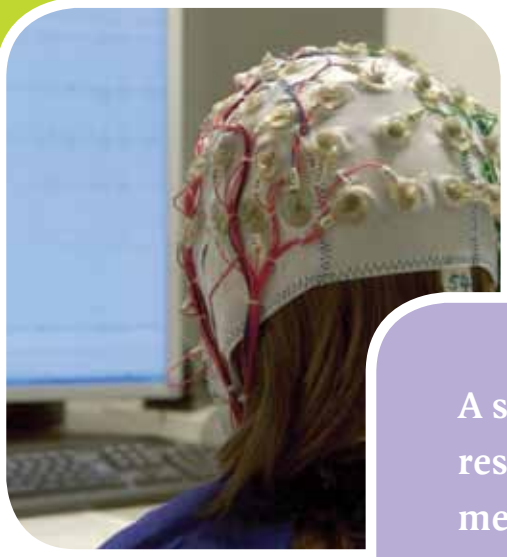
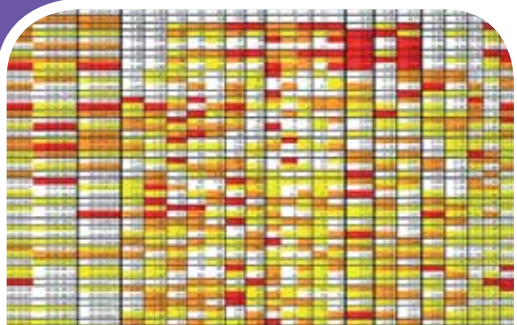
ICT for Brain, Body & Behavior

Business Plan



A sustainable Living Lab for research and development of measurement and analysis systems for brain, cognition, physiology and behavior



ICT for Brain, Body & Behavior

A sustainable Living Lab for research and development of measurement and analysis systems for brain, cognition, physiology and behavior

Business Plan

Colophon

Text | Lucas Noldus, Frits Grotenhuis and Huib Pasman
Graphical design | Op de millimeter, Veenendaal
Print | Digigrafi, Veenendaal
June 2012

Contact information
i3B Foundation
P.O. Box 268
6700 AG Wageningen
The Netherlands
Phone: +31-317-473300
Fax: +31-317-424496
E-mail: info@i3b.org

Disclaimer
This business plan contains proprietary information regarding '*ICT for Brain, Body & Behavior*' (i3B). The information contained herein has been prepared for the purpose of assisting i3B stakeholders in investigating the feasibility and commercial potential of i3B and/or its activities. No representation or warranty, expressed or implied, is made to the accuracy or completeness of such information. Nothing contained in this report is, or shall be relied upon as a promise or representation, whether to the past or the future, on i3B and/or its activities.

Contents

Summary | 6

Background | 8

Context | 9

Scientific and technical breakthroughs | 9
New application areas | 9
ICT Innovation Platform Brain & Cognition | 10
The Brain & Cognition working area | 10

Definition of the problem | 11

Need for collaboration | 11
Need for test facilities | 12
Need for reference data | 13
Need for demonstration facilities | 14
Education, training and knowledge dissemination | 14
Access to R&D funding | 15

Legitimacy | 15

Relevance for the Dutch top sectors | 15
Relevance for regional policy | 17
Relevance for local policy and initiatives | 17
International context | 18
Complementarity with respect to other Living Labs and similar initiatives | 19

Focus and activities | 20

Ambition, horizon and focus | 21

Scientific disciplines | 21
Technology areas | 22
Application areas | 24
Translational approach | 25

Activities and services | 25

Overview | 25
The i3B Lab | 27
E-science Lab | 33
Knowledge dissemination | 34
Events | 34
Education | 35
Research services | 36
Business development | 36

Parties involved | 38

Realization | 40

Organization and governance | 41

Business model | 42

Forms of participation | 42
Levels of participation for SMEs | 43
Contribution of technology | 43
Value proposition for participating SMEs | 44
Value proposition for knowledge institutions | 45
Strategic clients | 46

Financial model | 46

Costs | 46
Revenues | 47

Investment plan and operating budget | 48

Planning | 48

Appendices | 50

1. Existing field labs relevant for i3B | 51

2. Organizations involved in i3B | 55

Small and medium-sized enterprises | 55
Knowledge institutions | 56
Related field labs | 56
Foreign technology providers | 57
Network and sector organizations | 57
Government | 57

3. i3B projects | 60

Current projects | 60
Possible future projects | 62

4. Financial returns for a university | 64

5. Acknowledgements | 65

Contributions | 65
Illustrations | 66

Summary

The initiative ICT for Brain, Body & Behavior, abbreviated i3B, proposes a new Living Lab where innovative high-tech companies can consolidate their strengths for research and development of measurement and analysis systems in the areas of brain, cognition, physiology and behavior.

Background

The Netherlands has a small yet flourishing sector of about 50 companies, mostly SMEs[1], in the area of measurement and analysis systems for research into the brain, physiology and behavior. Most of these companies are global players. The growth and economic success of this sector is, however, constrained by various factors.

[1] SME = Small and medium-sized enterprises, companies with fewer than 250 employees. For the official definition of the European Commission, see http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/sme-definition/index_en.htm.

Collaboration

Manufacturers are confronted by an increasing demand for high-throughput and high-content measurement and analysis. Researchers want to concomitantly collect as much data as possible from their test subjects and process this as quickly as possible. This requires multi-sensory measurements, multimodal analyses, multifunctional systems and solutions. Few companies have all of the necessary technologies in house. Besides, the active involvement of end users is a precondition for success. Multidisciplinary and user-centered product development demands collaboration between manufacturers, knowledge institutions and end users.

Test facilities

The testing of prototype measurement and analysis systems covers evaluation of the functionality, technical performance, usability, reliability and validity. SME companies do not usually have their own test laboratory and the limited availability of test subjects forms a bottleneck for validation studies of measurement instruments. A well-equipped joint test laboratory could be a solution for collaborating SMEs and knowledge institutions.

Reference data

The development of algorithms for automatic pattern recognition requires reference data that reflect as great a number of situations that occur in practice as possible. Obtaining such data is a very time-consuming and labor-intensive activity. For an SME, building up an extensive archive of reference data is a nigh on impossible task. This problem is therefore ideally suited to a collaborative approach.

The i3B initiative ties in well with the regional ambitions of the Province of Gelderland as well as various top sectors at a national level. Collaboration within Europe, e.g. with Knowledge & Innovation Communities (KICs), part of the European Institute of Innovation & Technology (EIT), is being explored.

Focus and activities

The i3B Living Lab will meet the aforementioned needs with a network of physical locations, including a central laboratory in Wageningen and various satellite locations, from which services can be offered to participants, partners and clients. Wherever possible, use will be made of existing facilities. The satellite locations will be set up according to specific themes relevant for i3B and to which partners will also have access, depending on the type of partnership. Various activities and services can be distinguished within i3B such as research and development, facilities and services, communication, events and education. The research and development activities will be clustered according to thematic labs. These labs will develop from a growth model based on the principle of market demand legitimizing a new activity.

