

THE TECHNO-ENTREPRENEUR OF THE FUTURE

Perspectives and Practices

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Abstract

Present sustainability problems require a new type of techno-entrepreneurship, in which traditional entrepreneurial qualities are combined with new capabilities related to the role, mission and responsibilities of future engineers. There are two sources of these new capabilities: Innovation Systems of which engineer-entrepreneurs are architects and the demands of Sustainable Development. The Functions of Innovation Systems approach distinguishes seven functions which are crucial in transforming niche innovations into successful business and mainstream system innovations and transitions: Entrepreneurial activities, Knowledge development, Knowledge diffusion through networks, Guidance of the search, Market formation, Resources mobilization and Creation of legitimacy/counteract resistance to change. Sustainable entrepreneurship could be based on the characteristics of Natural Capitalism: increasing natural resources productivity, Bio mimicry, a Service Business Model and investing in natural capital. All these functions and characteristics involve knowledge, insight and capabilities, which should belong to the basic equipment of sustainability problem-solving engineers. The question is how to educate and facilitate these new engineers? The paper will deal with this question in relation to training and coaching programs of university supported incubators, focusing on sustainability. The activities of Delft University of Technology aimed at promoting entrepreneurship among engineering students and stimulating techno-starters, both through the academic courses of the Delft Centre for Entrepreneurship and the incubators of Yes!Delft and Dnamo; both incubators will be subject of research. Models of entrepreneurship and programs of training and support will be assessed from a sustainability perspective, on the basis of which suggestions will be done to improve the entrepreneurial capabilities of future engineers.

Keywords

Sustainability problems, techno-entrepreneurship, training and coaching of techno-entrepreneurs, TU Delft linked business incubators, educational renewal.

1. Introduction

Business incubators are considered to be a vital instrument in stimulating economic development, both in the East and the West, the North and the South (Carayannis & Von Zedtwitz, 2005; Mian, 1996; Porter, 1990). Though they are sometimes part and parcel of complete science and technology parks, usually they are centres aimed at starting entrepreneurs, offering a range of services, including coaching and training programs (Aernoudt, 2002). Preparing would-be entrepreneurs for tasks ahead may increasingly require attention for sustainability issues, as conceptions of and efforts to advance economic development more and more include environmental care and equity safeguards beside growth. This paper investigates incubators' models of entrepreneurship and programs of training and support focusing on the role of sustainability in these models and programs. Further, we limit ourselves to technical university supported incubators; new technology often plays an important part in economic development (cf. Mian, 1994 and 1996). Our ultimate aim is to look for characteristics a techno-entrepreneur should possess or acquire, in which the sustainability capabilities of such an entrepreneur are central. We aspire to give a general descriptive model which could help in benchmarking incubators (cf. Bergek et al., 2008; Erlewine, 2007; Philips, 2002).

We will argue that present sustainability problems require a new type of techno-entrepreneurship, in which traditional entrepreneurial qualities are combined with new capabilities related to the role, mission and responsibilities of future engineers. Two sources of these new capabilities will be discussed: the Functions of Innovation Systems approach and Natural Capitalism. Our lead question is how to educate and facilitate these new engineers. We will deal with this question in relation to our home base: Delft University of Technology in the Netherlands. Delft University of Technology develops a variety of activities aimed at promoting entrepreneurship among engineering students and stimulating techno-starters. It supports the incubators Yes!Delft and Dnamo (in Rotterdam) and these will serve as our cases. Models of entrepreneurship and programs of training and support will be held against the light from a sustainability perspective. Our empirical questions are: What sustainability vision is used in training and coaching activities? How is sustainability dealt with? When is it addressed in incubation trajectories?

First, we will briefly discuss the nature and challenge of sustainability problems, identifying and specifying these problems as “wicked problems”. Second, two approaches, i.e. Natural Capitalism and the Functions of Innovation Systems approach, will be discussed and investigated in terms of what they ask from future techno-entrepreneurs. Third, we will discuss the role of sustainability at the university supported incubators of Yes!Delft and Dnamo, determining to what extent the requirements derived from the theoretical analysis can be recognized. Finally, we will draw some conclusions.

