing money over small research projects, it does not matter if one project does not deliver as the others will. However, when investing huge amounts of money in large research networks I need to know how the money is spent. (Interview with Remacle, 2005)[7]

Moreover, it is argued that research policy takes place on a playing field in which science is not the only player, and that research has to compete with other national and European priorities and should therefore produce tangible economic or social benefits in order to be legitimate.

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[7] Interview with Dr Jacques Remacle, Policy Officer Unit F4, DG Research, European Commision, Brussels, Belgium, 6 October 2006.

These dissimilar scientific and policy perspectives on bureaucracy are to some extent reconciled in the VIRGO project. The project structure enabled the scientists to develop their own internal management practices, while also staying accountable to the funding organisation. On the one hand, the internal coordination of the project could be organised by participating scientists themselves, minimising bureaucracy. Within the VIRGO project they explicitly tried to keep the organisational structure simple:

> In other consortiums they put an extra management layer in between, but they often take the bureaucracy of The Hague [the seat of government and many funding organisations] into the research projects […] In contrast, we are very decisive compared to the sister projects who often have about three people being responsible for daily business. (Interview with Andeweg, 2005)

Initially, they chose Andeweg as the central coordinator: like a spider-in-the-web involved in research as well as management and communication towards outside organisations. And although participants sometimes got annoyed when Andeweg sent them too many different emails, they certainly appreciated the lack of bureaucracy. Nevertheless, during the course of the project they had to expand the management of the project by hiring a special project manager (personal communication with Andeweg, 2009).

On the other hand, the project format enables accountability and evaluation of science by making science open to external control. By constructing VIRGO as a research project, it becomes a separate organisational entity with pre-set goals that can be evaluated, not only at the beginning and the end of projects, but also at regular intervals in between. More concretely, in case of VIRGO three different evaluation procedures were in place. First, VIRGO started with a so-called ‘zero measurement’ in which the situation at the beginning of the project was pictured, followed by monitoring halfway and at the end. Secondly, reports of progress for the Netherlands Genomics Initiative had to be made every six months. In addition, VIRGO is part of evaluations of the NGI as a whole. Moreover, reports of progress not only focus on scientific results but also on the management process and societal evaluation criteria. As under the influence of government and industry standards of evaluation have become more diverse in comparison to the peer-review that is the common form of evaluation in the scientific domain. Therefore, evaluations also pay attention to the commercialisation of research results, such as the number of partners, patents and start-up companies.

Making Time and Space

Next to dealing with control and accountability, the project enables the creation of its own time and space. Firstly, the project intermediates between the different time regimes in science, government and industry. While research results can take quite some time and certainly do not come at a pre-set time, administrative time has an annual rhythm and is relatively short-term. Finally, industrial time is configured as 'time to market' (TTM), which refers to the time it takes to transform knowledge into a product that can be sold and which is ideally as short as possible. By going beyond these different orderings, the research project makes its own time. This coordination of different temporal regimes can be clearly seen at the start of VIRGO project. While the development of the new line of research by Andeweg already started at the end of the last century, the project proposal for VIRGO was handed in at the beginning of 2003. Although they soon heard that chances of funding were high, and funding was officially confirmed in October 2003, the year 2004 was well under way before they could officially start the research:

> In the summer [of 2003] we already knew that we were in second position concerning the science review of about 70 projects that would eventually get funded, so we knew we had a very big chance. But it took almost a year before we actually got the letter that we could start. That was around March or April 2004. And to make matters worse, we had to start retro-actively in January. (Interview with Andeweg, 2005)

So while the research project could only start after they received the letter, the official starting point of the project became the beginning of a new (administrative) year: January 2004.

Although the project format enables harmonisation of different timeframes through the creation of a project timeline, it proves difficult to connect them smoothly. This can not only be seen in the process of designating a common starting point, but also in the evaluation procedures. Although January 2004 was considered to be the project's starting point the research had not actually started yet, which turned the first six-month progress report into a problem because no research had taken place yet. A similar problem became apparent during the external evaluation of the Netherlands Genomics Institute in 2006. Four years after the start of the NGI, the initiative was subject to thorough evaluation, including the 11 research centres that were established under its supervision. As a result, also the VIRGO consortium was evaluated by an international review committee chaired by Sebastian Johnston, Professor of Respiratory Medicine at Imperial College in London. And although overall the consortium was evaluated as 'very good to excellent' the report stated:

> This evaluation is carried out prematurely as the Consortium only received confirmation of its funding in October 2004 and many of the Work Packages only started their work between 1 year and 1½ years ago. The Committee were really only able to review planned activities and preliminary data. Productivity for all Work Packages was impossible to assess. The scoring of the various Work Packages has potential to be considerably higher than that awarded in this assessment as there was little in the way of outputs available for review. The "Work in Progress" was generally considered to be of excellent quality. (Johnston et al., 2007: 11)

So Professor Johnston and his colleagues came all the way from the United Kingdom, Canada, Northern Ireland, and Spain while the time was not right.

In addition to time, different spatial orderings need to be aligned. While science and flu research is an international activity and also industry is often multi-national operating on global markets, government has a national orientation. Within the VIRGO project these different spatial orderings are realigned into a national space: it consists only of Dutch research institutes and companies located in the Netherlands. The funding source is the reason that VIRGO has become a national collaboration, as the NGI has been established to build a genomics research infrastructure within the Netherlands and does not support scientists from other countries and BSIK funding also has a national label. This tension between international and national also becomes apparent when analysing the output of VIRGO, which shows how publications were still predominantly international, while national publications show increasing collaboration between the consortium partners (Hessels et al., 2012; Hessels and Deuten, 2012).

[insert figure 3.4 here – portrait, full page]

Figure 3.4 Map of publications showing connections between participating organisations from VIRGO in the period 2000–2003[8]

[insert figure 3.5 here – portrait, full page]

Figure 3.5 Map of publications showing connections between participating organisations from VIRGO in the period 2007–2010[9]

Only when the NGI later broadened its scope to include internationalisation as an objective, the international context of the VIRGO project became more acknowledged. As a result, the creation of VIRGO shows how sometimes a specific ordering can be more dominant in the new project configuration then others and the government proved to have the upper hand within VIRGO.

New Roles for Scientists

When reflecting on his own role in the construction of VIRGO, Andeweg notes that building collaboration is a different way of doing science, as coordination and management become more important: ‘The motivation to start such a project is the fascination for the content of the research, but in practice you gradually transform into a manager’ (interview with Andeweg, 2005). Managing research can have important consequences for the career of a scientist. Building a new research project simply affects the academic performance of a scientist, as no time is left for performing research and writing publications:

> I just got to the point in this research project where I can start thinking of publishing again, but I didn’t have that for years. Of course it does matter if

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[8] With a special thank you to Edwin Horlings of the Rathenau Institute in The Hague for making this map, and CWTS, Leiden for providing part of the data.

[9] *Idem*.

> you manage to acquire such a project, because it allows you to stay on a bit longer. But I made an enormous time investment that might as well have left me with nothing if the project would not have been funded. It is victory or death. (Interview with Andeweg, 2005)

In addition to the lure of management, the crossing of the boundary between academia and industry has implications on an individual level as well. For instance, within the Industrial Cluster format of VIRGO it would have been easier if Andeweg as the person in charge had started to work for the leading company ViroNovative. However, he explicitly refused to make the transfer to industry as he prefers being an academic:

> I simply do not want that. You will get the most bizarre situations, for it is all about money there, and you are also dependent on the decisions of the American parent company […] My heart is with research and I want to do that within academia because I want to be independent. (*Idem*)

At the same time Andeweg states that being an academic increasingly can be compared to being an entrepreneur. Scientists can only perform research when they write research proposals. If in this case Andeweg made a clear choice to stay within academia, his role as an academic transformed anyway. He is forced to balance managerial interests and scientific standards: a double role.

Although Andeweg stays put, individual border crossings have become quite common within the scientific world these days (Shapin, 2008). Some scientists even seem to be particularly good at it: they manage to strike a balance between science, business and policy interests and in addition sometimes even master public communication. A famous example is Craig Venter who, after the beginning of his scientific career within the National Institutes of Health, reinvented himself as an entrepreneur competing with the public project to sequence the human genome and then became a non-profit scientist again (Shreeve, 2004; Venter, 2007). If this made him world famous, it also turned him into a scientist who is able to combine different roles, as is expressed by the well-known picture that shows Venter half as a scientists and half as a businessman. The official leader of VIRGO, Professor Ab Osterhaus, performs a similar hybrid role within the Dutch national context and the international community of influenza experts. He combines his role as a successful academic, with his roles as director of the Dutch National Influenza Centre, government advisor and entrepreneur. In addition, he regularly appears as an expert in all kinds of media to talk about the risks of influenza.