Realization

The ambition is to establish the i3B Foundation in 2012 and to appoint a board, director and small staff so as to keep the basic costs low. A facility will be set up in Wageningen where the various thematic labs will be given space. The business model will work with a budget for the i3B organization and specific project budgets. Revenues will be contributions from participants, project contributions and payments from lab users. Several categories of participants will be distinguished dependent upon the contributions, and this will be a determining factor for the use of facilities. In addition to this, an initial start-up subsidy will be requested from the government. Various value propositions have been defined for SMEs and knowledge institutions in which the intended synergy will have a multiplier effect for participants. The initiative has started in 2012 and the growth of i3B will be determined by the market's response.

Image courtesy | SensoMotoric Instruments GmbH

1 Background

9 **Context**
Scientific and technical breakthroughs | 9
New application areas | 9
ICT Innovation Platform Brain & Cognition | 10
The Brain & Cognition working area | 10

11 **Definition of the problem**
Need for collaboration | 11
Need for test facilities | 12
Need for reference data | 13
Need for demonstration facilities | 14
Education, training and knowledge dissemination | 14
Access to R&D funding | 15

15 **Legitimacy**
Relevance for the Dutch top sectors | 15
Relevance for regional policy | 17
Relevance for local policy and initiatives | 17
International context | 18
Complementarity with respect to other Living Labs and similar initiatives | 19

Context

Scientific and technical breakthroughs

Scientific research on the human brain has undergone rapid progress in recent years. New techniques have made it possible for researchers to observe the brain in action and to visualize the effects of neurological and psychiatric disorders. Thanks to breakthroughs in neuroimaging we can measure the relationship between brain activity and behavior online. Developments in information and communication technology (ICT) mean that we can collect psychophysiological signals in a manner that was quite inconceivable until very recently. Measurements of EEG, heart rate and galvanic skin resistance are no longer confined to the laboratory. With the development of body area networks and wireless sensor networks, physiological parameters can be unobtrusively measured in an ambulant setting. Thanks to fast processors and advanced digital image processing we can follow movements, postures, gestures and facial expressions with a video camera. And breakthroughs in signal analysis, pattern recognition, machine learning and data mining mean that we can now interpret behavioral patterns in real time. Due to the ubiquitous presence of wireless networks and the miniaturization of RFID, people, animals and objects can be identified and followed ('*Internet of Things*'). All of these developments together form the basis for an enormous range of new applications.

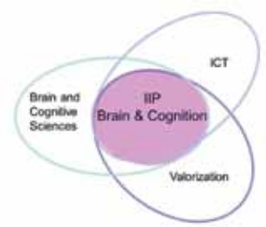
New application areas

The combination of ICT breakthroughs and knowledge about the brain, cognition, physiology and behavior has resulted in generations of new products and services with a considerable social and economic impact. First and foremost the increasingly ageing population places an enormous burden on the healthcare system due to neurodegenerative disorders. The number of patients

with Alzheimer's Disease is steadily increasing, and depression is starting to become the disorder with the most significant consequences for the quality of life. This demands new non-invasive tools for diagnostics, behavioral monitoring and ambient-assisted living. There is a growing demand for tools for a healthy lifestyle, for example for reducing stress, improving sleep, facilitating physical activity and preventing obesity. Serious games that provide physiological measurements and neurofeedback offer new options for training and education. Brain-computer interfaces will enable people to control systems by mental activity alone. Intelligent systems can improve human-computer interaction and reduce the errors of operators and clinicians. Finally society is demanding that we treat farm animals more carefully and this calls for precision livestock farming with the aid of ICT.

ICT Innovation Platform Brain & Cognition

To bridge the gap between the rapid developments in ICT on the one hand and the progress in neurosciences on the other, the ICT Innovation Platform Brain & Cognition (IIP B&C) was founded in 2009 under the auspices of ICTRegie (part of NWO, the Netherlands Organization of Scientific Research). Within this platform, knowledge institutions, companies and end users collaborate at the interface of ICT, brain and cognitive sciences, and valorization. The platform members include leading university research groups, TNO institutes, large companies and dozens of SMEs. IIP B&C aims to be a lively ecosystem and to make a contribution to a productive and innovative climate for the development of new products and services in the Netherlands. In September 2010 the platform published its first Strategic Research Agenda (can be downloaded from www.iipbc.nl). This contains the most important research themes and application areas, with an analysis of the priorities for each one as well as proposals for concrete steps to utilize short-term possibilities and to realize a long-term ambition. IIP Brain & Cognition maintains close contact with the other IIPs, especially IIP Create and IIP Sensor Networks. After the disbanding of ICTRegie at the end of 2010, IIP Brain & Cognition became embedded with effect from 1-1-2012 within NWO's National Initiative Brain & Cognition (NIHC, www.hersenenencognitie.nl).



IIP/B&C
ICT INNOVATION PLATFORM BRAIN & COGNITION

National Initiative Brain & Cognition

The Brain & Cognition working area

For companies active at the interface of ICT and Brain & Cognition, that is – slightly more broadly defined – research into the brain, cognition, physiology and behavior, the working field in the Netherlands can be characterized as follows. The companies can benefit from a number of strengths: a strong neuroscience and behavior knowledge base with excellent academic and RTO research groups[2], superb ICT facilities with ubiquitous broadband and wireless internet and short geographical distances which makes facilitates collaboration. Dutch companies are usually global players with a focus on worldwide export. At the same time there is a real chasm between knowledge and application: much scientific knowledge remains unutilized and is not translated into applications that reach the consumer and patient (the well-known '*innovation paradox*'). And this is despite the immense social relevance of Brain & Cognition applications. Opportunities are simply waiting for entrepreneurs to pick them up!

[2] An illustration of the Netherlands' international top position in computer vision-based cognitive modelling and behavior monitoring is the DARPA project CORTEX, which was won by TNO and partners in competition with, among others, MIT.

Definition of the problem

The Netherlands has a small yet flourishing sector of about 50 companies, mostly SMEs, in the area of measurement and analysis systems for research into the brain, cognition, physiology and behavior. Most of these companies participate in the global market. These include – as Martin Rem put it – several '*jewels*' from the Dutch ICT industry[3]. The growth and economic success of this sector are, however, impeded by various factors, which are stated and described below.

[3] M.Rem (2009). Tegen de stroom in - De rol van de Nederlandse in de ICT (Going against the flow - the Dutch role in ICT). The Hague: ICTRegie

Need for collaboration

Manufacturers of measurement and analysis systems for research into the brain, cognition, physiology and behavior are confronted by an increasing demand for high-throughput and high-content measurement and analysis. Suitable test subjects are scarce, there is social pressure to use as few experimental animals as possible, experiments are expensive and the time pressure is high. Therefore researchers want to concomitantly collect as much data as possible from their research subjects and process this as quickly as possible. So instead of a cognitive task, followed by a physiological test and then behavioral observation they want a single test that integrates the cognitive, physiological and behavioral assessment. This requires multisensory measurements, multimodal analyses, multifunctional systems and solutions. That can only be realized by means of multidisciplinary product development with the use of various technological disciplines: sensor technology, optics, video and audio techniques, analogue and digital electronics, mechanics, mechatronics, measurement and control technology, mathematics and statistics, software application development and system integration. Only few SME companies have all of these disciplines in house; manufacturers must therefore collaborate with each other. This can largely be realized at the precompetitive stage according to the rules for open innovation: by agreeing upon standards and interfaces companies can share certain knowledge and technology with each other whilst still safeguarding their own IPR. An example of precompetitive knowledge sharing is the collection, annotation and central storage of reference data for the development and validation of algorithms for automated behavior recognition based on different sensors (see '*Need for reference data*', page 13).