2 The sustainability challenge for techno-entrepreneurs

Joseph Schumpeter (1883-1950) has played an important part in the analysis of and debate about capitalism and entrepreneurship in particular. He emphasized the role of innovation and considered the entrepreneur first and foremost as an innovator who generates new products or services and/or increases efficiency and productivity through introducing new technologies. The entrepreneur’s innovative activity does not remain limited to technology; he changes business norms as well. Schumpeter stressed “creative destruction” as a precondition for continued economic growth and development. This traditional image of entrepreneurs is still valid but has to be supplemented in view of present-day sustainability problems and the answers these require. We aim to do so in this section.

There are sustainability problems in all shapes and sizes. Instead of describing these problems, we take an analytical view by characterizing and specifying them as “wicked problems”. Consequently, we discuss two solution strategies: Natural Capitalism and the Functions of Innovation Systems approach. This results in a frame of reference to evaluate the sustainability characteristics of techno-entrepreneurs.

2.1 Sustainability problems

Sustainability problems regard the environmental impact of human activity all across the planet as well as the world poverty problem. They are “wicked problems” (Churchman, 1967; Ritchey, 2007) that derive their form and nature from the following facets (Pesch & Cuppen, 2010):

- a. They are multi-dimensional. Management of this type of risks requires a balance between economic, social and ecological values. “Socially responsible innovation” meets this challenge.
- b. They are long-term and involve the interests of various generations.
- c. They go beyond national borders and intervene in the operation of “system Earth”. However, addressing these complex problems, embracing ecological, social as well as economic aspects, seems to require a local and regional approach.

- d. They are characterized by conflicting knowledge and value claims. Actors have divergent views on the nature and seriousness of these risks and the borders between values and knowledge are not always clear.
- e. Technology development has a double character in relation to these problems. On the one hand, technology constitutes a main cause; while on the other hand, it offers the proper method to tackle these risks.

Given their nature sustainability problems challenge society to come up with radical and comprehensive solution strategies. Two elements seem to be essential and will be discussed here: new forms of entrepreneurship and an innovation system approach.

2.2 The answers of Natural Capitalism

In view of sustainability problems, Paul Hawken, Amory Lovins & L. Hunter Lovins (1999, see also Lovins et al., 1999) argue in favour of a new form of capitalism in which nature is considered. Their Natural Capitalism embraces the following aspects:

- A dramatic increase of natural resources productivity; during the Industrial Revolution in Britain labour productivity grew with some 100%, we should repeat that for natural resources, through Whole System Design and the introduction of innovative technologies
- Shift to biologically inspired production models: Bio mimicry and Industrial Ecology; natural cycles as a metaphor for technological innovations and the clustering of business
- Transition to a solution-based business model; focus on services instead of products; providing floor-covering services instead of selling carpets
- Reinvesting in natural capital instead of plundering natural resources, in order to maintain the ecological base of the economy

Hawken et al. offer an approach which combines the advantages of a free enterprise economy with the restraints of the natural environment, integrating ecological goals with economic goals. People are not scarce nowadays, natural resources are and Natural Capitalism offers a compass for a transition from traditional industrialism to a new paradigm of production. One consequence of their argument is a strengthening of the relationships between local economy and ecology, while controlling unlimited growth of international trade.

2.3 Innovation through systems' function engineering

An extensive literature has developed the past decades on the topic of Transition Management, which provides a tool – or set of tools – to accomplish the necessary transitions to sustainability (Geels, 2005; Kemp et al., 1998; Rotmans, 2003). Significant concepts and insights in this framework – and the broader scope of Technology Dynamics, a field of scientific activity that integrates Transition Management with an analysis of technology development from a social perspective – are the Three-Level Model (see Figure 1) and the Functions of Innovation Systems (FIS) approach. The first distinguishes between regimes (e.g. the fossil-energy-regime), the landscape (the broader social context and its problems, e.g. global warming) and niche developments (e.g. the emergence of solar technology and business), theorizing that niche developments result from landscape pressures and could have an impact on the regime level, where these landscape pressures are also manifest.

