Rathenau Instituut

Beyond public acceptance

Design of a societal incubator for promising (nano)technologies

Report

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Foreword

In 2015, I was a guest in the Dutch TV programme Future Makers. The programme was about the bright future in store for nanotechnology. Nanotechnology is highly promising in theory, but the road to putting it into practice is paved with uncertainties, for example concerning public acceptance, policy, regulation, and liability. These uncertainties mean that developers, companies, the authorities, risk assessors, and civil-society organisations all often adopt a wait-and-see attitude, leading to useful innovations being “left on the shelf”.

This report describes how a “societal incubator” could contribute to embedding promising new technologies within society. A societal incubator is a gathering place for collective learning processes at which all parties involved get to know one another’s opinions and motives better. It involves more than just looking for public acceptance. For example, a societal incubator challenges technology developers to show how innovation can contribute to solving important societal challenges. In that sense, it can be seen as an example of responsible research and innovation.

The report *Beyond public acceptance: Design of a societal incubator for promising (nano)technologies* is the result of an exploratory study by the Rathenau Instituut (in collaboration with the Agricultural Economics Research Institute at Wageningen University), that was commissioned by the Dutch research and innovation consortium NanoNextNL. The Rathenau Instituut has a long history of facilitating and organising dialogue about new technologies such as nanotechnology, and the request therefore linked up well with our work.

The study involved holding interviews, organising workshops, and studying the relevant literature. Our conclusion is that the societal incubator is a viable concept, although one that requires investment in time and manpower. Moreover, we believe that a societal incubator should be viewed as an opportunity for mutual social learning and also as a new kind of institution.

I hope that with this exploratory study will contribute to advancing towards the societal incubator and that promising innovations will in future find their way onto the market more quickly.

Dr Melanie Peters
Director
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Part I

Design of a societal incubator

A societal incubator for promising (nano)technologies

> *The societal incubator is an experiment in learning about future possibilities, the variety of responses, mutual adjustment of strategies and, in general, reflexivity about one's role in the emergence and embedment of novel technologies in society.*
>
> *Harro van Lente, 2015*

This report is the result of an exploratory study, commissioned by NanoNextNL, of the development of a "societal incubator". Our approach, findings and conclusions are discussed in part II. In this section, we begin by presenting the design of a societal incubator as the final product of our study.

The design consists of (1) a general description of the concept of a societal incubator, (2) a roadmap of activities which should be included in the societal incubator process, (3) a script for an interactive stakeholder workshop as a component of this process, and finally (4) the requirements and rules necessary for a societal incubator to be viable.

1 The concept of a societal incubator

A societal incubator, set up in response to "waiting games" or as a means to prevent them, creates conditions for an open and participatory learning process which will accelerate socially responsible innovation and increase the likelihood of social success.

New (nano)technologies can help to solve important problems facing society, but technology developers face many uncertainties, for instance, with regard to public acceptance, policymaking, regulation, and liability. This sense of uncertainty is shared by other relevant parties such as the authorities, companies, risk assessors, and civil-society organisations. Given the uncertainties regarding what other parties might do next, all those involved adopt a cautious stance. This leads to "waiting games" which help perpetuate uncertainty, and, as a result, potentially useful innovations are "left on the shelf". In order to break free from (or prevent) this stasis, collective action is required. The societal incubator aims to enable that collective action.

2 Roadmap of activities within a societal incubator

A societal incubator starts with a promising (nano)innovation that, ideally, helps to address a challenge facing society, for instance in the field of sustainability or health. Scientific, technical, and economic barriers will already have been addressed, and the stakes are therefore high. But there remain significant uncertainties as regards public support, policymaking, risk assessment, regulation, and liability.

A societal incubator concludes ideally with a product which is socially acceptable and has added value for society. To achieve this ideal end result, conditions must be created that enable a collective learning process regarding the possibilities, significance, and implications of (nano)technological innovations. The figure below outlines the crucial stages of a societal incubator in the form of a roadmap.

This proposed roadmap is designed to enable a learning process which allows the technology developer to determine his or her chances of success while ensuring socially responsible innovation. A societal incubator includes three crucial steps: (I) collecting information and organising interaction, (II) analysis, and (III) deciding whether to continue the development trajectory or bring it to a halt.

Step I – Information and Interaction
Given the uncertainties surrounding potential innovation, it is important that technology developers clearly understand those uncertainties from the outset. The aim of this “Information and Interaction” step is to learn from the knowledge and perspectives of as many stakeholders as possible that are relevant to the innovation concerned. Ideally, this first step derives from a combination of desk research, interviews, and finally interaction between the various stakeholders and the technology developer. A stakeholder map is first drawn up, based on the uncertainties with which the technology developer is confronted. This includes an overview of the relevant stakeholders, such as producers, retailers, users, consumer organisations, policymakers and civil-society organisations. Next, as much knowledge as possible is gathered about the stakeholders’ views on potential technological innovations.

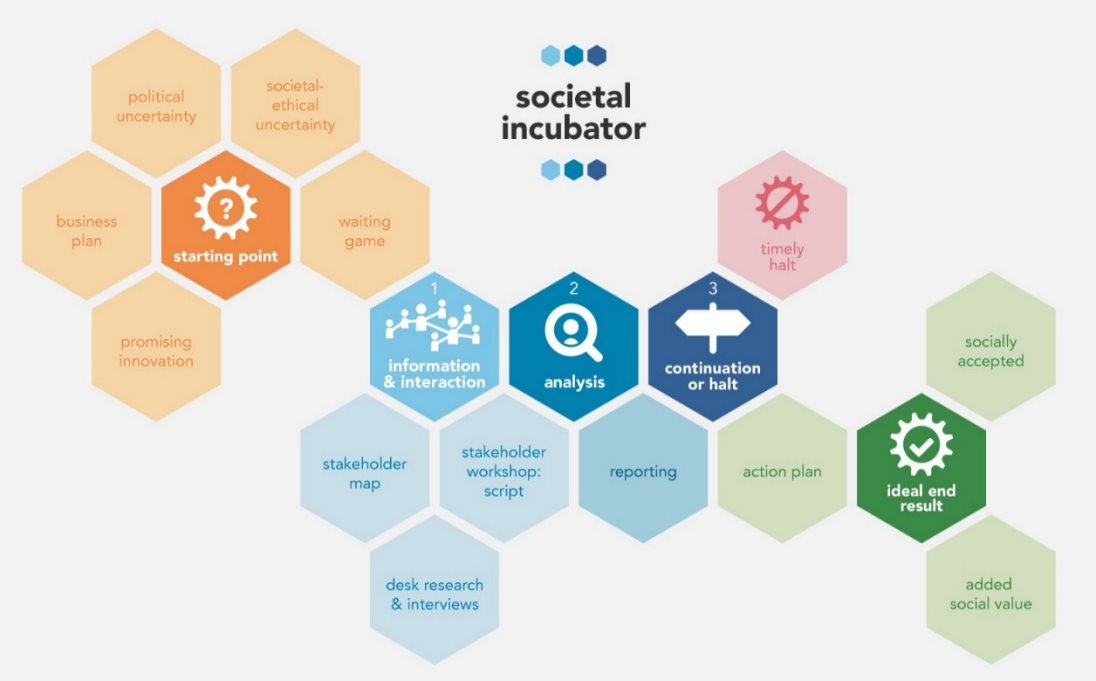
Reports available on the Internet often provide valuable relevant information. However, it is highly likely that knowledge gaps will remain, for instance because there is no information on how stakeholders assess this specific innovation. In order to address these gaps, additional interviews should be conducted.

The reduction of uncertainties and the disruption or prevention of waiting games demand a collective learning process, and therefore interaction between the stakeholders and the technology developer. This is why we refer to the first step as Information and Interaction. A societal incubator should contribute to mutual understanding and trust between stakeholders, it should offer an overview of the causes of waiting games, and it should provide scope for developing creative solutions collectively. One or more interactive stakeholder workshops are therefore an essential component of this step.

Step II – Analysis
During the activities in step I, the parties concerned achieve a broader understanding of the uncertainties faced by the technology developer. The stakeholders also gain increased clarity about one another’s views as regards societal needs, socio-ethical acceptability, and (risk) regulation. The technology developer also achieves a better understanding of the possibilities and challenges involved in creating a promising and socially acceptable product. Furthermore, this learning process creates scope for other stakeholders, playing a critical intermediary role, to contribute to the innovation process and to breaking free from, or preventing, waiting games. An analysis, in the form of a report, will weigh up the results of the process and will be made available to all participants.

Step III – Continue or halt

Once the first two steps have reduced uncertainty and identified perspectives for action, the technology developer can decide more effectively whether or not to continue with development. In the event of continuation, the analysis can form the basis for an action plan with subsequent steps towards the ideal end result: a socially accepted product with added value for society. The analysis might, for instance, identify potential conditions to be met by the technology developer, or alternative design choices which meet the concerns and/or needs of the stakeholders. It might also become clear that specific stakeholders should become further involved, to clarify steps needed for risk analysis, for example. Conversely, risk assessors might themselves be helped by a specific case in developing a risk analysis. Finally, it might transpire that further opportunities for interaction are desirable. All these steps should be accommodated within the action plan. Alternatively, the technology developer can choose to cease development of the product. In that case, a timely and informed decision can be made by the technology developer which minimises potential (financial) damage.