A growing number of companies realize that successful product development depends upon the active involvement of end users (user-driven innovation). Involvement changes users from being '*passive critics*' into '*active creators*'. This is especially true for interactive systems where the user should be the focus during the design (user-centered design, UCD) and nowadays users are often worked with right from the start of the project (co-creation, co-design) to collect and analyze their wishes and demands, to predict the utility and user experience of the product, to estimate the extent to which the interface covers the user requirements, and the potential of the technology to meet latent needs. UCD also covers usability testing, a mature method for which good tools are available and which has long been introduced in large companies but is not yet widely used by SME product developers[4]. Usability testing should be done throughout the entire design and development process.

[4] B. Steenbekkers (2007). Usability netwerk Nederland (Usability Network The Netherlands). Research carried out by Wageningen University on behalf of IOP Mens-Machine Interactie.

Multidisciplinary and user-focused product development demands collaboration between manufacturers, knowledge institutions and end users. And despite the ubiquitous presence of digital communication devices we also know that collaboration between people proceeds most effectively when there is physical proximity, preferably in the form of co-location.

Need for test facilities

The development of new measurement and analysis instruments (including software) requires considerable investments in research, design, development and testing. The testing of prototypes in various states of readiness includes an evaluation of the functionality, technical performance, usability, reliability and validity. Certain tests (such as functionality, technical performance) can be realized in the development laboratory, but others (such as usability, reliability and validity) must be performed in a relevant context). For example, a system that detects subtle differences in facial expression can only be validated in an environment where these expressions are induced and the relationship between specific body movements and emotions can only be established in a context where both occur.

Driver observation and feedback in car simulators

Technologies
Car simulator
Video observation
Eye tracking
Heart rate
GSR

Projects
DRIVOBS
ADVICE

Partners
Noldus IT
Green Dino
Cruden
TomTom
Smart Eye
TU Delft
TNO
HAN

Driving simulators enable flexible, efficient, and safe testing of new driver assistance and infotainment systems, human-machine interfaces, and vehicle dynamics control systems. Results are usually analyzed using objective driving performance data recorded with the simulator combined with subjective driver evaluation of comfort, driving pleasure, etc. Such traditional analyses often do not clarify how drivers use and adapt to new systems and innovative methods are needed to get more insight into driving behavior from simulator testing. In the DRIVOBS project, driver behavior in a car simulator is observed using computer vision, physiological measurements and system identification in complex driving scenarios. From this we can learn how drivers use vision, motion, and other information to control vehicles. The project ADVICE goes one step further: behavior and physiology are analyzed in real-time, and translated to feedback to the driver. The intended result is a suite of automotive simulation products with integrated driver observation and feedback to aid the development of vehicle dynamic control systems, active safety systems, infotainment systems and human-machine interfaces, and for the training of drivers.

Large companies usually have extensive laboratory facilities in which their R&D staff can carry out all relevant experiments. For example, Philips has its ExperienceLab, consisting of a HomeLab, ShopLab and CareLab. The same is true for universities and large research institutes, which traditionally have all of the necessary facilities on their own premises. The '*measurement and analysis instruments*' sector, however, comprises largely SMEs who cannot afford their own laboratories. They do not usually get access to the labs of large companies as these are closed facilities. The labs of TNO can be used in projects with TNO, but the fees involved may be a barrier for SMEs. To finance such projects, the Ministry of Economic Affairs, Agriculture and Innovation provides financial support to Dutch SMEs under its knowledge transfer schemes. Another option is to collaborate with universities. This means approaching a professor with the request to test a new tool in a research context, to validate this and to publish the outcomes. However, in practice this only works if the request ties in with research currently in progress. Most professors do not have the time to carry out such experiments themselves and will therefore delegate the task to a member of staff or an MSc or PhD student. The validation study must therefore fit within the student's time planning, which can be up to 4 years in the case of a PhD project. Furthermore, qualified students are not always available and if a new student needs to be recruited his or her quality cannot be guaranteed. All things being considered this leads to delays that are often unacceptable in today's economy, where a short time to market can be decisive for commercial success. SME entrepreneurs are often impatient: they want things to happen quickly and they want to be in charge of their own development process and planning. This being the case, the ideal situation would be where collaborating SMEs had access to their own well-equipped joint testing laboratory.

The availability of test subjects often forms a bottleneck in validation studies for measurement instruments. Finding a representative sample from the target group of end users is usually a difficult process. Consequently many manufacturers come no further than testing prototypes on volunteers within their own company. This clearly does not benefit the scope of the outcomes. Cost is also an issue: large-scale trials with human subjects are usually unaffordable for a single SME company. If efforts are combined and multiple technologies can be tested in a single trial, costs can be shared.

Need for reference data

The Achilles heel of developing algorithms for automatic pattern classification is the availability of '*ground truth*': data sets annotated by experts that serve as the training set for the development of classifiers and as a test set for the validation of these. These data sets should contain as many situations that occur in practice as possible. Many i3B measurement systems depend on such data sets, for example the automatic recognition of facial expressions, gestures, body postures and behavioral patterns of humans and animals. Reference data are also needed for cross-modality pattern recognition, which means that the ground truth obtained from one modality is used to recognize patterns in other modalities. An example of this is the simultaneous recording of video and EMG signals in which pattern recognition in the EMG signal is tested against annotation of the video images.

Obtaining such data sets is a very time-consuming and labor-intensive activity and many high-potential development projects have not reached their end goal due to a lack of good reference data. For SMEs, building up an extensive repository of ground truth is a nigh on impossible task due to the costs and time required. This problem is therefore ideally suited to a joint approach.

Need for demonstration facilities

Seeing is believing is true for every product. Before they purchase new measurement and analysis systems, researchers and clinicians want to have seen and experienced these at work and preferably in a realistic environment. For products in the area of brain, physiology and behavior that is no simple task: a demonstration cannot quickly be set up and behavioral measurements in particular usually require a lot of space. A presentation at a trade fair gives a nice first impression but not usually much more than that. The chances are that the offices of an SME entrepreneur have a showroom but not the facilities for real-life demonstrations. An obliging client can sometimes grant access to his laboratory, factory or hospital where a system is installed, but in practice this cannot be used too freely. As many systems are the result of the integration of subsystems from several manufacturers it would be logical to facilitate the joint demonstration of these.

Education, training and knowledge dissemination

Measurement and analysis systems in the area of brain, cognition, physiology and behavior are usually complex products with a steep learning curve. Everyone involved in the value chain experiences this: employees of the manufacturer, distribution partners and end users. First of all they need to acquire a knowledge and understanding of the methods that underlie the product. After all, you must first of all understand how brain activity results in an electrical signal before you can effectively use an EEG system, and you must first know how you must design a behavioral experiment before you can make use of a video-tracking system. Next how the measurement and analysis system works must be conveyed to those involved. Manufacturers must therefore continually invest in the education and training of their own staff (sales engineers, marketing communication staff, support engineers), their distributors, value-added resellers and agents, and their clients. A significant proportion of these training efforts concerns general knowledge and skills that are also relevant for fellow companies. However, in practice this knowledge is scarcely shared; each company provides its own training courses and the wheel is regularly reinvented.