Although Osterhaus's embodiment of different identities has been an asset for the promotion of VIRGO in the different domains, the combination of different roles can also give rise to criticism. In the case of Osterhaus it was the epidemiologist Dr Luc Bonneux from the Belgium Health Care Centrum who took a stance against virologists who are predicting the coming of a pandemic and are at the same time advising governments to buy anti-viral medicines while also having ties to the pharmaceutical industry (De Rijck, 2005).[10] Consequently, Bonneux questions whether it is possible to combine the different identities in a single person, suggesting that a scientist should keep to their scientific role.

VIRGO Continued

While projects have a clear end, the research process continues to develop, providing new challenges and opportunities. Although the VIRGO project was granted for the period of 2004–2009 with a project extension till 2010, the participants were eager to continue the line of research that grew out of the combination of virology and genomics: 'We have learned from VIRGO and other scientific developments and we would like to broaden our ability and skills' (interview with Andeweg, 2012).[11] As the NGI was granted another five years after its initial period from 2002–2007, some NGI projects were refunded and this also provided opportunities

[10] This critique was first formulated in a newspaper article in the Belgium national newspaper *De Standaard* and was followed by an interview on Dutch radio in 'De Ochtenden' on 19 October 2005, retrieved 1 December 2005, http://www.ochtenden.nl/afleveringen/23986305/, and a debate between Bonneux and Osterhaus on *NOVA*, a Dutch current affairs television programme, on 22 October 2005, retrieved 1 December 2005, http://www.novatv.nl/-index.cfm?LN=nl&FUSEACTION=videoaudio.details&REPORTAGE_ID=3808.

[11] Interview with Dr Arno Andeweg, Managing Director of VIRGO, Viroscience Lab, Erasmus Medical Centrum, Rotterdam, the Netherlands, Utrecht, 14 November 2012.

for VIRGO. Despite good outcomes (over 200 peer reviewed publications and about 20 patent applications and licences) and evaluations of the initial VIRGO project, this did not lead to a continuation of NGI funding. NGI did not give a full second grant but a partial one to enable some continuation of the research and find additional funding which was provided by the Dutch Life Sciences Health sector FES grant.[12] As a result, VIRGO II combines two funding sources thereby not only increasing the total research budget to about €30 million (including 50 per cent matching by the partners), but also the scale and scope of the project.[13]

VIRGO II explicitly builds on the work of VIRGO but the project has broadened in various ways. First of all, the single focus on acute, respiratory viruses has expanded towards the inclusion of chronic viral infections (including hepatitis B and C and HIV infections), and pioneering research on neurological disorders with suspected viral origin. Secondly, and in line with a more general trend in the life sciences, there has been a move from a focus on genomics towards the use of a broader spectrum of technologies and computation: 'a so-called integrative way of working […] as given the complexity of the systems we study in biology, we need to combine existing and new technologies in our research' (interview with Andeweg, 2012). This also allows a shift towards virus discovery and identification, in addition to the understanding of viral infections and the development of anti-viral strategies. Similarly, the project organisation expanded from 14 to 19 partners: seven academic institutions, three research organisations and nine private sector companies. In parallel, also the management of the project expanded: 'While I started doing it alone, we now have a project management office of two to three people' (*idem*).

[12] FES is the abbreviation of 'Fonds voor Economische Structuurversterking' which is a Dutch fund for the strengthening of the economical infrastructure which is sourced from the profit the Netherlands makes with its natural gas.

[13] See also: http://www.genomics.nl/Research/GenomicsCentres/VIRGO.aspx and http://www.virgo.nl, retrieved 8 January 2012.

The prolongation of VIRGO I into VIRGO II shows the resilience of large-scale science projects as it proves difficult to break these new structures down again once they are in place (Lambright, 1998) but the end seems near as the project funds will finish in 2015: 'After that the dessert starts, then it is over. That is really true' (interview with Andeweg, 2012). The end seems final as the NGI dissolves completely in 2013, while VIRGO FES runs till 2015 – maybe allowing an extension till 2016 – but then also terminates as FES money will not be invested in research afterwards. This situation does not only provide VIRGO, but Dutch life sciences research in general with a dark funding future: 'We will have to see how things will develop […] but it would be nice if it will not burn out like a candle, isn't it?' (*idem*).