3. Script for the stakeholder workshops

A critically important condition for the collective learning process within a societal incubator is the organisation of interactive stakeholder workshops. A script for these workshops is therefore a crucial aspect of the societal incubator design. As stated above, the ideal end result of the learning process is a socially accepted product with added value for society. The latter refers to the way in which a given product contributes to tackling a pressing societal problem. A first test of our script – in a pilot stakeholder workshop on a specific business case – made clear that the participants required a broadening of the discussion in order to devote more attention to the issue of added value. This involved questions such as, "What types of future development is society waiting for, and under what conditions can nano(technology) contribute to that, ensuring social acceptance?". What follows below is the definitive design for a script, including scope for discussion of the relevant *societal context and needs*, and for discussion of *alternative (nano)technological innovations* in response to those needs.

Script for interactive stakeholder workshops

	Explanation
Welcome	The discussion leader welcomes the participants and introduces the aims and rules (Chatham House Rule). A rapporteur produces a written report of the meeting.
Introductions	Participants introduce themselves and indicate how they are involved with nanotechnology and/or the relevant social context under discussion.
Introduction of business case	The technology developer (problem owner) explains the business case, including the technical-commercial aspects, the intended added value for society, and the political-regulatory and socio-ethical uncertainties he/she faces. Questions can be asked to clarify matters.
Social Context	Selected participants will be invited to make a presentation regarding the relevant societal context and related challenges that the business case will have to meet. This will provide a framework for the exploration of added value for society.

Initial responses	All participants give their initial response and indicate the uncertainties that they foresee. The participants note down their answers on Post-its. When explanations are given, the discussion leader asks follow-up questions ("Why?") in each case so that it also becomes clear what values are concealed behind the comments. Participants can respond to one another. Each Post-it is handed to one of the organisers, who sticks it on a flipchart. There are five flipcharts, one for the initial responses, the others for the various types of uncertainties: techno-scientific, commercial, political-regulatory, and socio-ethical.
Prioritising uncertainties and points for consideration	Each participant is given a number of stickers. They mark the uncertainties that they find most important with a sticker.
Further discussion of dominant uncertainties and bottlenecks	Based on this priority ranking, the discussion leader and problem owner identify two or three dominant uncertainties/bottlenecks for discussion in greater detail. During the discussion, the discussion leader looks for common ground, possible solutions, and perspectives for action. The focus is on the ideal of a socially *accepted* product with *added value* for society. The discussion focuses on the following questions in particular: 1. What is going on? What is the core of the uncertainty? (better understanding) 2. How will we deal with it? What needs to be done? (possible solutions, and perspectives for action) 3. Who will do what? (appropriation and assignment of responsibilities) In each case, the discussion leader requests feedback from the problem owner: Are things sufficiently clear? Can responsibilities be allocated clearly? Do problems remain? The problem owner is given the last word each time.
Broadening of the discussion	Based on the discussion, a better oversight is achieved regarding societal challenges as well as the potential added value for society present in the business case. Beyond the business case, there are most likely additional (nano)technological innovations which could

	contribute to tackling the societal challenges at issue.
Lessons learned and action points	In this final round, the participants share their take-home message, as well as any additional perspectives and suggestions for follow-up steps. Again, the problem owner is allowed the last word.
Closing	Thank the participants and conclude the workshop.

4 Requirements and rules

In the final section of this design we present the salient requirements and rules for the successful development and viability of a societal incubator.

Problem ownership and support
The assumption within the societal incubator process is that the technology developer or (start-up) business is the problem owner and initiator. Within this process, the initiator should be granted the capacity to assess his or her own (potential) success and to develop socially responsible innovations. In this regard, it is crucial that the initiator is supported during the trajectory by an independent *analyst*. Akin to the business incubator, where coaching and support is given with regard to entrepreneurship, a societal incubator must offer expertise and support with regard to the societal dimensions of innovation and interaction with stakeholders. Furthermore, to ensure a collective learning process, a sincere commitment is requested from societal stakeholders and organisations. To this end, relevant stakeholders and societal organisations can be facilitated through financial compensation as an investment in the social learning process.

Confidentiality rules
As a confidential, safe space, the societal incubator encourages participants to speak openly, increasing the quality of the learning process. However, some participants may feel that their participation in the societal incubator is hampered by requirements of confidentiality. Strict forms of confidentiality may be prohibitive to some civil-society organisations if their role in the process cannot be transparent and open to discussion with their own members and/or donors. It is therefore necessary to discuss the confidentiality rules with stakeholders in a timely and clear manner.

5 Towards public acceptance and beyond

In this design for a societal incubator, we consciously chose a case-based approach (instead of a broad range of products) given the comparative ease of implementation. Additionally, it proved to be a good starting point for an initial experiment with an incubator workshop. However, this initial experiment has shown that more is needed than just finding public support for (nano)technological innovation. Added value for society is an important theme for discussion for both those involved and those affected. We conclude here that a societal incubator must, and in fact can, offer more than just the case-based approach presented in this design. As a new form of organisation, the societal incubator can also be used as a platform for a more programmatic approach. Here, technology developers, businesses, and civil-society stakeholders and organisations can explore a range of possibilities for technological innovation with an emphasis on important and pressing challenges facing society. By involving diverse parties and stakeholders in a more general and collective learning process, this approach becomes a perfect strategy to break free from, or better yet, avoid waiting games.

Part II

Report on an exploratory study

1 Introduction

This report presents the results of an exploratory study of the potential role and organisation of a societal incubator for innovations in the field of nanotechnology. The study was carried out by the Rathenau Instituut at the request of NanoNextNL, a national research and innovation consortium in the Netherlands. The initial phase of the study comprised consideration of relevant literature and interviews with a number of experts and stakeholders from industry, government, and civil-society organisations. The purpose of this phase was to gain a better understanding of the concept of a societal incubator and of the views of relevant stakeholders regarding its potential added value and how it should be organised. During this phase we also organised a small-scale workshop on the idea of a societal incubator during NanoCity, an annual national event for scientists and stakeholders of NanoNextNL. The second phase of the study involved drawing up an inventory of cases in the field of nano-innovation that could be suitable as the subject of a societal incubator workshop. This phase was completed with the development of a roadmap for a societal incubator and implementation of a pilot workshop based on a script developed for the purpose. In that context, we made use of the findings from the interviews, but also built on existing insights in the literature on interactive and constructive technology assessment and responsible research and innovation (RRI).

In this introductory section we discuss the reasons for the study and the questions that it considered. The findings of the literature study and the interviews are dealt with in Section 2. We then attempt, on the basis of these findings, to define the problems to which a societal incubator is intended to provide answers. We also formulate the requirements for the design of a societal incubator. In Section 3 we present these insights and requirements in the form of a roadmap for the societal incubator process. This includes a detailed script for a pilot workshop. The results of the workshop are discussed in Section 4 and we draw lessons for improvement from them. Section 5 concludes the report with the main findings and conclusions.

1.1 Reason for this exploratory report

“From iPads to medicines: The Netherlands leads the way in Nanotechnology”. That was the title of a news item in the Dutch TV programme Future Makers in 2015. Developments in nanotechnology – researching and processing material at the smallest possible scale – are moving fast, and the Netherlands plays a

significant role internationally. Nanotechnology has now grown into an industry worth billions.

According to the literature, the size of the global market of that industry will be around 75 billion dollars by 2020 (RCNOS 2015). The Netherlands has acquired a strong position by joining forces within public-private consortia such as NanoNextNL and its predecessors NanoNed and MicroNed (for information about NanoNextNL see Box 1).

Despite the promising potential of nanotechnology, actually putting it into practice often encounters uncertainties of a technical, commercial, regulatory, and social nature. Consortium partners within NanoNextNL believe that in some fields parties are caught in a “waiting game”. That means that certain (nano)technological developments are stalled because technology developers, the authorities, civil-society organisations, and other parties adopt a wait-and-see attitude, fuelled by uncertainty about one another’s responses (Robinson et al. 2012; Parandian et al. 2012; Te Kulve 2010).

According to the consortium partners, there is an urgent need for a collective approach to break free from these waiting games. It is against this background that the idea of a societal incubator has emerged, i.e. an approach that aims to bring about a dialogue about an emerging technology between experts and stakeholders in a safe environment, to enable them to learn from one another, and to encourage them to look for new action perspectives (Van Lente 2015). The overarching goal of the societal incubator is to break free from the waiting game situation and thus contribute to socially successful innovation. The inspiration for this comes from the proven formula of the business incubator (see Section 2.1).

Early in 2015, NanoNextNL approached the Rathenau Instituut to carry out an exploratory study of the concept of the societal incubator, and to implement an initial version so as to test its practical feasibility and added value. It was suggested that applications in the field of nanotechnology and food (“nano food”) might provide interesting case studies, given the great deal of potential this offers for innovation, with public sensitivities also playing a role (Nanopodium 2011; Te Kulve et al. 2013).