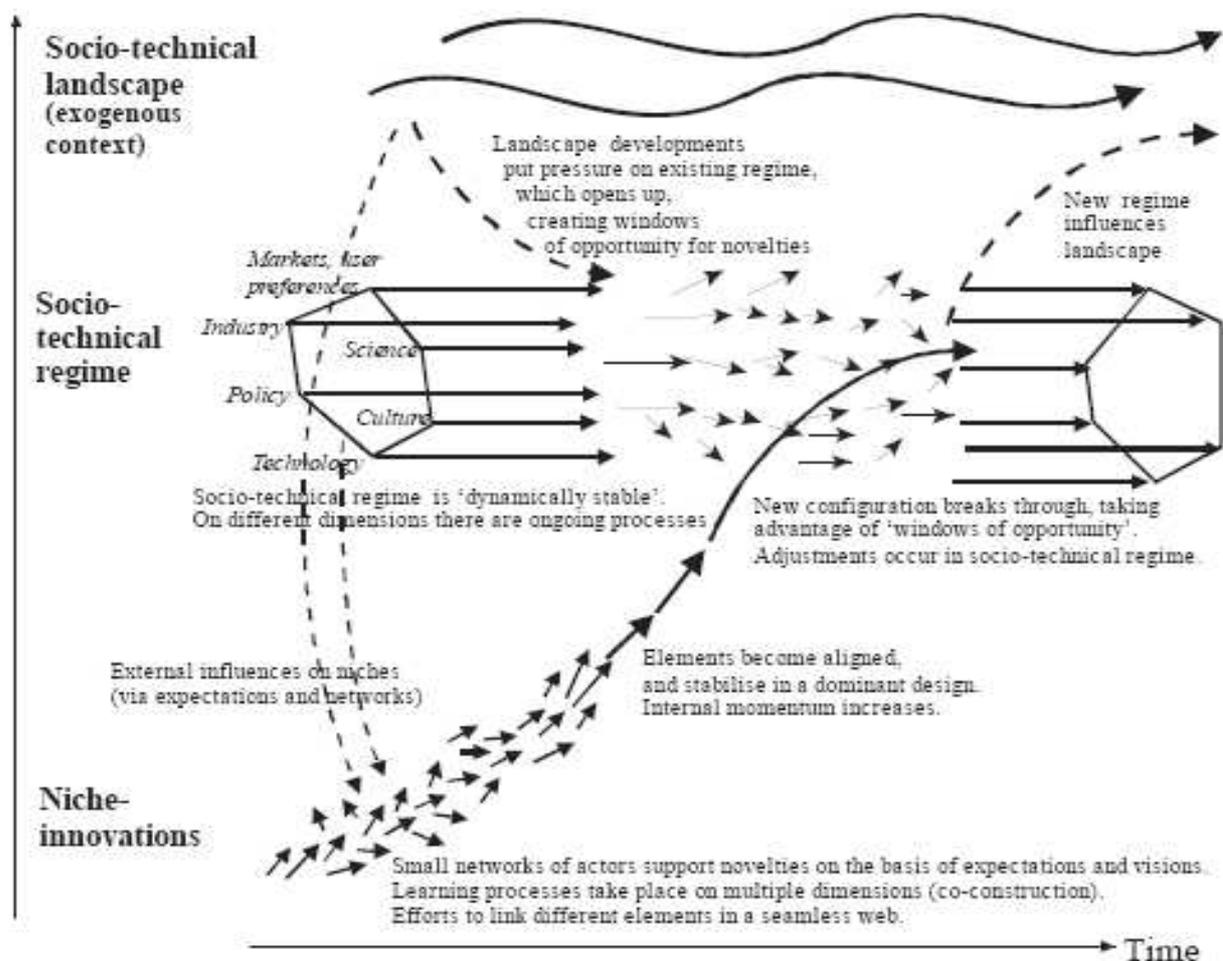


Figure 1: Three-Level Model (Geels & Schot, 2007)

The FIS approach is a theoretical answer to the question of how niche developments could become part of mainstream regime pathways, changing or even replacing the dominant regime. It shows how entrepreneurship aimed at sustainability transitions could be successful. Innovation systems comprise the following functions (Hekkert et al., 2007):

1. Entrepreneurial activities: taking risks and being innovative in relation to starting and continuing business (Schumpeter's model entrepreneur).
2. Knowledge development: R&D as the essential base for innovation and enterprise.
3. Knowledge diffusion through networks: the exchange of information in a network of entrepreneurs and other actors involved.
4. Guidance of the search: relates to expectations with regard to a new technology or policy targets.
5. Market formation: the creation of niche markets as a starting point for market penetration.
6. Resources mobilization: the gathering of all inputs required, labour, financial resources, knowledge, raw materials etc.
7. Creation of legitimacy and counteracting resistance to change: involves lobbying, e.g. in political circles, and other activities to promote a product or service.

Within the framework of innovation systems functions are connected in cycles, in which several routes could lead to success. Starting points could be entrepreneurial activities or the guidance of the search in terms of a policy goal (see Figure 2; Hekkert et al., 2007; see also Suurs, 2009).