The aforementioned scenario occurs in emerging economies in particular. Dutch manufacturers of research tools are mainly focused on export and currently see a strong growth in countries such as China and India. These countries have increasing funds available for investments in research tools but not the commensurate level of knowledge required to use these. Education is therefore needed. For example, there is a clear need for teaching materials in Chinese that cover the methods and techniques of behavioral research. This is a sector-wide problem that rises over and above the interests of any one company. In addition to the emerging economies other developing countries can also benefit from a more active outreach of Dutch technology.

Initiatives already exist to bring together knowledge about methods and techniques from different market parties. For example, Noldus Information Technology has organized the international congress '*Measuring Behavior*' since 1996 and this has grown into an established event[5]. Once every two years about 400 delegates from around the world come together to inform each other about innovations in the area of measuring and analyzing behavior. In 2010 the congress was held at the High-Tech Campus in Eindhoven and Utrecht University will be the venue for the 2012 edition. Various parties involved in the underlying business plan are regular participants at the Measuring Behavior congress. Noldus Information Technology wonders whether this congress might flourish even more if it were organized independently of the company.

5 www.measuringbehavior.org

Access to R&D funding

SMEs traditionally find it difficult to gain access to R&D funding (via Agentschap NL, the EU Framework Programs, etc.). They are deterred by the administrative burden of project proposals and reports. This is particularly true for micro companies (up to 10 employees) but small and medium-sized companies also do not usually have the administrative staff needed to head up a consortium and act as the official coordinator. Consequently many of the opportunities to utilize grants for the development of innovative technology and products are left untouched. A joint approach to obtaining funding could be an attractive option.

i3B

To meet the needs for joint facilities for research, product development, demonstration and training we propose the setting up of the organization

ICT for Brain, Body & Behavior

abbreviated as i3B

Legitimacy

The plan for setting up i3B is highly opportune for several reasons and ties in extremely well with the current national, regional and local policy. Furthermore i3B complements a series of existing Living Labs and comparable initiatives elsewhere.

Relevance for the Dutch top sectors

The Dutch government's current policy with respect to the commercial sector is aimed at strengthening the innovation in nine top sectors. The i3B initiative is relevant to five of the nine top sectors:

- HIGH TECH SYSTEMS AND MATERIALS
  Examples of i3B themes are the analysis of human-system interaction in the design of cars, airplane cockpits, air traffic control systems and every other product with a complex user interface; design of adaptive systems; ambient intelligence, affective computing. In the top sector HTSM seven technologies and nine application areas are distinguished.
- LIFE SCIENCES & HEALTH
  Examples of i3B themes are monitoring of body functions for prevention, diagnosis and telecare; e-coaching for behavioral change (e.g. healthy food choice); neurofeedback and

rehabilitation; measuring physiology and behavior to support the development of drugs (especially those for neurological and psychiatric disorders). In its advice to Minister Verhagen the top team LS&H emphasized the importance of high-throughput and high-content measurements in biomedical research (for which the i3B partners develop the tools). The top sector LS&H has ten road maps where potential links can be made. A newly emerged theme is Parkinson's disease, which is directly relevant for the i3B initiative.

- CREATIVE INDUSTRY
  Examples of the i3B themes are human-system interaction in virtual environments; user experience in the design of living environments; web applications; mobile apps; games and serious gaming. The top sector Creative Industry distinguishes seven innovative networks, including GATHER[6]. GATHER focuses on three interrelated research themes (game worlds, users and interaction and transfer of gaming) and provides particularly good starting points for gaming and simulations.

- AGRO & FOOD
  Examples of i3B themes are shopping behavior; consumption and experience in relation to nutrition and health; farm animal welfare (precision livestock farming). The relationship between product characteristics (of food) and food choice, consumption and experience (by the consumer) is receiving increasing attention and therefore a specialized laboratory in which the necessary research tools for this are developed and validated would provide a welcome strengthening of the agro-food knowledge chain. Eleven relevant themes are distinguished in this top sector. In the area of Food, Cognition & Behavior a specific program is being developed that will have a direct interface with i3B.

- HORTICULTURE AND PROPAGATION MATERIALS
  Examples of i3B themes are the search and feeding behavior of insects; resistance breeding of vegetables and ornamental plants; the effects of plants on the ambient experience of consumers (visual, olfactory). One element of this top sector is the setting up of '*experience centers*', with the aim of '*letting the consumer see, smell, taste, feel and experience the horticultural sector from seed to plate*'. One example of this is the World Food Center in which i3B is represented in the project team.

In practice, the top sectors are often still '*separate worlds*': there is relatively little interaction and collaboration between the parties in the various sectors. Manufacturers of cars, hospital equipment, games and food products do not look each other up that quickly. However, the i3B initiative could definitely change that as the i3B working area (brain, cognition, physiology and behavior) is a linking pin between the top sectors. We are convinced that we can bring about demonstrable cross-fertilization between the sectors through both the i3B Lab and the i3B network.

An early version of this i3B business plan was presented to the aforementioned five top sector teams in spring 2011. The plan did not go unnoticed. The i3B initiative was mentioned in the advisory report Life Sciences & Health[7] and the top sector team High Tech Systems and Materials even referred to it as one of the ten '*leading R&D projects*' in the Netherlands[8]. In the autumn of 2011 the i3B initiative acquired a place in various innovation contracts, roadmaps and Top consortia for Knowledge and Innovation (TKIs), including the top sectors HTSM (roadmap ICT[9]), LS&H[10] and Agro&Food[11]. How consortium partners can participate in new projects and programs emerging from these top sectors will be examined in greater detail over the coming months.

[6] GATHER: GAmes for SafeTy, Health, and IndustRy - Empowering people and changes through games. Source: CLICK// Innovation contract outline, Top sector Creative Industry | December 2011, p. 19.

[7] Top sector plan Life Sciences & Health: Voor een gezond en welvarend Nederland | For a healthy and prosperous Netherlands | June 2011, p. 20.

[8] Holland High Tech: Advies Topteam High Tech Systemen en Materialen | Advisory Board Top Team High Tech Systems and Materials | June 2011, p. 60.

[9] A. Smeulders, P. Apers, E. Huizer & P. Mandersloot. Roadmap ICT for the top sectors, version 4.0 | December 2011, p. 15.

[10] LS&H Top consortium for Knowledge and Innovation: Parkinson's Disease | in preparation

[11] Innovation contract Top sector Agro & Food, version 2.0 | December 2011, p. 53.

Relevance for regional policy

The intended geographical focus of the i3B activities is Wageningen. This forms the heart of Food Valley, a partnership between municipalities in the Gelderse Vallei in the area of nutrition and health. The i3B initiative fits in well with Food Valley's ambition of attracting knowledge-intensive business to this area. An active collaboration already exists between intended i3B partner companies and the Restaurant of the Future (Wageningen UR) in Wageningen, the research facility for the study of food choice and eating behavior. Links will also be sought with CAT-Agro-Food[12], the Center for Advanced Technology in the Agro and Food sector. i3B can also make a contribution to the annual Food4You festival, where the general public is involved in health and nutrition research and innovation. In the future, i3B may be connected to the EIT-KIC Food (in preparation, coordinated by Wageningen UR) and the World Food Center (for which Food Valley is one of the potential locations).