The Rathenau Instituut has a long history of studying, reflecting on, and organising dialogue on new technologies. Nanotechnology offers countless opportunities, but it also raises numerous questions, for example about the safety of people and the environment. It has therefore been an important topic for the Institute, which has undertaken a wide range of activities since 2004 to encourage and broaden political

and public debate on nanotechnology (for an overview see Van Est et al. 2012). The request from NanoNextNL therefore linked up well with the Institute's work. Within NanoNextNL, too, attention focuses not only on technical research but also on the potential risks and the ethical, legal, and societal dimensions of nanotechnology. *Risk analysis* and *technology assessment* are part of the mission of the consortium, in the form of the so-called RATA programme.[1]

Box 1 – About NanoNextNL

NanoNextNL is a consortium of more than a hundred companies, universities, knowledge institutes and university medical centres, focusing on research into microtechnology and nanotechnology. Its total budget comes to 250 million euros. half of which is contributed by the 130 partners and the other half by the Dutch government. The consortium has some 750 researchers. The research program ran from 2011 to the end of 2016. In addition to technical and scientific research, NanoNextNL pays substantial attention to valorisation, by encouraging entrepreneurship, and to the potential risks and societal impact of nanotechnology, as a theme of the RATA programme.

We can regard NanoNextNL as an initiative within which the aim of *responsible research and innovation* is implemented in practice. During a discussion of the RATA programme from the perspective of RRI, it was noted that learning processes regarding the societal aspects of innovation should take place not only at the level of the individual researcher but also at the collective level. In addition, civil-society players outside the field of technical and scientific (nano)research have an important role to play in this (Walhout 2016). We can therefore view a societal incubator as a contribution to RRI, in that it creates conditions for *collective and inclusive learning* about the possibilities, significance, and implications of (nano)technological innovations.

1 See http://www.nanonextnl.nl/themes/risk-analysis-and-technology-assessment/.

1.2 Four kinds of uncertainty when discussing nanotechnology

Uncertainties play an important role in discussions of the social significance and implications of nanotechnology. There are four kinds of uncertainty that researchers and entrepreneurs may find themselves facing when they want to bring an innovative product onto the market and into society. First, when technology developers have an interesting idea, they come up against *techno-scientific* uncertainty. Will their idea work in actual practice? But even if does "work", that doesn't mean that it will realise a profit. Is there a revenue model? Commercial uncertainty therefore plays a crucial role also. In addition to these technical and commercial uncertainties, other types of uncertainty may also be involved, such as political-regulatory uncertainty: how does the new product relate to existing forms of policy and regulation? For example, the regulation of nanotechnology has been the subject of debate for years now, both in the Netherlands and in the EU as a whole, with finding an appropriate definition of nanomaterials proving to be a thorny issue (Van Est et al. 2012). In addition, there may be fundamental uncertainty about the public response, both in terms of consumer attitudes and responses from civil-society organisations. The latter in fact took action at an early stage against the potential risks posed by nanotechnology, with organisations such as Friends of the Earth, Greenpeace, and the ETC Group calling for a moratorium on the commercial use of nanoparticles in food, packaging, and agrochemicals (Stemerding & Van Est 2013; Fautz et al. 2015). We classify this fourth type of uncertainty as socio-ethical uncertainty.

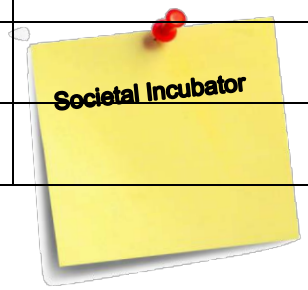
1.2.1 How NanoNextNL deals with these uncertainties

Technology developers can therefore come up against these various uncertainties when attempting to put their ideas into practice. How do technology developers within NanoNextNL deal with these uncertainties? Their work is of course aimed primarily at reducing techno-scientific uncertainty. But once that uncertainty has been removed, there is still no guarantee that an innovative idea will lead to a commercially viable product. In order to overcome this commercial uncertainty, NanoNextNL has set up an extensive business incubator programme under the heading of valorisation. This programme component enables researchers to submit business cases and be considered for funding and business support. They are required to submit a "Lean Business Model Canvas". In addition, an online "Golden Egg Check" is carried out, in which the proposal is examined in terms of, for example, the potential market size, investment opportunities, and possibilities for scaling up (NanoNextNL 2015).

Institutional arrangements have therefore been put in place within NanoNextNL to support technology developers in dealing with techno-scientific and commercial uncertainties. Those arrangements are lacking when it comes to dealing with political-regulatory and socio-ethical uncertainties. As Table 1 shows, a societal incubator is intended to fill that gap.

Table 1 Dealing with uncertainties within NanoNextNL

Type of uncertainty	Assessment criterion	Tool within NanoNextNL
Techno-scientific	Does it work?	Research and training
Commercial	Is there a revenue model?	Business incubator
Political-regulatory	How does it relate to policy and regulations?	
Socio-ethical	Is there public confidence?	



1.3 Questions to be answered by this study

This exploratory study focuses on how a societal incubator can contribute to dealing with uncertainties in bringing about innovation in the field of nanotechnology. In particular, it concerns situations in which those uncertainties lead to “waiting games”. In carrying out the study, we were guided by the following questions:

- How can we understand the dynamics of waiting games and break free from them?
- How can a societal incubator contribute to doing so?
- How do the stakeholders involved view the desirability and viability of a societal incubator?
- What requirements does a societal incubator need to meet in order to be effective and viable?

2 A first look at the desirability and form of the societal incubator

In this section we report on our initial findings based on the relevant literature and ten interviews with experts and stakeholders in the field of nanotechnology. We tested the insights that we derived from the literature during discussions with three scientists in the field of science and technology studies and an expert on business incubators. This gave us a better idea of the dynamics of waiting games and the concept of the societal incubator. We then interviewed representatives of the business community, the Dutch national government, and a civil-society organisation. The interviews mainly concerned the recognisability of the "waiting game" phenomenon and the potential added value and organisation of a societal incubator.

In addition, during NanoCity – NanoNextNL's annual showcase event – we organised a small-scale societal incubator workshop on possible nano-innovation in the field of meat substitutes. These activities have given us an understanding of the potential added value and limitations of the concept of the societal incubator, its purpose and organisation, important rules of the game, and the necessary discussion partners. We reported on these during the exploratory study in an internal progress report.

2.1 Study of the literature and interviews with experts

Our work began with a brief study of the relevant literature on the dynamics of waiting games (Robinson et al. 2012; Parandian et al. 2012; Te Kulve 2010) and the related idea of the societal incubator (Van Lente 2015). We also interviewed three experts, including the inventor of the societal incubator concept Harro van Lente (coordinator of the Technology Assessment component of the RATA programme). Given the relationship between the concept of a societal incubator, the phenomenon of waiting games and the practice of the business incubator, we spoke to two experts in this field, namely Haico te Kulve (a researcher within the RATA programme, University of Twente) and Pim de Bokx (an entrepreneur and chairman of the Dutch Incubation Association). The purpose of the literature study and the interviews with the experts was to arrive at a working definition of the societal incubator and to determine discussion topics for the interviews with relevant stakeholders.

We will first discuss the phenomenon of the waiting game, i.e. a situation in which a technological innovation is not commercialised because technology developers, the authorities, civil-society organisations, and other parties adopt a wait-and-see attitude, largely because of uncertainty about one another's responses. We refer to a waiting "game" because its dynamics transcend the strategy of individual actors, even if those actors are convinced of the usefulness and necessity of certain innovations (Robinson et al. 2011). Waiting games can occur at the level of a sector as a whole, as in the case of the food packaging industry, and are not only evoked by uncertainty, but also in fact perpetuate uncertainty (Te Kulve 2010). Box 2 gives a number of general examples, taken from Robinson et al.

Box 2 – Examples of waiting games (Robinson et al. 2011)

Scene 1: two companies competing in the same sector of sustainable energy technologies, having developed a novel technology, and both waiting for the other to make the first move and introduce the innovation, which would present the first and best opportunity really to learn about public acceptance of the innovation.

Scene 2: a start-up venture in the medical devices sector waiting for established companies to invest in the early phases of the development of a new demonstrator; these companies waiting for the start-up to demonstrate the reproducibility of its demonstrator.

Scene 3: a company in the emerging field of nanomedicine waiting for regulatory decisions by the traditional organisations mandated to make these decisions, whilst the latter waits for the new technology to stabilise so that its risks and benefits can be assessed.

Waiting games occur at a collective level and as such can have far-reaching consequences. By creating a situation in which investment in R&D does not materialise, they can affect the competitive position of the Netherlands, despite the country's strong position in the field of nanotechnology. There is also a risk that (nano)innovations that can contribute to tackling major societal problems will ultimately be left on the shelf. Haico te Kulve recognises this picture and foresees,

for example, that small businesses may find interesting niches for applications of "lab-on-a-chip" nanotechnology[2], but that "the field isn't really making any progress". So, despite all the investment, the high expectations of lab-on-a-chip have not yet been fulfilled sufficiently.

Reducing uncertainties in this situation brings with it an additional challenge for innovation, namely breaking free from waiting games. Because the parties in a waiting game are dependent on one another, doing so requires a collective effort. It involves a shared learning process in which technology developers need to gain an understanding not only of technical and commercial requirements but also of issues regarding regulation (including risk regulation), public needs, and social/ethical acceptability. The aim of a societal incubator is to make such learning processes possible, thus offering new perspectives for action.

The idea of the societal incubator is very much inspired by the practice of the business incubator. The Dutch Incubation Association (DIA), the network of/for professionals working for business incubators, accelerators and start-up programmes, defines the business incubator as "an organisation that creates a(n) (incubation) process to enable the accelerated growth of high-quality start-ups into successful enterprises by deploying an integrated package of services such as workspace, services, culture, coaching, networking, access to capital, etc." (DIA n.d.). A business incubator therefore provides resources, protected space, and coaching to enable innovative ideas to develop into commercially successful products.