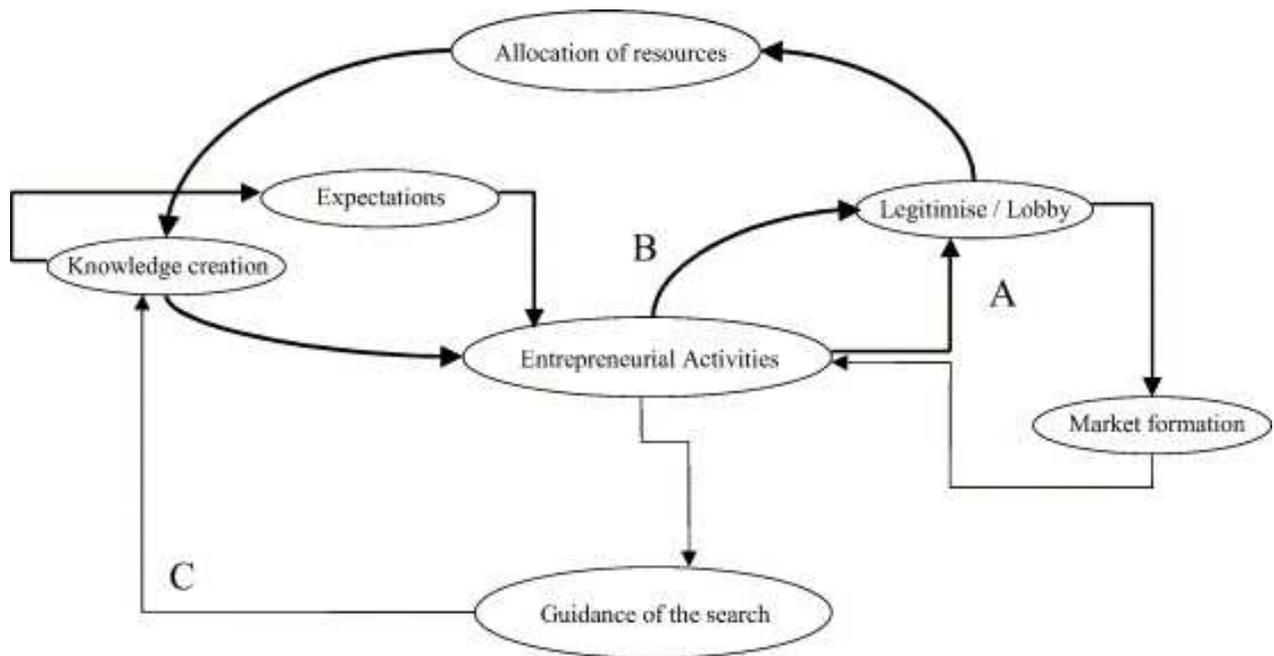


Figure 2: Routes within innovation systems (Hekkert et al., 2007)

2.4 Sustainability: frame of reference

Sustainability in terms of wicked problems, Natural Capitalism and the Functions of Innovation Systems approach constitute our frame of reference for evaluating our cases. In this paper we limit ourselves to the following aspects:

- Ideas about resource use: economizing on raw materials?
- The means through which enterprises are considered to make profit: products or services?
- Consideration of the broader context: Is there a notion enterprise embraces more than the classic image of entrepreneurship?

We will focus the latter point on Knowledge Management, which relates to some of the functions (notably 2, 3 and 6), but also has a wider significance.

3 Sustainability at incubation centres for techno-entrepreneurs

An incubation centre aims to facilitate (technology based) innovations and helps to commercialize them. Two Dutch incubation centres serve as case studies: Yes!Delft and Dnamo. Yes!Delft is an initiative of TU Delft and Dnamo is an incubator in Rotterdam founded by Enviu, an international network organization for young entrepreneurship. They work in close collaboration with Yes!Delft, the Port of Rotterdam and Rotterdam University of Applied Sciences. Both centres support entrepreneurs interested in starting a high-tech company or further developing an early stage high-tech company. Dnamo, however, adds an

explicit target of increasing sustainability: “entrepreneurs could get assistance in the development of their sustainable and innovative businesses” (<http://www.dnamo.nl>). The question is what they mean by “sustainability”; What role does sustainability play in these incubation centres? And to what extent can the points from the theoretical analysis (section 2.4) be recognized? Data is obtained through the websites and underlying documents; in addition, the coordinators of both incubation centres have been interviewed.