[12] www.cat-agrofood.wur.nl

Besides the AgroFood-related initiatives there are various field labs in the vicinity of Wageningen that can benefit from the proximity of the i3B Lab: InnoSportLab Papendal (Arnhem), Dr Leo Kannerhuis (Doorwerth), GGz Meerkanten (Ermelo), Siza Zorggroep (Arnhem) and HAN Automotive (Arnhem).

Relevance for local policy and initiatives

Wageningen has a concentration of knowledge-intensive activities at two campuses:

- DE BORN
  The campus of Wageningen University and Research Center and related institutes such as NIOO-KNAW.

- BUSINESS & SCIENCE PARK
  A concentration of about 50 knowledge-intensive companies.

The Business & Science Park is the intended location for the i3B headquarters, nestled between companies and yet just a short distance away from the Wageningen UR campus. This will further strengthen the formation of a campus with high-value R&D activities.

Wageningen municipality has for many years profiled itself as the '*City of Life Sciences*'. By choosing Wageningen as the base for i3B this label will acquire even more significance.

International context

The i3B initiative will start in the Netherlands but it will have a clear international horizon. We want to be clearly visible within the European R&D arena and link up with existing relevant initiatives. One such important example is the European Institute of Innovation & Technology (EIT) that has launched several Knowledge & Innovation Communities (KICs). One of these, ICT Labs, carries out research that is closely related to the ambitions of i3B. The core partners of the ICT Labs nodes in various countries are large companies, technical universities and large technology institutes. i3B can offer its facilities and services to the ICT Labs partners, who can obtain funding from ICT Labs for the use of these facilities and services. In this manner i3B provides the ICT Labs partners with '*one-stop shopping*' in the form of application-oriented services at the interface of ICT and brain/body/behavior. This concept can also be applied to the other EIT KICs such as Climate and Food (under preparation). This ties in well with i3B's ambition of acquiring business for its participants and profiling our organization to large companies. This will also contribute to an improved availability of venture capital for the participating companies.

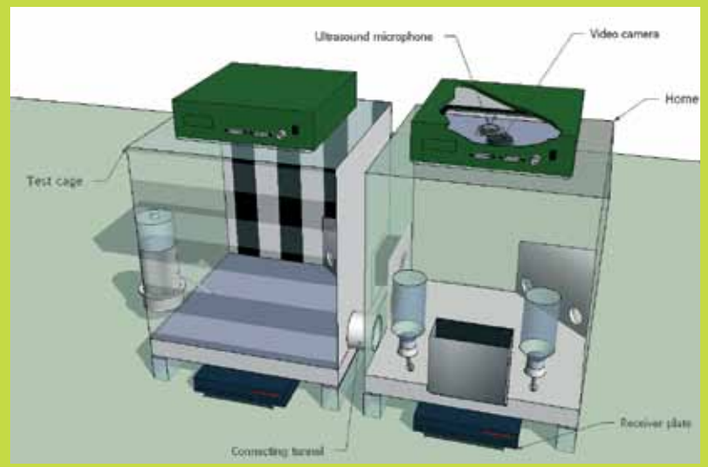
i3B can also play a role in determining the content of EU Framework Programs. SME entrepreneurs do not usually have the time to actively participate in discussions about lines of action and themes in work programs of FP7 or Horizon 2020. The i3B organization can, however, fulfill this role. Initiator Lucas Noldus regularly participates in discussions with EU officials about this subject on the behalf of i3B supporters. Eventually a professional i3B organization can adopt a more explicit role in this respect.

Automated analysis of behavior, vocalizations and physiology

Technologies
Video tracking
Behavior recognition
Ultrasound analysis
Biotelemetry
Heart rate
Body temperature

Partners
Noldus IT
Metris
TeleMetronics Biomedical
Delta Phenomics
WUR: PSG/Biometris
Utrecht University

Projects
SenseWell
NeuroBasic PharmaPhenomics



Rodent behavior models are indispensable in drug discovery strategies for neurological and psychiatric diseases. Increasingly, rats and mice are tested in instrumented home cages for objective assessment of spontaneous and provoked behavioral changes associated with genetic variation or pharmacological treatment. Such automated systems may also be used for early detection of symptoms of disease and chronic stress, in order to assess health and wellbeing in socially housed animals. In the projects NeuroBasic PharmaPhenomics and SenseWell, researchers and engineers are taking the next step: integration of ultrasonic recording and biotelemetry with behavioral measurement. Recent advances in sensor technology, image processing, data fusion and pattern recognition will be implemented in the automated system. The next generation home cage will not only track the movement and behavior of multiple animals, it will also capture vocalizations and physiological signals, and provide an integrated analysis.

Complementarity with respect to other Living Labs and similar initiatives

i3B will undertake a range of activities and offer a spectrum of services to facilitate collaboration and co-development between participating companies themselves, and between participating companies and their clients. In this respect i3B will be a '*Living Lab*' according to the definition of Feurstein et al.[13]: '*Collaborations of public-private-civic partnerships in which stakeholders co-create new products, services, businesses and technologies in real-life environments and virtual networks in multi-contextual spheres*'. The initiators of i3B have thoroughly familiarized themselves with existing Living Labs and similar initiatives. This has enabled us to learn from others and has also convinced us that there is a '*gap in the market*' that needs to be filled. Appendix 1 (page 51) provides a non-exhaustive list of Living Labs relevant for i3B. The binding element differs per lab: sometimes it is an application area (nutrition, sport, forensic research, consumer lifestyle), and sometimes a technological area (industrial electronics, actor-agent communities).

[13] Feurstein, K.A. Hesmer, K.A. Hribernik, K.-D. Thoben & J. Schumacher (2008). Living Labs: a new development strategy. In: European Living Labs: a new approach for human centric regional innovation (Schumacher, J. and Veli-Pekka Niitamo, ed.).

21 Ambition, horizon and focus
Scientific disciplines | 21
Technology areas | 22
Application areas | 24
Translational approach | 25

25 Activities and services
Overview | 25
The i3B Lab | 27
E-science lab | 33
Knowledge dissimination | 34
Events | 34
Education | 35
Research services | 36
Business development | 36

38 Parties involved

Image courtesy | Microsoft Corporation

2

Focus and activities

Ambition, horizon and focus

For the companies involved, the i3B organization will develop, manage and offer a broad range of facilities and services for the purpose of innovative product development at the interface of ICT and brain, cognition, physiology and behavior. We foresee a growth model: we will start with a limited number of activities that will be expanded according to market demand and the needs of participants. Several aspects will now be explained in greater detail to provide a clear picture of the ambition, scope (horizon) and lines of action (focus) of the i3B initiative.