Harro van Lente notes that business incubation too can be seen as an answer to waiting games within which start-ups cannot obtain capital as long as they do not have a convincing product and cannot develop that product as long as they do not have capital (Van Lente 2015). In a similar way, a societal incubator aims to provide a protected space in which various interested parties can learn about the societal opportunities and conditions for innovation in a timely manner. Whereas a business incubator focuses on individual businesses, a societal incubator specifically brings together a broader group of stakeholders for the sake of a shared learning process in which it is possible to break free from waiting games. This learning process does not need to involve any one specific innovation but can also focus specifically on a range of innovations that are of interest for multiple businesses at a sector level, such as new food packaging or nanomedicines. A comparison with the existing practice of business incubators not only serves to inspire the idea of a societal incubator but also helps us to further define its specific characteristics. Harro van Lente provides a good illustration of this in a tabular comparison (Table 2).

2 A laboratory the size of a postage stamp, consisting of microscopically small channels on a chip, with which chemical and physical analyses can be carried out on a blood drop, for example (Walhout et al. 2010).

Table 2 Comparison between business incubator and societal incubator (source: Van Lente 2015)

Incubator type	*Resources*	*Protected space*	*Coaching*
Business incubator (specific innovation; one firm)	venture capital; office support; ICT and other infrastructure	small scale pilots; possibilities for trial and error	peer efforts; business consultancy
Societal incubator (range of innovations in a sector; more firms and other actors)	technical background studies; actor mappings; foresight/roadmapping	mutual trust; suspense of judgment	collective learning; learn from similar cases

Given the relationship between the concept of a societal incubator and the practice of the business incubator, we also spoke to Pim de Bokx (an entrepreneur and chairman of the Dutch Incubation Association). De Bokx recognises the depiction of the fundamental uncertainties that technology developers find themselves facing. He also endorses the need for a level of collective action in order to advance an emerging technology. According to De Bokx, biotechnology did not get off the ground in the Netherlands until a valorisation infrastructure was put in place, partly by the government. Against this background, he believes, the societal incubator must in any case be action-oriented. The process must focus on “thinking, talking, and doing”. In principle, De Bokx is also enthusiastic about the idea of giving social embedding issues a more explicit place in the context of business incubators.

Based on the literature and interviews discussed so far, we arrive at the following definition and explanation:

A societal incubator creates conditions for an open and participatory learning process, with the aim to break free from or prevent waiting games and to support and accelerate responsible research and innovation.

New (nano)technologies can contribute to tackling major problems facing society, but in practice technology developers find themselves facing many uncertainties. There is, for example, uncertainty about public support, policy, regulation, and liability. That uncertainty is felt not only by technology developers but also by other stakeholders, such as the authorities, businesses, risk assessors, and civil-society organisations. The players involved adopt a wait-and-see attitude, not knowing what the others are going to do. This leads to waiting games that perpetuate the uncertainty. As a result, potentially useful innovations are “left on the shelf”. One can only prevent or break free from this situation by means of collective action. The societal incubator aims to facilitate that action.

2.2 Interviews with stakeholders

The literature study and a number of interviews gave us a better understanding of the phenomenon of waiting games and the idea of a societal incubator as a means of preventing or breaking free from such a situation. We then went on to conduct interviews with three different types of stakeholders: representatives of the business community (in particular the food industry), government, and civil-society organisations. The interviews focussed on the following questions:

- Is the image of waiting games a recognisable one?
- What is the potential added value of a societal incubator in responding to and preventing waiting games?
- How should a societal incubator be organised?

We discussed these questions with Thea Koning (Unilever), Ger Willems (FrieslandCampina diary products), Willem-Henk Streekstra (nanotechnology working group set up by the Dutch employers' federation), and Geert de Rooij (Federation of the Dutch food industry). As representatives of the government, the interviewees were Sikko Beukema (Ministry of Economic Affairs) and Dick Jung (Ministry of Infrastructure and the Environment). Sijas Akkerman (Nature and Environment Foundation) represented the civil-society organisations. We did not manage to organise any more interviews with civil-society organisations; we will return to the reasons later.

The findings from the interviews are discussed below on the basis of the main questions and important related themes mentioned above. The emphasis is on the business community.

2.2.1 Waiting games

During the interviews we first sketched out the dynamics of waiting games, as described in Section 2.1. The representatives of the business community found those dynamics very recognisable. The innovation potential of nanotechnology enjoys broad endorsement. Geert de Rooij, for example, sees many opportunities for nanotechnology to make food healthier and safer. There is nevertheless reluctance to get to work on this. To what extent do you, as a company, want to stick your neck out? At FrieslandCampina, nanotechnology is currently not an option for product innovation. After all, if it leads to a commotion, "you can't just reverse it". For the interviewees from the business community, consumer attitudes and regulations (partly due to the lack of a clear legal definition of nanotechnology) are major sources of uncertainty. They also often mention fear of responses from

civil-society organisations. Sijas Akkerman and the two representatives of national government also found waiting games recognisable. Sikko Beukema emphasised the “framing power” of civil-society organisations: “supporters don’t know how to communicate the image effectively, but opponents do in fact know”. Supporters (for example producers) often start from the rationale and the scientific evidence, while opponents more often base their position and framing on emotion and principles.

2.2.2 The potential functions and limitations of a societal incubator

We then asked the various stakeholders about the potential added value of a societal incubator. The interviewees from the business community found that a societal incubator may certainly have a function in enabling the parties in a waiting game to get to know and understand one another’s thinking better. Thea Koning speaks of a forum within which the advantages and disadvantages of a potential innovation can be explored and parties can jointly seek benefits for society. She believes that a societal incubator can thus contribute to socially responsible innovation. For Ger Willems, a societal incubator should provide a process that can increase confidence in technological innovations and bring widely supported innovations to the market. Dick Jung contends that, from the perspective of national government, a societal incubator should primarily serve to show what the actual factors are that cause waiting games. Sikko Beukema mentioned the dialogue that the Ministry of Agriculture, Nature and Food Quality organised between the livestock farming industry, the Dutch Society for the Protection of Animals, and the government on the topic of animal welfare policy, with trust between the business community and the Society as the ultimate result. A tangible result of that cooperation is the establishment of the “Better Life” (Beter Leven) seal of approval. This can be seen as an example of how a societal incubator could induce various parties to take joint action. Finally, Sijas Akkerman sees an increasing role for civil-society organisations as “social entrepreneurs”, with a societal incubator being able to offer these organisations the scope to play a critical mediating role in the introduction of new technology.

However, some of the stakeholders interviewed also perceive limitations. In practice, it often turns out to be extremely difficult to get different parties to discuss matters with one another. According to Geert de Rooij, past experience shows that discussions with civil-society organisations have not achieved very much. And Ger Willems wonders how much confidence you can have in the outcome of a societal incubator, if outsiders can undo it again.

2.2.3 The organisation of a societal incubator

We then discussed in the interviews how a societal incubator should be organised. Who should be involved in a societal incubator process? What preconditions and rules are required if that process is to be successful? Who should facilitate matters? In addition to these process-oriented questions, the interviews also raised an important substantive issue: what is the primary object of a societal incubator, and what should the learning process focus on? We came across two different views on this. The societal incubator process can focus on specific options for (nano)technological innovation, with the main issue being its societal acceptability and desirability, but it can also focus primarily on societal needs and challenges, in order to examine how (nano)technology can contribute to meeting these needs. We will first discuss the process-related questions and then conclude with the substantive issue.

Who should be involved?
All the interviewees argued that a wide range of stakeholders should be represented in a societal incubator process, including industry, government, interest groups, universities, and civil-society organisations. They also emphasised that these parties must be represented by persons of a certain level of importance, although it will not always be easy to get those persons to the table. Waiting games can arise because different stakeholders have different goals and interests and cannot trust – or dare not trust – one another. Parties will therefore have very different motives for deciding whether or not to participate in a societal incubator process. For the process to be successful, the societal incubator will need to be receptive to these differences. During our discussions, we therefore asked about the reasons of the various stakeholders for perhaps participating in a societal incubator process (Table 3).

Table 3 Reasons of various stakeholders for participating in a societal incubator

Technology developers	Increase likelihood of success Responsible Research and Innovation
Business community	Economic benefit Corporate Social Responsibility
Government	Achieve policy objectives Understand quality of policy and regulation
Civil-society organisations	Exercise influence Guide new technology critically with a view to its added value for society

Involvement of civil-society organisations

Uncertainties regarding the responses of civil-society organisations play a major role in waiting games, especially as regards nanotechnology and food.
The involvement of these organisations, including consumer organisations, in a societal incubator process is therefore vitally important. As already noted, Sijas Akkerman (Nature and Environment Foundation) views the involvement of civil-society organisations as an interesting opportunity for them to play a critical mediating role in the introduction of new technology. Nevertheless, such involvement will not be easy to achieve in actual practice. Civil-society organisations receive numerous requests to participate in projects, interviews, symposia and the like, but have limited capacity to respond to all those requests. Moreover, participation in a societal incubator process entails civil-society organisations playing a different role, one less focused on mobilising critical opposition and therefore more difficult to justify in terms of a directly visible impact for their own supporters. Some business community interviewees also have the impression that civil-society organisations are not interested in dialogue but merely in campaigning.