3.1 Yes!Delft

Yes!Delft facilitates technical entrepreneurs in different phases. Four centres have been established: 1. inspiration centre for students and others to generate enthusiasm for entrepreneurship; 2. educational centre that provides education at the Bachelor’s and Master’s levels in cooperation with Delft Centre for Entrepreneurship (TU Delft), 3. incubation centre where entrepreneurs can gain support for the start-up of their company 4. growth centre which support the post start-up phase. In this paper, we focus on the incubation centre.

Techno-starters that want to be admitted to the incubation centre must satisfy a number of selection criteria. They must present a business plan that demonstrates that the business idea is feasible and expandable; they must show a growth ambition. The new business should be a company with a product - not a project or a service - using a new technological invention or a new application of existing technology. “A new type of wind mill at the TU Delft is a project; a windmill that is used throughout Europe might be a scalable product with growth potential”. Techno-starters can stay at the centre for a maximum of three years.

3.1.1 (Pre) incubation program of Yes!Delft

To qualify for the program YES!Delft offers a 100 days pre-incubation program. The program consists of personal business coaching and mentoring, a working space and a series of workshops to provide candidates with the knowledge and skills they need to write a business plan. Once selected, the incubation centre supports techno-starters by providing accommodation, the facilities of the TU Delft – for example a wind tunnel to conduct tests, coaching and education. Two types of coaching are offered, 1. strategic company coach to redevelop the strategy in the first year and 2. personal coach, who can be compared to personal development programs for large companies: “intervision for small businesses”. Further, many master classes are offered about marketing, sales, finance, negotiation and project management. Important lessons learned in the first year(s) are: first, focus on the initially selected product-market combination, e.g. always keep an eye on your goal, and,

second, take care of a complete and diverse team: “Ultimately, it is not an entrepreneur or a product, but a team that is successful”. According to the website of Yes!Delft, the following competencies should be ensured within the company:

- Product expertise and the ability to deliver quality (the “technician”);
- Sales ability (the “salesman”);
- Ability and interest in governance and finance (the “manager/policy maker”).

3.1.2 Role of sustainability at Yes!Delft

Sustainability in the sense of “clean tech” is not the main focus of Yes!Delft. However, there are a number of sustainable techno-starters at Yes!Delft, e.g. companies producing a wind turbine for the built environment, fuel-saving aerodynamic devices for road transport or affordable biogas systems for rural households in (sub) tropical regions. Further, Yes!Delft has been one of the promoters of a new incubator: Dnamo, which focuses on techno-starters who want their innovations to be sustainable. Nevertheless, sustainability at Yes!Delft is seen as “something extra”, which can give “a competitive edge”. It can be stimulated by partners or launching customers. Most entrepreneurs are in business to business markets and if large companies consider sustainability important, then they must ensure sustainable production. According to the incubator coordinator it is important to start early and include sustainability in the Bachelor and Master courses of the TU Delft. “Not so much just by telling about sustainability, but by showing students and even better let them experience the problems that exist in the world”. What also works well is using role models. “Entrepreneurs who have already done it and say: ‘I did not think about sustainability, this was the price and I’ve learned my lesson’. Then you have a very different story than when it comes from a non-commercial side. Starters’ primary concern is how to ultimately survive”.

3.2 Dnamo

The slogan of Dnamo is: “empowering tomorrows firms in sustainability”. The (pre) incubation program is more or less the same as Yes!Delft. Sustainability, however, is one of the selection criteria for admittance. “The intended product should be a (partial) solution to a real environmental or social problem within society: How does your idea contribute to a solution to a specific sustainability problem (environmental, social or both)? Do you have a (quantitative) indication of the size of the problem? To what extent will your idea contribute to the reduction of this problem?” For admittance to the incubation program a letter of recommendation by a technical expert or sustainability expert is necessary. In addition, “the

starters in sustainability have to prove that they have ambition, guts, perseverance and have their heart in sustainability” (<http://www.dnamo.nl/en/>).