Scientific disciplines

i3B will be a melting pot of scientific disciplines that will act as an incubator for new insights and technical breakthroughs. i3B will encompass the following research areas (NB: the list is not exhaustive and will change over the course of time):

- *cognitive psychology*
- *communication science (coaching)*
- *neurosciences*
- *behavioral biology (ethology)*
- *ergonomics (human factors)*
- *computer science*
- *electronics*
- *mechatronics*
- *industrial design*
- *mathematics and statistics*
- *artificial intelligence*
- *physiology*
- *experimental psychology (psychonomics)*

Technology areas

The aforementioned scientific disciplines will utilize the following technology areas as enablers:

- SENSOR TECHNOLOGY
  Design of small, low-cost, wireless sensors and body area networks for physiological measurements
- AUDIO SIGNAL PROCESSING
  Analysis of human speech and vocalizations of animals for the purpose of classifying content and detecting emotions
- PHYSIOLOGICAL SENSING
  Pattern recognition in EEG, ECG, EMG, GSR and other physiological signals
- VIDEO TECHNOLOGY
  Analogue and digital video recording, storage and disclosure, decompression and compression
- COMPUTER VISION
  Digital image processing with monocular cameras, stereo cameras and multi-camera set ups
- VIDEO TRACKING
  Following the movements of one or more persons or animals against static or variable backgrounds
- HEAD POSE & BODY POSTURE RECOGNITION
  Recognition of specific head poses and body postures
- GESTURE TRACKING
  Recognition of gestures (head, arms, hands)
- EYE TRACKING
  Following of eye movements in stationary and ambulatory situations
- FACIAL EXPRESSION ANALYSIS
  Non-invasive measurement of facial expressions
- USER-SYSTEM INTERACTION
  Capture and interpretation of real-time keyboard and mouse events, detection of usage patterns and mental states
- SENSOR FUSION
  Integration of the signals from several different types of sensors
- MULTIMODAL DATA INTEGRATION
  Integration of data from different sources (sensors, video, system events, databases, etc.)
- COMPLEX EVENT RECOGNITION
  Recognition of high-level (complex) events based on combinations of low-level (simple) events

Measuring product perception and choice behavior

Why do consumers like or dislike certain products? How does the choice and purchase process work? How do food and brain influence each other? The goal of the FOCOM project is to design novel test setups to answer these questions. The 'virtual shop simulator' will combine innovative stimulus display with the measurement of consumer behavior, physiology and brain responses. A translation will be made from a clinical fMRI environment to a more consumer-friendly test environment in which eye movement and brain responses such as EEG and NIRS can be measured. If successful, the new instrument can help food companies to predict the effect of product attributes in an early stage of development, and thus enhance the process of product development and market introduction, thereby reducing development costs and shortening time to market. Possibly, the new technology will also support early diagnosis, better understanding and treatment of obesity, eating disorders, and age-related diseases such as Alzheimer and Parkinson. These results will be of benefit for the food industry, consumer scientists, hospitals and healthcare organizations.

Technologies
Virtual reality
Eye tracking
EEG
NIRS
GSR
Heart rate

Partners
Noldus IT
Green Dino
Artinis
TMS International
Essensor
NIZO Research
Heinz
Radboud University
Wageningen UR
University of Twente

Projects
FOCOM

- SIMULATION
  Design of virtual reality and augmented reality environments for research and training purposes
- REAL-TIME FEEDBACK
  Design of systems capable of processing very large numbers of low-level events in real time, detecting high-level events and on the basis of this giving feedback to a person or animal
- STIMULATION
  Actuators based on light, sound, scent, haptics and digital displays
- BRAIN-COMPUTER INTERFACE
  Pattern recognition in brain signals for the purpose of controlling actuators

- ROBOTICS
  Design of robots capable of recognizing human behavior and responding adequately to this

Application areas

i3B products and systems are used in a large number of application areas such as:

- HEALTHCARE
  Design of intelligent living environments and digital devices to support independent and healthy living
- FOOD & NUTRITION
  Development of healthy nutritional products supporting consumers with respect to healthy food choice
- PUBLIC SECURITY
  Design of intelligent cameras and sensor networks, automatic detection of suspicious behavior
- WORKPLACE ERGONOMICS
  Design of intelligent systems that recognize the behavior and physiology of the user and intervene preventively to prevent stress, excessive mental load or critical errors
- BIOMEDICAL RESEARCH
  Development of drugs for people, farm animals and pets
- AUTOMOTIVE
  Design of interactive systems in vehicles; simulation and training
- AEROSPACE
  Design of interactive systems for the aerospace industry; simulation and training
- GAMING
  Design of games for relaxation (leisure games) and training (serious gaming)
- CROP PROTECTION
  Use of parasites and predators to control insect plagues, resistance breeding
- WILDLIFE
  Biodiversity research, wildlife management, nature conservation

When they write the first joint research program, the participating companies will make a selection of the technology areas and application areas detailed above and prioritize these. The green boxes throughout this business plan provide examples of the applications that i3B projects could focus on.

Translational approach

i3B is not just limited to human applications. Besides people, animals are also an object of research and application due to the large economic and social importance of livestock farming and biomedical research. An important '*driver*' is the emergence of precision livestock farming, in which each individual animal is followed. The prevention of diseases and the improvement of animal welfare require real-time measurement of physiology and behavior. In the research into the genetic basis of neurological and psychiatric disorders and the quest for new drugs there is a growing demand for better (validated) animal models. At the same time society wants a reduction, replacement and refinement of animal experiments (the 3Rs). Advanced test set-ups and ICT measurement systems can make a significant contribution in this respect.

Many measurement instruments are being developed for both preclinical animal studies and clinical human studies: motion capture systems, video tracking systems, sensors and data acquisition software for ECG, EEG, EMG, etc. There are a lot of similarities in the necessary sensor technology, measurement methods, signal processing and data analysis. Nevertheless, developers of instruments for human and animal applications often move in separate '*worlds*' with little interaction and transfer of knowledge and experiences. This is often because the company develops tools for animal research or human testing but not for both. We are convinced that a translational approach in which developers of human and animal research tools closely collaborate will benefit all parties involved. This vision is shared by an increasing number of scientists and technicians[14], although no initiative has made it so tangible in practice as this proposal.

[14] See the proceedings of the interdisciplinary Measuring Behavior congress where this is a recurring theme (www.measuringbehavior.org).

Activities and services

Overview

The i3B organization will undertake a range of activities for the benefit of the participating companies and other interested parties. A provisional but non-exhaustive list of activities is provided below, which is grouped into five categories. These activities will not all be initiated at once; we intend to start with a limited number of activities and this will be extended according to market demand and the needs of participants.

i3B Research & Development

- Setting up and coordination of the implementation of a joint research program
- Coordination of system integration and validation projects based on the technology of two or more participating companies
- Offering positions to researchers (students, PhDs, postdocs, guest staff)

- Coordination and administrative support of collaborative projects (Agentschap NL, EU FP7, etc.) to obtain grants for R&D in the area of i3B for which i3B will act as the project coordinator or partner (in EU context)
- Initiation of applied scientific research projects under the co-financing scheme of TNO (for Dutch SMEs)
- Initiation of new domain-specific field labs

i3B Facilities & Services

- Design, management and exploitation of joint laboratory facilities (i3B Lab)
- Design, management and exploitation of the i3B E-science Lab, a '*virtual laboratory for e-science*' (including a repository with annotated reference data sets)
- Facilitating user-oriented product development (user-centered design, UCD): organization of co-creation/co-design workshops, requirements elicitation sessions, etc.
- Recruiting of test subjects for experimental studies
- Usability testing services for product developers
- Assistance with product certification (e.g. Medical CE, Class 1) for developers of hardware products
- Assistance with product localization (e.g. Chinese versions of software)
- Note: for the aforementioned items i3B does not intend to employ staff for all of these services but rather to act as an intermediary between specialists (employed by the participants) and the clients of the service

i3B Communications

- Knowledge dissemination: publication of i3B results via website, e-mail newsletter, RSS feeds, social media, blogs, printed matter, etc.
- Coordination and/or hosting of networks and think tanks in the i3B working area

i3B Events

- Organization of events: i3B Café, annual symposium, congresses (including the Measuring Behavior congress), thematic workshops, joint trade show presentations
- Organization of thematic trade missions and '*science & technology missions*' to specific countries and regions (in cooperation with Dutch embassies)

i3B Academy

- Education: courses for employees and clients (use of products and systems, R&D methodologies), certification
- Outreach: education in emerging economies
- Initiation of TNO SME technology clusters (knowledge transfer from TNO to Dutch SMEs with financial support from the Ministry of Economic Affairs, Agriculture and Innovation)
- Publisher (i3B Press): publication of manuals, protocols, etc. in the i3B working area

i3B Business Development

- Assisting with the development of OEM and value-added relationships between participating companies
- Acting as a contract partner to (foreign) companies in the tendering of R&D, in which i3B acts as the primary contractor and one or more i3B participants are engaged as subcontractors