We discussed this with Lucien Hanssen (Consultant on social communication and governance), an expert with experience in the field of public debate on contested technologies. He indicated that if it proves difficult to actually involve civil-society organisations, more independent, critical, and expert “counter thinkers” could also be called upon to provide a social perspective (see also Hanssen et al. 2013). Both Lucien Hanssen and Sijas Akkerman also stress the importance of financial compensation as a means of enabling civil-society organisations, and perhaps also other parties, to participate in a societal incubator process. Businesses should see this as a way of investing not only in R&D but also in social learning processes.

Free of commitment or binding?

What can we expect from participants who are prepared to commit themselves to a societal incubator process? All the stakeholders interviewed stated that “something really needs to be at stake”. It requires a collective process of learning and experimentation, over a substantial period of time. Stakeholders are asked to enter into the process with an open mind. There must be a willingness to take a critical look at one’s own position and to strike out in new directions if the results are disappointing. Participation in a societal incubator process is therefore not free of commitment, but the results of the process cannot be binding on the participants either. It is only in this way that growing trust be created between the parties involved. The ultimate goal is a learning process that will reduce uncertainty and thus enable technology developers to better assess their own chances of success and contribute to a socially responsible innovation process.

Rules

If trust is to be established, there must also be some clear rules. Rules such as the "Chatham House Rule" are often cited as an important precondition for participants to be able to speak openly.[3] As the process progresses and the interests (and the likelihood of success) increase, even tougher agreements on confidentiality may be necessary. Although these rules are intended to give participants the freedom to speak openly, they can also be a hindrance. Strict forms of confidentiality can become insurmountable, particularly for civil-society organisations if they can no longer make their own role in the process apparent and open to discussion with those whom they represent.

Organisation and facilitation

Who should organise the societal incubator process? The stakeholders consulted did not express any specific preference regarding this point. It could be an independent party but the business community itself could also take the initiative. It is important, however, for technology developers to take responsibility as co-owners of the process and for the process to be supervised by an independent discussion leader who can guarantee the equality of the parties involved and the openness of the process.

Topics

What exactly should the societal incubator be about? What topics should be discussed? We have already referred to two different views on this matter, one based on specific technological options and the other prioritising social needs or challenges. These views are also reflected in the literature on responsible research and innovation (Stemerding 2015, see also Stemerding et al. forthcoming). For those who take technological options as their starting point, RRI is a matter of "doing science right", with the views and interests of social stakeholders being taken into account when seeking support for the further development of these options. For those who focus on social needs and challenges, however, RRI is about "doing the right science", with the aim of creating an innovation agenda inspired by societal problems and values (Von Schomberg 2013; Stemerding 2015; Stilgoe et al. 2013).

Where the topics for a societal incubator are concerned, this distinction implies two different approaches, one case-oriented and one programmatic. A case-oriented approach is most closely aligned with the practice of business incubators, which concern themselves with a specific innovation that is pursued by an enterprising

3 When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed". For more information, go to https://www.chathamhouse.org/about/chatham-house-rule.

technology developer. This approach has the advantage of focusing on a specific technological promise, with the entrepreneur concerned being able to make clear that “something really is at stake”. Haico te Kulve notes that this approach also links up best with technology developers’ own motives (see also Table 3) and can actually persuade them to concern themselves with social embedding issues. Moreover, this approach is relatively easy to graft on to the existing practice of business incubators, with – in Pim de Bokx’s view – demonstrators and prototypes serving as test material within a broader social learning process with the stakeholders involved (including risk assessors, for example).

The programmatic approach is based on pressing social issues and as such is more ambitious. It requires greater efforts on the part of societal stakeholders, but it links up better with the motives, values, and interests of these stakeholders, in particular civil-society organisations (Table 3). This approach will need to be developed at the sector level, with various technology developers and companies, together with societal stakeholders, exploring a range of possibilities for innovation with a view to a particular social issue. This explicitly distinguishes a programmatic approach from the practice of business incubators and ties in with the way in which Harro van Lente implements the societal incubator concept (see Table 2). By involving various parties in learning processes at a more generic and collective level, this approach also seems ideally suited to breaking free from waiting games, or even better, preventing them.

These different approaches raise questions about the possible and most desirable design and institutionalisation of a societal incubator, questions that bring us back from the content to the process. We will deal with these in greater detail in the concluding Section 5.

Box 3 Experience at NanoCity

During the NanoCity event in 2015, we organised a small-scale workshop as an initial exploration of the societal incubator concept. The idea was to examine a possible nano-innovation from a societal perspective. We looked at ways of improving meat substitutes with the aid of nanotechnology. Atze Jan van der Goot (Wageningen University and Research) gave a presentation in which he first addressed the need to reduce meat consumption and then outlined ways in which soya and lupines could be adapted to give them the same qualities as meat in terms of taste, texture, and nutritional value. Erik de Bakker (Agricultural Economics Research Institute [LEI]) gave an initial response to that presentation on the basis of his consumer research on meat substitutes. There was then a group discussion, led by Virgil Rerimassie, during which the possibilities for nano-innovation in soy and lupines were discussed in terms of opportunities, obstacles, and possible follow-up steps.

The workshop was an initial experiment and the participants came mainly from academic circles (the business community was barely represented and there were no representatives of civil-society organisations). The approach had both programmatic and case-oriented elements. Meat consumption as a pressing societal issue served as the starting point for a discussion of the significance of nanotechnology. The discussion then focused on nano-modified meat substitutes as a specific technological option, with new ideas being put forward for possible applications and how they could be marketed. In this respect, the workshop was both instructive and inspiring for participants.

2.3 Summary of the main findings

Our main findings from the first phase of this exploratory study can be summarised as follows.

- The image of waiting games that formed the basis for this exploratory study is one that was recognised by the stakeholders interviewed. Breaking away from waiting games or preventing them requires a collective effort in the form of a

collective learning process. A societal incubator could play a useful role in this, thus also contributing to responsible research and innovation (RRI). This idea was also generally endorsed by the stakeholders interviewed.

- The learning process within a societal incubator can focus on specific technological innovations as case studies, with a technology developer or (start-up) company as the problem owner. In that case, one can attempt to link up with the existing practice of business incubators, with particular attention being paid to broader issues of social embedding and acceptability.

- A societal incubator can also be a shared platform for a more generic approach that takes major societal challenges as its starting point and translates them into a range of potential innovations and innovation paths at sector level. This specifically distinguishes this approach from the existing practice of business incubators.

- We can conclude from the interviews that both approaches need to be accommodated by a societal incubator, fitting in with the differing motives, values, and interests of the various parties involved in discussions about new technological developments. In other words, a societal incubator must provide scope for learning processes concerning the societal acceptability of promising technological innovations, and for learning processes concerning the added value for society of innovations in the light of pressing societal challenges.

3 Roadmap for a societal incubator focussing on a specific product

In this chapter we convert our findings as discussed in Section 2 into a roadmap for a case-oriented societal incubator process. With this roadmap we show what an incubator process should preferably look like as a contribution to an open and participatory learning process that can accelerate socially responsible innovation. As part of the roadmap, we present a script for a societal incubator workshop at which stakeholders are involved in a collective learning process about the societal acceptability and added value of a specific innovative product.

In working out the roadmap and script, we have assumed a case-oriented approach. As we stated in Section 2, this approach links up best with the existing practice of business incubators and the motives of technology developers. The approach is therefore relatively easy to implement and was also well suited for the societal incubator workshop, which we organised as a proof of concept in the context of our exploratory study. However, a programmatic approach also remains important for a societal incubator. We will return to this in Section 5 when we deal with the question of how to turn a societal incubator into a viable concept.

3.1 Towards a socially acceptable product with added value

For our roadmap, we first defined a starting point and an ideal endpoint or end result of a societal incubator process. From that endpoint, we then considered what steps needed to be taken in order to achieve the desired end result.

3.1.1 A promising product as starting point

Our starting point is a promising (nano)innovation that ideally contributes to tackling a major societal a challenge (in the field of sustainability, health, etc.). Techno-scientific and commercial barriers to innovation have already been largely overcome: there is really something at stake. However, there are still many uncertainties regarding public support, policy, risk analysis, regulation, and liability. Continuing the development process requires an enterprising technology developer, but a spirit of enterprise is not enough. What emerges is a waiting game, within

which a reduction of uncertainty can only be achieved through a collective and inclusive learning process.

As part of our exploratory study, we identified a number of cases in the field of nanotechnology and food in which this situation appears to occur, or might occur. A description of these cases is included as an appendix to this report. One of these cases we took as a starting point for a pilot societal incubator workshop which is reported on in Section 4.

3.1.2 Public acceptance and added value as an ideal end result

As we concluded in Section 2, the ideal end result of a societal incubator process is a socially accepted product with added value for society. In order to achieve this ideal end result, we need to create the conditions for a collective and inclusive learning process regarding the possibilities, significance, and implications of (nano)technological innovations. In the figure below, those conditions have been translated into roadmap for a societal incubator.