3.2.1 Role of sustainability at Dnamo

Sustainability is defined as a product in the field of:

- Energy: e.g. windmills, solar cells
- Mobility: e.g. electric transportation
- Lifestyle: e.g. healthy products

It should be a product, not a service, since Dnamo is like Yes!Delft funded by Agentschap.nl (a Dutch government agency for consultation and funding) that is concerned with innovation and job creation. The idea is that production of products generates work, so the company should be based on a tangible, scalable product (with regard to scope and production). For example: a company that designs, develops and markets innovative concepts for healthy snacks. The concepts are specifically designed for and by children aged 4-12 years. Popular snacks become healthier by new technology, adding vegetables or fruit, while clean label development adds to the environmental value. The healthy snack concepts contribute to a healthier lifestyle and reducing social problems of obesity.

According to the incubator coordinator a sustainable techno-entrepreneur should be able to compete on price, quality and functionality first. Therefore, it is not a requirement to produce sustainably, or to use materials that are produced without waste. By doing everything sustainably, the price is too high. People are willing to pay slightly more for sustainable products, but not much. Further, not everyone wonders if all has been produced sustainably. Though, some markets have the wind behind, e.g. with European law stipulating that motors may not make much noise, there is a chance for the electric motor.

3.2.2 Facilities of Dnamo

Dnamo has a similar program as Yes!Delft. An extra facility is the sustainability coach. His main task is to help formulating sustainability claims. Entrepreneurs must demonstrate in what way they are sustainable. For instance the electric motor: recharging is cheaper and greener. The next step is to communicate this to the market by comparing it with an engine, how much is the saving?

People from different backgrounds can apply for the (pre) incubators program. Some simply see the business case. Others have “their heart in sustainability”. Most sustainable entrepreneurs had an experience like: “It is a waste of energy that streetlights burn when no one is out there. If you detect such problems, then you have in your head: there is too much

energy waste”. However, Dnamo does not support foundations or NGO’s that want to save Africa: “we want people who want to make profit”. The best way to do that is to stimulate entrepreneurship via networks and communities, workshops and through scouting of sustainable ideas.

In the next paragraph the role of sustainability in the incubation centres will be analysed using the ideas of Natural Capitalism of Hawken et al. (see section 2.2). Two points will be addressed: the ideas on resource-use and the business model. Further, a consideration of the broader context is assessed. Is there a notion enterprise embraces more than the classic image of entrepreneurship? (See section 2.3).

3.3 Role of sustainability for techno-entrepreneurs

3.3.1 “Big” is not necessary to make a profit; resources are scarce

The main focus of the techno-entrepreneurs is said to be a tangible, scalable product. “Can the solution be replicated in order for the impact to be as big as possible? Does the idea have scalability; can it be implemented in different situations and still deliver the same output?” If you compare this to the ideas of Hawken et al. then you could ask:

- Does the product make sense? Which need or problem does it meet?
- Is a product the best solution to this problem? What other solutions are thinkable?
- How do we ensure that we use fewer products *and* make profit?
- How do we ensure that we make better use of resources *and* make profit?

Hawken et al. argue that “many” and “large” is not necessary to make profit. They tend to plea for small series and custom-made designs and want to recover the relationship with the local ecology. Not based on idealism, but because sustainability is ultimately more profitable. The fewer materials used, the less money it costs; the less resources transported over the world the cheaper it is. Moreover, all costs must be included, such as depletion of raw materials, pollution that should be cleaned up, transportation etc. In the pricing, the entire product chain must be considered.

3.3.2 Sustainability is not a trade-off but an integral part of a business strategy

Sustainability is viewed as “a competitive edge” or a product in the field of energy, mobility or lifestyle. Only when entrepreneurs can compete on price, quality and functionality, they can also start thinking about sustainability in the rest of the chain, such as sustainable packaging.

According to Hawken et al this is a limited view on sustainability in entrepreneurship. Sustainability is not a trade-off but an integral part of the business strategy. That makes sustainable not “nice to have” or “would like to have in the future”, but a “must have” in order to be a success. And a business model that is based on paid services (not meaning consultancy) better fits in than the traditional product orientation.

3.3.3 Sustainability involves managing knowledge processes

From the interviews appears sensitivity to the importance of the broader context, though this is partially addressed in the programs. Partnering, big enterprises taking starters along, is recognized to be important and is stimulated. In general, teaming up is considered essential and a condition for survival. Both facets refer to networking, which connects techno-entrepreneurs with other actors, which could be understood in terms of “innovation-system building”. The guidance of the search-function appears in a negative way: the preference for products results from the subsidy regime. Emphasizing role models also makes starting entrepreneurs aware of the importance of the broader context.