- Encouraging and supervising the start-up of new companies by researchers and developers involved in i3B

The i3B Lab

The most visible part of i3B's activities will be the i3B Lab, a shared laboratory that will be made available to participating companies. The positioning, facilities, functions and value proposition of the i3B Lab are elaborated upon below.

Positioning

The i3B Lab will assume a crucial position in the value chain for research, development and application of measurement and analysis tools for brain, cognition, physiology and behavior (brain/body/behavior: 3B). This position is illustrated in the diagram on the next page, which should be read as follows:

KNOWLEDGE PROVIDERS
Research at universities and institutes results in scientific knowledge about brain, cognition, physiology and behavior, the measurements needed for this and the desired read-out parameters.

TECHNOLOGY PROVIDERS
These are the participating high-tech SMEs that develop ICT tools (hardware or software, components or systems) with which specific 3B aspects can be measured and analyzed. The design of these tools is based on the knowledge produced by the knowledge providers.

FIELD LABS
These are domain-specific research facilities such as the Restaurant of the Future (nutrition), Philips ExperienceLab (consumer lifestyle), CSI Lab (forensic research), InnoSportLabs (sport), etc. Here the 3B tools are validated in field tests and clinical studies before they are launched commercially.

END USERS
Eventually money is earned as soon as i3B tools are sold to consumers, hospitals, universities and companies.

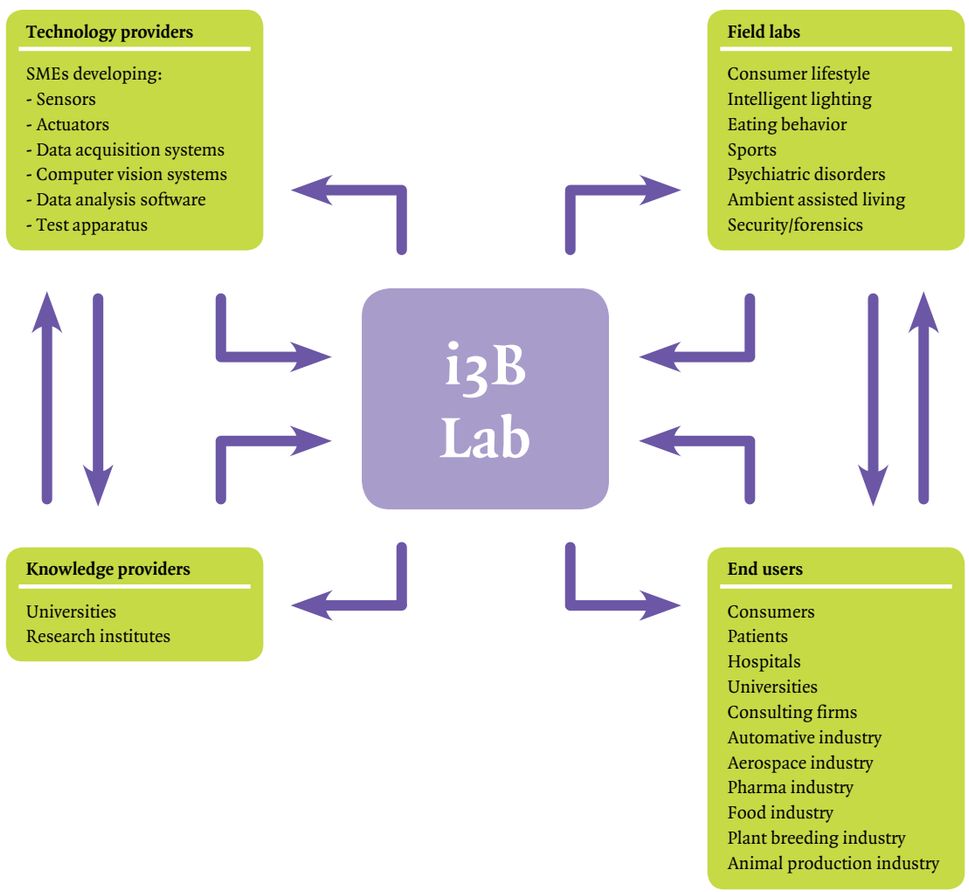
The links in the chain pass their results onto the next link and then receive feedback in the form of practical experiences, error reports and suggestions for improvement.

The linking element in this scheme is the i3B Lab, which forms the bridge between technology providers and the field labs. In the i3B Lab the prototypes of the technology providers are tested in relevant but small-scale lab environments, with representative test subjects. The prototypes are technically validated, debugged, iteratively improved and combined with tools from other partners into integrated systems. As soon as these are robust enough, for example TRL6[15], they are offered to the next link in the chain, the field labs, for validation in a specific application area. With this approach the field labs are guaranteed that they will not lose valuable time or burden test subjects or patients with hardware or software that is full of bugs. The central i3B Lab is not linked to a specific application area.

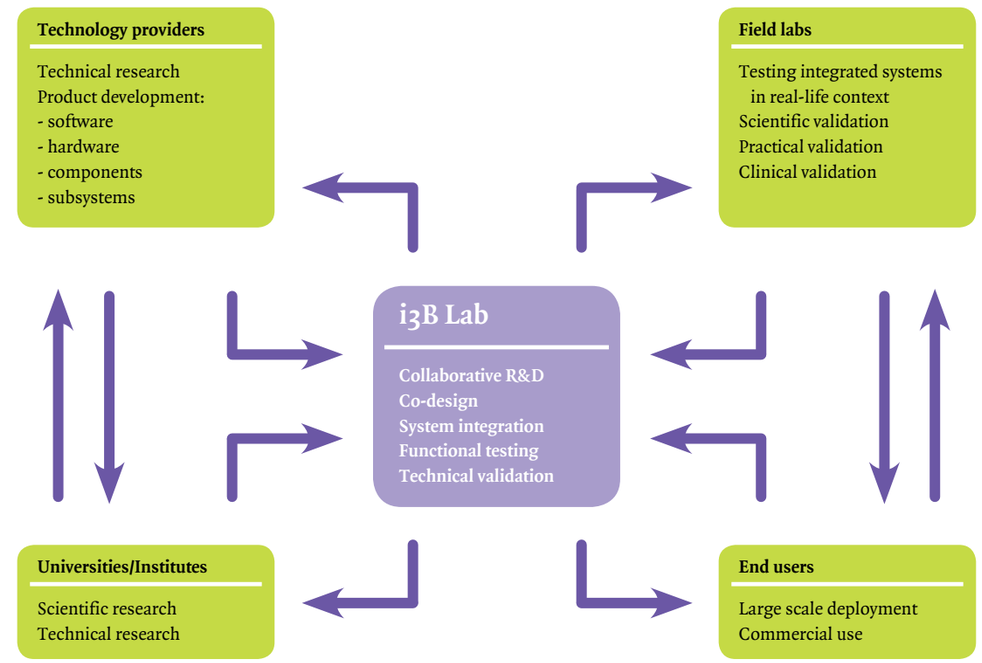
Of course knowledge providers and end users can also be directly involved in the i3B Lab. University researchers and students can participate in studies in the i3B Lab and end users will be involved in the UCD process.