Figure 1 Roadmap for societal incubator

Societal incubator

Starting point	**I – Information and interaction**	**II – Analysis**	**III – Continue or discontinue?**	**Ideal endpoint**
Technology developer has interesting innovation but faces major uncertainties (“waiting game”)	Draw up *social map*, collect *information*, and organise *interaction* between stakeholders	*Understanding* of societal issues, views of actors, problems, possibilities, commitment etc. (*reporting*)	*Action plan* with follow-up steps or *Discontinue* development process in good time	Socially *accepted* product with *added value* for society

3.2 Three crucial steps in a societal incubator process

The aim of the societal incubator is to facilitate the development of a promising innovation into a socially accepted product with added value. In the roadmap, we distinguish three crucial steps toward achieving this. We see this step-by-step plan as a template which allows for different variants of the process, both “light” and more “engaging”, with multiple rounds of interviews and interaction moments. The

latter will be particularly necessary in the case of a programmatic approach as described in Section 2.[4]

The proposed incubator process must create the conditions for a learning process that will enable technology developers to better assess their own chances of success and contribute to a socially responsible innovation. For this it is crucial that the technology developer is supported during the societal incubator process by an independent analyst with knowledge of the societal dimensions of innovation. The technology developer cannot be expected to have the necessary expertise and methodological skills for organising a social learning process on these matters.

As with the coaching and support within a business incubator regarding entrepreneurship, a societal incubator needs coaching and support with regard to the societal dimensions of innovation and interaction with stakeholders. For that purpose, the kind of expertise available from the RATA programme of NanoNextNL could be called upon.

3.2.1 Information and interaction

Given the uncertainties surrounding a potential innovation, it is important first of all for the technology developer to gain a better understanding of those uncertainties. We refer to this step as information and interaction (Step I). The aim is to learn from the knowledge and perspectives of societal stakeholders who are relevant to this innovation. For this part we have drawn on the guide published by the Rathenau Instituut on Interactive Technology Assessment (Grin et al. 1997).

Ideally, the first step should consist of a combination of desk research, interviews, and finally interaction between the various stakeholders and the technology developer. Based on the uncertainties that the technology developer is confronted with, a social map is first drawn up, i.e. an overview of relevant stakeholders, including, for example, producers, vendors, users, consumers (and consumer organisations), policymakers, and civil-society organisations. Next, available knowledge is acquired about how these stakeholders might think about the intended technological innovation. A great deal of such information can already be found by desk research. Based on this information, interviews are prepared with various stakeholders. It goes without saying that as many stakeholders as possible should be involved in this consultation. However, it will not always be possible to interview all the relevant stakeholders and to later involve them in the interaction,

4 Harro van Lente speaks in this connection of “collective experimentation and learning … supported by foresight studies and technology roadmapping exercises” (Van Lente 2015).

for example because of insufficient interest in the subject or lack of capacity among those involved. In Section 2 we already mentioned the possibility of calling on more independent experts with experience of public debate on science and technology, for example social scientists or philosophers and also (science) journalists (Korthagen 2016).

Reducing uncertainties and breaking away from or preventing the resulting waiting games requires a collective learning process and therefore interaction between various stakeholders and the technology developer. That is why we refer to this first step as “Information and Interaction”. A societal incubator must contribute to mutual understanding and trust between stakeholders, provide insight into the causes of waiting games, and offer scope for arriving at creative solutions together. One or more interactive stakeholder workshops are therefore a necessary component of this first step. We will return to this in greater detail below in the form of a script.

3.2.2 Analysis

Based on the first-step activities, those involved acquired a better understanding of the uncertainties with which the technology developer is confronted. The parties involved also gained greater clarity regarding one another’s views on society’s needs, issues of social/ethical acceptability, and matters regarding risk regulation. This gives the technology developer a better understanding of the possibilities and opportunities for creating a promising and socially acceptable product. Moreover, this learning process also creates scope for other parties involved to contribute, in a critical mediating role, to the innovation process and to preventing or breaking away from waiting games. It is therefore important to take stock of the situation by an analysis (Step II) in the form of a report in which the findings are critically explained and weighed up and made available to the participants.

3.2.3 Continue or discontinue?

Based on the two preceding steps and the resulting reduction of uncertainty and identification of perspectives for action, the technology developer is in a better position to weigh up whether or not he or she wishes to continue the development process. If a decision is taken to continue, the analysis made can lead to an action plan (Step III) with follow-up steps that can lead to the ideal end result, namely a socially accepted product with added value. The analysis may perhaps have identified preconditions that the technology developer must take into account, or alternative design choices that respond to objections or wishes on the part of stakeholders. It may also have become clear that other stakeholders need to be

involved in order to proceed, for example, stakeholders who can provide clarity about the risk analyses required, while risk assessors can be helped by a specific case on the basis of which to develop a risk analysis. Finally, there may also be a wish for other interaction moments to be arranged. These kinds of follow-up steps must be included in the action plan. The alternative scenario is that the technology developer decides not to continue development of the intended product (at least not for the present). In that case, the technology developer will have been able to take that decision not only in good time but also in full knowledge of the situation, thereby limiting the damage.

3.2.4 Script for an incubator workshop pilot

One component of our exploratory study was an interactive stakeholder workshop as proof of concept, with which we wanted to gain actual experience with a collective and inclusive learning process concerning a specific innovative product and a technology developer involved with it. We developed a script for the workshop, taking account of the findings of our study. The workshop thus enabled us to test these findings and to investigate how such a workshop can contribute to a societal incubator process.

The table below provides an outline of the script that formed the basis for the incubator workshop pilot. Important elements are guidance from a skilled discussion leader who ensures that all participants can contribute, a rapporteur who keeps track of the discussion, timely agreements regarding confidentiality, follow-up questions so as to clarify arguments and values, and a quest for common ground as regards general views and associated perspectives for action.

Table 4 Scenario for incubator workshop pilot

Component	Explanation
Welcome	The discussion leader welcomes the participants and introduces the aims and rules (Chatham House Rule). A rapporteur produces a written report of the meeting.
Introductions	Participants introduce themselves and indicate how they are involved with nanotechnology and/or the relevant social context under discussion.
Introduction of business case	The technology developer (problem owner) explains the business case, including the technical aspects, intended added value for society, and the uncertainties he/she faces. Questions can be asked to clarify matters.

Initial responses	All participants give their initial response and indicate the uncertainties that they foresee. The participants note down their answers on Post-its. When explanations are being given, the discussion leader asks follow-up questions ("Why?") in each case so that it also becomes clear what values are concealed behind the comments. Participants can respond to one another. Each Post-it is handed to one of the organisers, who sticks it on a flipchart. There are five flipcharts, one for the initial impression and for the various types of uncertainties: techno-scientific, commercial, political-regulatory, and socio-ethical.
Prioritising uncertainties and points for consideration	Each participant is given a number of stickers. They mark the uncertainties they find most important with a sticker.
Further discussion of dominant uncertainties and bottlenecks	Based on this priority ranking, the discussion leader and problem owner identify two or three dominant uncertainties/bottlenecks for discussion in greater detail. During the discussion, the discussion leader looks for common ground, possible solutions, and perspectives for action. The focus is on the ideal of a socially accepted product with *added value* for society. The discussion focuses on the following questions in particular: 1. What is going on? What is the core of the uncertainty? (better understanding) 2. How will we deal with it? What needs to be done? (possible solutions, and perspectives for action) 3. Who will do what? (appropriation and assignment of responsibilities) In each case, the discussion leader requests feedbacks from the problem owner: Are things sufficiently clear? Can responsibilities be allocated clearly? Do problems remain? The problem owner is given the last word each time.
Lessons learned and points for consideration	A final round during which all the participants share what they consider to be the most important lesson, as well as possible perspectives for action and follow-up steps. The problem owner is again allowed the last word.
Evaluation and thanks	What did the participants think about the meeting and the way

	it was organised?

4 Societal incubator in action: an initial experiment

As part of our exploratory study, we organised a societal incubator experiment in March 2016, in the form of an interactive stakeholder workshop on a specific nano business case. The workshop was attended by seventeen invited stakeholders and experts, including representatives from the fields of risk assessment, central government, the business community, insurance, sector organisations, science communication, and the environmental movement. Experts were also present with knowledge of consumer views and the public debate on nanotechnology.

Within NanoNextNL we found a technology developer who was prepared to present a specific product-oriented innovation at the workshop as a “virtual business case” in the field of nano-food (see also the appendix). The workshop could help the technology developer to clarify the possibilities for actually continuing development of the innovation. Discussion in the workshop was structured on the basis of the script described in Table 4 (Section 3). This section reports on the workshop results, focussing on the points for consideration that the participants identified as the most important regarding this case. We also highlight a number of lessons concerning how the collective learning process during such an interactive workshop can gain in openness and quality.

4.1 Main points for consideration when discussing the case

The product innovation presented by the technology developer aims to tackle iron deficiency in pubescent girls by enriching chocolate with nano-iron (see also Van Lente 2015). Blood loss during menstruation and/or too little iron in the diet are major causes of iron deficiency. That condition therefore often occurs among growing girls and manifests itself as fatigue, pale skin, being quickly out of breath, and restless legs (cf. Voedingscentrum n.d.). The technology developer aims to tackle this problem by developing a tasty, enriched snack as a consumer product, aimed at the specific target group. To prevent the added iron from spoiling the taste of the chocolate, the iron particles are packed within a covering at nanoscale. The covering breaks down in the intestine into “food-grade” components and releases the iron for take-up into the bloodstream.

How did the workshop participants respond to this idea? Some of them viewed the product as an interesting combination of tasty and healthy, but the responses were in general critical. During the first round of discussion, with an inventory of uncertainties (on Post-its), the following issues were raised. We have clustered the responses according to the four types of uncertainties in Table 1 (Section 1).