One aspect of the broader context is the attention to knowledge management. A sustainable techno-entrepreneur must have detailed knowledge of the processes of the intended product. Where do (raw) materials come from? How are they produced? By whom? Are they tested? What does production of these materials costs – everything included? This information needs to be acquired, stored, shared, applied and evaluated. Therefore, knowledge management is a very important topic for every entrepreneur and should be added to the team competences.

4 Discussion

Schumpeter’s model of an entrepreneur needs some upgrading in view of the nature of sustainability problems as well as the transformative activity these “wicked problems” require. Broadly formulated, entrepreneurs and especially techno-entrepreneurs should have a set of capabilities enabling them to tackle sustainability problems; we could speak of a “sustainability competence” (like a “moral competence”, see Royakkers et al., 2004). In view of the Natural Capitalism principles as well as the Functions of Innovation Systems approach such a sustainability competence contains knowledge, insight beside capabilities with regard to the analysis and ways to deal with sustainability problems.

We can distinguish two ideal types of techno-entrepreneurs:

- the classic Schumpeterian entrepreneur focused on risk-taking, innovation and competition

- the sustainable entrepreneur who tackles social problems using the market mechanism as a means to accomplish change and transformation in the direction of a stable growth-economy and society

The second type is the new type of techno-entrepreneur, possibly “the techno-entrepreneur of the future” (table 1, the last column), which we can introduce on the basis of our discussion of sustainability problems and the general approach these call for. This is the entrepreneur the theories of Technology Dynamics prescribe: a wicked problem-solver, a Natural Capitalist, an architect of innovation systems aspiring sustainability transitions.

Our empirical material suggests the techno-innovator of the column in table 1, positioned between the classic entrepreneur and the sustainable techno-innovator: the techno-innovator who establishes innovations through entrepreneurship within the framework of the existing socio-economic context; Table 1 gives a few example characteristics.

Table 1: Models of entrepreneurship

	Classic entrepreneur	Techno-innovator	Sustainable techno-innovator
Final goal	Profit	Profit, employment, continuity	Profit, people, planet
Means	Product	Product	Service
Technology development	Increasing labour productivity	Increasing labour productivity	Increasing resource productivity
Market orientation	Technology push	Technology push and Market pull	Problem-solving
Market formation	Marketing	Scalable product	Creation of niches
Social strategy	Individual	Networking	System-building
Knowledge	R&D	R&D, diffusion	Knowledge management

For the sustainable techno-innovator sustainability is part and parcel of his commercial strategy; an example is the 3M company, which exploits the Pollution Prevention Pays principle. For the TU Delft supported techno-innovator, however, as described in section 3, sustainability has a price and, consequently, it is the subject of a trade-off.

5 Conclusion

Advancing economic development without aggravating ecological and social problems is the sustainability challenge of the future, facing global society and techno-entrepreneurs in particular. Present sustainability problems are “wicked problems” that require a new type of techno-entrepreneurship, in which traditional entrepreneurial qualities are combined with new capabilities related to the role, mission and responsibilities of future engineer-entrepreneurs. We have discussed two sources of these new capabilities: Natural Capitalism and the Functions of Innovation Systems approach.

We might conclude from this discussion that sustainability can be a significant value driver in the context of a transition towards what we could call a responsible capitalist economic system, in which nature is much more considered than now. However, such a transition can only be realized through a combination of innovative entrepreneurship and a favourable environment, in which a number of conditions is fulfilled. A full innovations system is required, in which entrepreneurial skills is just one function; other functions regard niche market formation, guidance of the search through policy targets and overcoming resistance.

Consequently, we have investigated the training and coaching programs of university supported incubators, notably Yes!Delft and Dnamo, linked to the Delft University of Technology. Our main question was how sustainability plays a part in all activities aimed at promoting techno-entrepreneurship. We found what we should and could have expected: sustainability is considered important in doing business. However, sustainability appears in different forms. The sustainable techno-entrepreneur who tackles social problems using the market mechanism as a means to accomplish change and transformation in the direction of a stable growth-economy and society seems to be scarce. A business strategy based on sustainability might be thinkable and necessary, it is not the strategy TU Delft supported techno-entrepreneurs are using. For them sustainability is a trade-off, desirable but only to the extent that it is commercially possible.

We have distinguished three types of techno-entrepreneurship: the traditional Schumpeterian type, a theoretically deduced type and the type that our empirical data revealed. The last two types are the future and we could hypothesize these types to be part of a transition process, in which the full sustainable techno-innovator will be the last to stand.

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