Conclusion

The analysis of the VIRGO consortium shows the influence of the project format on research and its role in bringing different societal domains together. Next to the creation of common objectives and deliverables, the project connects the different 'modes of ordering' of academia, industry and government: specific agendas, structures, procedures, and timeframes that are fundamental to the stories and actions of each specific domain (Law, 1994). The project accommodates the crossing of boundaries through the creation of a new structure, common procedures, and particular temporal and spatial orderings, thereby resolving tensions between the different modes of ordering, or at least finding a workable solution. As such, the project links various organisational structures, but also orchestrates different practices and procedures in the project proposal and later within the project management.

However, next to boundary crossing and the merging of different modes of ordering, the building of VIRGO also shows how boundaries become realigned or are kept steady. This can be seen for instance in the objectives of the project. Although the different parties involved have formulated a common goal, they maintain their own separate goals underneath the shared goal. In addition, the structure of the project still maintains boundaries between different domains; while the overall structure of VIRGO presents collaboration, the actual research takes place in separate Work Packages that only require specific researchers to work together so they can follow their own way of working. In addition, scientists have made procedures inside the project as simple as possible, trying to keep governmental bureaucracy outside of daily project activities. Finally, borders are protected on an individual level. While some individual scientists are able to cross boundaries between the different domains, others decide to stay put in the scientific domain or change to industry. As a result, projects have a different face on the level of management, the actual research practice, and the individual level of scientists: they enable the merge of science with governmental and industrial orderings, but the project structure also leaves room to protect the division between science and industry.

Nevertheless, the use of the project format in science also causes major tensions as the scientific order repeatedly becomes secondary to other ways of ordering. Most importantly, the project mode of working tries to make science a structured and controlled process, which opposes the unpredictable character of the research process. For example, the fact that research has to start with a clear-cut problem and concrete objective does not leave space for gradual scientific development or surprise which is characteristic for innovative scientific research. This tension is nicely illustrated by the obligation of scientists to predict the number of patents they expect to produce:

> We sometimes have a good laugh about these forms. If you can predict what will be the result of your research, you do not have to perform the research anymore […] And they want it [the number of patents] specified per year. It is like having to predict in which city you will live 10 years from now and also knowing in which street and at which number […] If I already knew, I would not be working in academia but I would work as an adviser to a company. (Interview with Andeweg, 2005)

Also with regard to other aspects such as output, time, and space, the scientific order has been compromised. For instance, the objectives of the VIRGO research shifted from academic publications to results that fit into the industrial mode of ordering aiming for patents. In addition, the project time followed the governmental mode of ordering as the evaluation of research complied with the annual political rhythm while ignoring the pace of scientific developments, and its termination is also caused by the governmental decisions to discontinue funding sources. Similarly, the national government space prevailed over the international scientific orientation. In such cases the intermingling of the three societal domains – science, industry, government – in the project format has more impact on scientific ordering than on the other orderings, a phenomenon called 'asymmetrical convergence' (Kleinman and Vallas, 2006).

When looking more precisely at practices of science and innovation it becomes clear that invention not only takes place with regard to development of new knowledge and applications but also importantly resides in organisational arrangements:

> inventiveness should not be equated with the development of novel artifacts, or indeed with novelty and innovation in general. Rather, inventiveness can be viewed as an index of the degree in which an object or practice is associated with opening up possibilities. In this view, scientific and technical objects and practices are inventive precisely in so far as they are aligned with inventive ways of thinking and doing and configuring and reconfiguring relations with other actors. (Barry, 2001: 211)

This begs the question if the project format allows enough inventiveness to harbour the possibilities of research. VIRGO is an 'innovative cluster', but does the implementation of the project format also result in an innovative arrangement of relations? In the analysis it became visible how VIRGO was inventive in opening up possibilities to get research funding and adapt the organisation of research to funding requirements and the projectification that comes with it. However, the project format also limited possibilities and relations from a scientific perspective, as the scientific order was repeatedly compromised. Perhaps the organisation of science should be more flexible than the current projectification allows, leaving room for inventive ways to configure and reconfigure relations and adapt the organisational form to specific research practices? The analysis of the VIRGO project has shown that when projectifying (health) science, it is important to realise the opportunities and limits it brings.

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