Techno-scientific

- *What is the right dose? How much chocolate do you need to eat in order to get enough iron?*
- *What are the health risks? How do the added nanocomponents break down in the body?*
- *What happens if other people who don't belong to the target group eat the product, for example pregnant women?*
- *The above points were aptly summarised by one of the participants as a "search for a balance between effectiveness and harmfulness".*

Commercial

- *Can the nano-iron also be added to other products? Shouldn't you think in terms of a much wider product range?*
- *How do you arrange the relationship between the chocolate manufacturer and the supplier of the nano-encapsulated ingredient? The supplier would seem to be the party with the main interest.*
- *What about the necessary investment? The combination of nanotechnology and food would not be attractive for investors.*
- *Labelling will probably be required, which will make the product less attractive.*

Political-regulatory

- *Do you consider the product just as food, or as a product with a health claim (functional food)? If the latter, then you will have to deal with demanding ("novel food") EU rules, requiring approval from both the European Food Safety Authority (EFSA) and the Netherlands Food and Consumer Product Safety Authority (NVWA).*
- *Is this an attempt to solve medical problems through the market (as a contribution to the privatisation of health care)?*

Socio-ethical

- *How substantial is the problem for which a solution is being sought here?*
- *Aren't there (already) better alternatives for tackling this problem in terms of both type of nutrition and medication?*
- *Isn't chocolate an unfortunate product to have chosen? You may be contributing to the obesity epidemic.*
- *In other words, is this the business case that should convince society of the value of nano in food? Shouldn't you be thinking about more important societal problems?*

- *And what kind of girls are you actually talking about? During puberty, girls pay a lot of attention to their eating habits anyway. Do you then want them to eat chocolate too? How do you identify the target group anyway?*
- *Is there equal access to the product if everyone has to pay for it him/herself?*

Based on how the participants prioritised these uncertainties (using stickers), there was then a second round of discussion to consider the following points for consideration in greater detail.

Point for consideration 1 – Risk analysis and novel food legislation
What knowledge and research do you need about the nature of the nanocomponents in the product and their safety aspects? How do the particles into which the nanoparticles break down react in the gastrointestinal tract? And exactly what kind of (food-grade) particles are you talking about? Are they indeed perfectly safe components? As the participants emphasised, these are questions that are important regarding a consumer product with health claims; they will need to be answered in the context of novel food legislation. It is not impossible for a producer to comply with the novel food legislation. But answering all EFSA's questions will cost hundreds of thousands of euros, and in the case of a new product it is often difficult to find out exactly what the requirements are that it needs to meet. Regarding this point, it was suggested during the discussion that the technology developer and the (intended) producer of the nano-coated iron ingredient should approach the EFSA jointly, with the new product as a test case. But according to some participants the EFSA does not appear to be very open to such contacts.

Point for consideration 2 – Is this the business case that should convince society of the value of nanofood?
"Nano" has the connotation of high-tech. That's why it is put into shoe polish, because that sounds good (even if it may not even in fact be nano). But high-tech in food evokes a lot of resistance. That's why in the case of food it's better not to go looking for all kinds of enrichment. Nevertheless, a specific and convincing nano-food product could perhaps overturn that image of nano. But what could be a suitable case? Some participants stressed the importance of linking up with a really pressing societal problem. But the bigger the problem, the more interests are involved and the more complicated the innovation process can become. Maybe that's why (as a reduction of uncertainty) you should start with a product where there isn't so much at stake. But even then, the question remains as to whether the chocolate business case is the right initiative to start with. According to some participants, it's better to think of applications about which hardly any disagreement is to be expected, in the medical field rather than in the consumer field. Once there is greater awareness and acceptance of nanotechnology, other applications might then also be considered.

Point for consideration 3 – What exactly do we expect from a societal incubator in response to socio-ethical uncertainty?
What exactly should the societal incubator discuss? That question was raised by several workshop participants and expressed a need to broaden the discussion of the business case. This involves such questions as: what kind of developments is society waiting for, and under what conditions could nanotechnology contribute to them and count on social acceptance? These questions are in line with the distinction we made in Section 2 between a case-oriented approach and a programmatic approach as two different starting points for a societal incubator. One of the workshop participants made a similar distinction between two different levels within the discussion of the business case: the action perspective for the specific case and/or a broader dialogue on nanotechnology and food. Both levels are necessary in order to be able to position the case within a broader perspective and to be able to nourish the broader dialogue based on a specific case.

4.2 Lessons for improving the collective learning process

Viewed in the light of the roadmap for a societal incubator presented in Section 3, the workshop that we organised had a number of important limitations as a proof of concept. In the roadmap, we assume that a societal incubator process will start with a nano-innovation that is already regarded as reasonably promising from a techno-scientific and commercial point of view. The questions will then focus specifically on political-regulatory and socio-ethical uncertainties. We also assume that these uncertainties have been identified – on the basis of desk research and interviews – in preparation for an interactive stakeholder workshop. However, in the context of the present exploratory study, it was not possible to properly meet these conditions given the time constraints of our study. Our pilot workshop was an experiment based on a business case with, as we have noted, a “virtual” character, for which the technology developer had carried out a limited preliminary study, mainly “on paper”.

The workshop not only led to substantive findings but also gave us the opportunity to gain experience with the script that we had drawn up. In the following we discuss four lessons learned with regard to our intended collective learning process. We do so on the basis of our own observations, but also on that of the (brief) evaluation session at the end of the workshop.

Lesson 1 – More preparation needed for a collective learning process
We already noted that our workshop, as an experiment, had a number of important limitations regarding the preparation of the business case; the participants also

indicated that a good discussion would require more preparation. Not all participants were convinced that in this business case “there was something really at stake”. This lesson underlines the importance of an information gathering process as the first crucial step in a societal incubator process, as described in Section 3. In Section 3 we also noted that responsibility for that step cannot be assigned solely to the technology developer concerned. Support from an independent analyst is essential. This does raise the question, however, of how much effort this step can be expected to take in terms of time and money. A minimal requirement is the kind of preparation that is also expected within a business incubator in the form of a Lean Business Model Canvas and an online Golden Egg Check (see 1.2.1). In addition, political-regulatory and socio-ethical uncertainties must be properly addressed, on the basis of desk research as well as interviews with relevant stakeholders (3.2.1). On that basis, a greater understanding can be gained of potential waiting games[5] and an agenda can be drawn up for one or more interactive workshops to bring together stakeholders and create the conditions for a collective and inclusive learning process. To support this process of information and interaction, a protocol could be developed – in addition to the script for the workshop – to identify political-regulatory and socio-ethical uncertainties as a basis for a more structured discussion. One of the workshop participants referred in this context to “technology rating” as an approach whereby – in addition to a technology developer or (start-up) entrepreneur – other experts and parties also assess the value of a technology.

Lesson 2 – A purely case-oriented approach is too limited a starting point for a collective learning process

When working out the roadmap for a societal incubator and the script for the workshop, we deliberately opted for a case-oriented approach because it was relatively easy to implement and was well suited to an initial experiment with an incubator workshop. We defined the ideal end result as a socially accepted product with added value for society. Added value refers here to the way in which a particular product can contribute to tackling a pressing societal challenge. It is specifically this orientation towards societal challenges that links up with the motives of societal stakeholders, in particular civil-society organisations (Table 2). This also became clear during our workshop, at which one of the participants was of the opinion that a discussion of added value for society was more important than societal acceptance. For some participants, the business case did not make sufficiently clear whether we were talking about a genuine societal problem. They added that better preparation is only part of the story. Indeed, it also raises the question what input from society is needed in order to determine what kind of product you want to put on the market. We can conclude that a purely case-

5 This is important because waiting games are difficult to reveal in practice (see appendix).

oriented approach is too limited a starting point for this. In order to create more scope for discussion of the potential added value of nano-innovations for society, one or two stakeholders could be invited – after the presentation of a business case – to provide a pitch about the societal challenge that the case concerns. This offers a broader societal context as a valuable input for the discussion, also broadening the scope of the conversation to alternative possibilities for nano-innovation in response to the societal issue that is being discussed.

Lesson 3 – Lack of enthusiasm or capacity on the part of civil-society organisations does not necessarily mean that the collective learning process is at risk

We emphasised in Section 2 that it is important, but also difficult, to involve civil-society organisations in collective learning processes regarding new (nano)technology. We suggested that in addition to involving civil-society organisations, more independent, critical, and expert "counter-thinkers" could also be called upon to provide a societal perspective. As became clear indeed from the initial responses during the workshop, a critical societal perspective came not only from civil-society organisations but also from the experts in the social field who were present. If civil-society organisations do not have the opportunity or capacity for participating in a societal incubator process, or are not interested in doing so, then we may also turn to various experts, such as social scientists, philosophers and (science) journalists, for social learning processes about new technology.

Lesson 4 – Confidentiality is and will remain a major concern

In a societal incubator as a protected space, confidentiality can contribute to openness on the part of those involved and therefore to the quality of the learning process. However, parties may also feel inhibited by confidentiality requirements from participating in a societal incubator process. When involving stakeholders in the process, the confidentiality rules must therefore be discussed clearly and in good time. This was not sufficiently the case at our experimental workshop, and some participants felt taken by surprise by this. Whether certain forms of confidentiality are necessary also depends on the approach taken for the societal incubator process. A more specifically case-oriented approach will be more likely to require a certain degree of confidentiality than a predominantly programmatic approach. In the first case, a technology developer or business will also need to be more explicitly considered as the "owner" of the process.

5 Conclusions

In this concluding section, we take stock, in the form of a brief summary, of the societal incubator as a key idea and viable concept, and then draw two conclusions. The first concerns the agenda for a societal incubator; the second underlines the importance of institutionalising a societal incubator.

5.1 The societal incubator as a viable concept

Based on our findings from the interviews and the incubator workshop, we conclude that the societal incubator is a viable concept. The stakeholders consulted recognise the waiting games phenomenon and the majority welcome the idea of a societal incubator. A societal incubator can help technology developers to gain a better understanding of the nature of waiting games, to reduce the associated uncertainties, and to assess their own chances of success more effectively. This is important because the very nature of waiting games often seems to be concealed from view. This leads to the somewhat paradoxical conclusion that a societal incubator is legitimised by the existence of waiting games and at the same time is an important means of revealing that such games are involved, or of preventing them (see also the appendix).

A societal incubator can also give stakeholders and organisations a better understanding of their (potential) role in innovation processes as “social entrepreneurs” who can contribute public views and interests to the often promissory and expectant considerations and assessments of technology developers. In this way, a societal incubator offers a platform or forum within which both those involved and those affected can collectively contribute to social learning processes and to the development of new perspectives for action. One possible outcome is that technology developers see new possibilities for themselves to break free from waiting games. Another outcome is that societal organisations in particular, such as regulatory bodies or social and consumer organisations, learn to better anticipate to new technological developments and thus may help to create opportunities and support for (nano)innovation.

5.2 The agenda for a societal incubator

We have referred to a socially accepted product with added value for society as being the ideal end result of a societal incubator process. An important finding from the incubator workshop is that societal stakeholders and organisations attach a great deal of importance to discussion of the added value for society. There was a clear need among those present for broadening discussion of the business case to include the nature of the societal issues and needs – in the fields of health or sustainability – that nanotechnology can or should address. A societal incubator process can help technology developers to develop a more critical and convincing overall view of the societal problem which they wish to help solve with their product. This means that in the interaction with societal stakeholders and organisations, a case-oriented approach must also offer scope for more programmatic discussion. We have incorporated this point in the script for an incubator workshop, as included in the final design of a societal incubator in Part I of this report. We explicitly allowed more scope for discussion of the societal context and needs, with input from societal stakeholders and organisations, and for discussion of alternative (nano)technological innovations, in addition to the business case, as a possible answer to the societal issues discussed.

5.3 Institutionalising a societal incubator

A societal incubator requires investment in terms of time and people. We concluded that – as with coaching and support within a business incubator – a societal incubator should also be able to offer support in the form of expertise and coaching with regard to the societal dimensions of innovation and social learning. Moreover, we need to view a societal incubator not only as a short-term process or a longer trajectory of social learning but also as a new kind of organisation (Robinson et al. 2012). Harro van Lente refers in this connection to a “next step of CTA” (Van Lente 2015). Constructive Technology Assessment is based on the idea of the “co-construction” of technology and society, and it attempts to promote such co-construction by bringing together technologists and social actors at an early stage in workshops. A societal incubator builds on this, but it can also be the next step, as an institutionalised space that provides a platform or forum for social learning processes regarding new technology and for aligning and coordinating different actors.

Indeed, as a new kind of organisation, a societal incubator has more to offer than the case-oriented approach that we adopted in this report as the starting point for drawing up the roadmap. In an institutionalised form, a societal incubator can also act as a platform for a more programmatic approach, in which various technology

developers and companies, together with societal stakeholders and organisations, explore a range of possibilities for technological innovation, with a view to pressing and important societal challenges

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Appendix: Case selection

In consultation with NanoNextNL, which commissioned this study, we looked for a case study in the field of nanofood for which parties see opportunities for innovation but also social sensitivities. The twofold basic principle was that (i) the problem owner of the case (a business, technology developer, or start-up) needed to learn from an incubator pilot and that (ii) it would be a case in which something was actually at stake for the parties in the incubator pilot. It should emphatically *not* be merely an academic exercise but a realistic example of a nanotechnological application in the field of food in which (potentially) sensitive issues play a role that makes the likelihood of social acceptance or appreciation problematic.

In a more specific sense, the case selection process was guided by the assumption that certain (nano)technological developments are stalled because technology developers, authorities, civil-society organisations, and other parties are adopting a wait-and-see attitude. More specific criteria in the selection process were uncertainties (technical-commercial but above all political-regulatory and socio-ethical) and divergent interests that led to parties waiting for one another to act (or keeping one another in a kind of stranglehold), as a result of which innovation was not able to take off, or only with difficulty. Ideally, the case should provide an example of a waiting game that can only be broken free from and prevented by collective action, and in which the societal incubator is a means of facilitating such collective action.

The search for a suitable case explored three different avenues:

- Drawing up an inventory of nanotechnological applications associated with NanoNextNL. Particularly important sources were NanoNextNL's magazine *NanotextNL* and information from a previous search for a suitable nano-food case for the European EST-Frame project (http://estframe.net/).
- The preparatory series of interviews with various stakeholders in the context of this exploratory study, with the interviewees being asked about cases that might appeal and, at a later stage, a discussion with a business developer linked to the NanoNextNL Valorisation Programme, with whom potential cases were discussed.
- Consultations with NanoNextNL's contacts regarding possible cases in which important factors were a clear problem owner and support for the case within NanoNextNL (recognisable and in line with the activities of the research consortium).

Potential cases

Amongst other things, the NanoNextNL research consortium is working on *taste sensors* (“taste laboratory on a chip”) that offer food companies advantages in predicting how food will actually taste, and on *colouring* vegetables (using colloidal particles) so that they look crisp and fresh. These examples were considered unsuitable as cases for an incubator pilot because, partly based on the findings from the preparatory interviews, they offered (too) few opportunities for public debate.

The case of *improved meat substitutes* based on nanotechnology, which was discussed as an exercise during NanoCity (see Box 3, Section 2), was also ultimately dropped. Although this example did offer sufficient opportunities for public debate, the relationship with nanotechnology was not sufficiently clear.

Candidates for an incubator pilot were then sought in the following fields:

1. ***Emulsions based on nanotechnology***. These are stable, homogeneous mixtures of non-miscible liquids, which are prepared by adding emulsifiers and are used in numerous food products. They contribute to taste and freshness (for example of bread, ice cream, mayonnaise, soft drinks) and make it possible to develop innovative food products with improved quality, which are healthier. One example is “nanonaise”, which is regularly mentioned in the media when the topic of nano-food comes up. This is a sauce to put on French fries in which a large proportion of the fat has been replaced by water without this impairing the taste.

2. ***Encapsulation based on nanotechnology.*** Another promising application of nanotechnology is encapsulation, in which food ingredients are packaged at nanoscale to be released at a predetermined location in the gastrointestinal tract. In this way, the body can absorb healthy substances much more effectively. A hypothetical case of encapsulation was discussed in March 2014 at a workshop on nano-food (EU project EST-Frame) which focused on an iron-enriched *chocolate product* for girls going through puberty. Because these girls suffer from above-average iron deficiency, such food products could be a tasty solution to this problem.

3. ***Nanosensors*.** In the field of logistics and packaging, *nanosensors* offer technical possibilities for increased transparency in food production processes (for example as regards freshness and quality). Specific examples are the development of an *ethylene sensor* that can accurately indicate the ripening of fruit, or a *detection system* that can trace bacterial spores more effectively and more precisely (and which also preserves beneficial bacteria and taste).

Because the introduction of this type of technology would have major consequences for (established) parties within the supply chain, innovations in this area are a rather tense matter. Who is prepared to invest in sensors and pay for them, and who will benefit from them? In this case, it is not the concerns of consumers, but the interests of chain parties that seem to be holding up innovations. Rather than a “waiting game”, it would seem to be a “delay game” that is involved, something that can be explained by conflicts of interest within the supply chain. A business case was discussed with the technology developer of the ethylene sensor, who was collaborating with a number of companies, which seemed interesting for the pilot incubator within this study.

Assessment and selection

Although emulsions based on nanotechnology seem to offer countless opportunities and possibilities for the food industry, we could not find any companies or technology developers with an interesting case in this field. For encapsulation, too, no problem owner came into the picture during our search who wanted to commit himself with a case for an incubator pilot. The ethylene sensor seemed interesting as a “disruptive case”, also because this example ties in with such issues as food waste, food safety, and transparency that can appeal to various parties within society. This case was ultimately rejected because of hesitations on the part of the problem owner about committing to an incubator pilot. It also became clear from consultations with NanoNextNL that a case focussing on a food product was preferred. The thinking was that because it is here that the public sensitivities are greatest, such a case can clarify what the possibilities are for a societal incubator to broaden the dialogue about uncertainties in technological innovations and to break free from “waiting games”.

A technology developer was ultimately found within NanoNextNL who had worked out the aforementioned hypothetical case of a chocolate product enriched with iron in detail, in the form of a business case. Although the business case was also of a hypothetical nature, something was actually at stake in this detailed design: if an incubator pilot were to offer positive prospects, the problem owner would actually like to develop the case further.

Concluding remarks

The above report makes clear that finding a suitable case is no simple matter. Although the uncertainties and related waiting games were broadly recognised during the interviews with experts and stakeholders, that recognition is difficult to substantiate with practical examples that demonstrate the actual existence of waiting games. One complication is that waiting games are linked to activities

behind the scenes, involving motives and decisions that are not public. That makes a realistic assessment of this phenomenon a difficult task.

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