The diagram below is a schematic representation of the i3B Lab as the central link between knowledge institutions (knowledge providers), high-tech SMEs (technology providers), domain-specific field labs and end users:

[15] TRL = Technology Readiness Level. TRL 6 = 'Representative model or prototype system is tested in a relevant environment. Examples include testing a prototype in a high fidelity laboratory environment or in simulated operational environment.' (en.wikipedia.org/wiki/Technology_readiness_level)



The diagram below shows the i3B Lab and the parties involved again but this time with the tasks each will assume:



Facilities and services

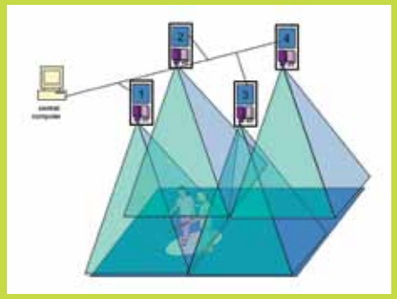
The i3B Lab will consist of several thematic labs and several general-purpose rooms. The labs will be set up such that the theme they are used for can be changed over the course of time and the equipment and furnishings continuously updated. Each thematic lab will be equipped with video and audio recording equipment (video cameras and microphones built into ceilings and walls) to observe the interaction between users and prototypes and products. The i3B Lab will gradually develop to achieve its full size and possibilities based on market demand. For the time being a total area of about 800 m² is assumed, split over two floors of an office building. A provisional summary of the thematic labs and general-purpose rooms is given on the next page.

Real-time tracking and coaching of consumers

Technologies
Video tracking
Trajectory analysis
Spatial event dectection
Reasoning
Mobile app

Partners
Eagle Vision
Noldus IT
MobiHealth
Wageningen UR
University of Twente

Projects
FOVEA
GUARANTEE



Many people would like to live healthy, but don't know how to realize this in their daily life. How much and what kind of exercise is required? Which food delivers the right balance of energy, vitamins, minerals and fibre? Which food combinations are right for me, as an individual, with my own preferences, habits and life style? For many people it seems to be difficult to judge which food combinations make up a healthy choice. The FOVEA project explores solutions to this problem. The project connects to the trend that more and more people use smart phones, and not just for calling others. Smart phones can be used as sensing devices, to record a person's activity, and as a display device for delivery of feedback messages. By tracking a person's movements through ceiling-mounted cameras, spatial events and specific behaviors can be detected. Combining knowledge of a person's habits, diet, recent activity and current choice situation, personalized advice can be provided. The same technology can also be applied to the detection of abnormal behavior and prevention of incidents in the home environment, which is the topic of the GUARANTEE project. This way, computer vision and mobile technology can help to increase health and safety, inside and outside the home.

Thematic labs

- USER EXPERIENCE LAB
  Human-computer interaction in an office environment, for studies varying from traditional usability tests to multimodal user experience studies
- GAME LAB
  Human-system interaction with games in a lounge environment for studies with new interaction modalities, games console and interfaces
- DYADIC INTERACTION LAB
  Instrumented room for 1-to-1 interviews (physician-patient interaction, assessment, counselling, interviews, etc.)
- GROUP INTERACTION LAB
  Instrumented room for group interaction (such as meetings), including multi-touch table or screen
- AUDITORIUM LAB
  Instrumented room (cinema set-up) for measuring the response of many subjects to a stimulus (lecturer, artist, TV advertising, cinema film, etc.)
- AUTOMOTIVE LAB
  Multimodal measurement of the driver's behavior and physiology in a driving simulator
- VIRTUAL REALITY LAB
  Room with VR display facilities for behavioral measurement in a virtual environment (e.g. purchasing behavior and eye-tracking in a virtual shop)
- TRACKING LAB
  A collection of spaces inside and outside of the building with a network of cameras (security cameras, 3D cameras) and other sensors to follow the movements of individual people or groups and the automated detection of specific behaviors

From this list, four labs are envisaged for the first phase of the i3B Lab: User Experience Lab, Automotive Lab, Virtual Reality Lab and Tracking Lab.

General-purpose rooms

- CO-CREATION ROOM
  Room with ICT facilities (mind-mapping software, smart board) for interactive co-creation, co-design and requirements of elicitation sessions
- R&D ROOM
  A room with workspaces for researchers, students and visiting scientists
- CONTROL ROOM
  Central observation room(s) with equipment for video and audio recording, storage, annotation and retrieval. For experiments where the researcher cannot be present in the lab space, all of the thematic labs can be reached from this room via several work stations

FORUM
Central room for seminars, symposia, informal meetings and brainstorming sessions

OFFICE
Office for the director of the i3B Foundation (annex i3B Lab manager)

Wherever possible cooperation will be sought with existing Living Lab infrastructures that are not too far away from the i3B Lab in order to prevent the unnecessary duplication of specific labs. Examples are labs of nearby universities or research institutes, some of which have excellent research facilities that are not fully used.

Functions

The facilities of the i3B Lab will be made available to the participating parties for the following functions:

CO-CREATION/CO-DESIGN
Receiving clients and prospects to explore ideas, wishes and requirements supported by the appropriate ICT tools.

RESEARCH AND DEVELOPMENT
The greatest synergetic value will be achieved in case of joint technical research and product development. After all, physical co-location leads to a more efficient and effective collaboration than remote collaboration via e-mail. However there must also be space for the R&D activities of an individual company which could, for example, be realized by having certain unique facilities in the i3B Lab. The lab will also accommodate interns, graduate students and PhD fellows employed by the participating companies and universities. The types of research undertaken would cover:

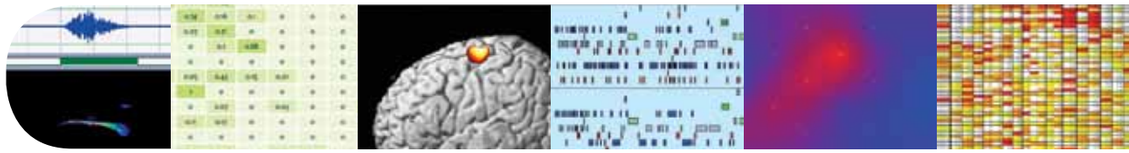
- Testing prototypes of new hardware and software to establish their technical reliability
- Collaboration between R&D staff from two or more participating companies for the purpose of system integration
- Experiments with test subjects for the purpose of validating new measurement and analysis tools before these are used in real-life contexts, in other words the next link in the value chain
- Cross-validation of measurement techniques: experiments in which two or more techniques of participating companies are simultaneously deployed, e.g. brain activity (EEG) and heart rate variability (HRV) as indicators of stress

DEMONSTRATION
The thematic labs can function as a showroom where prospects and clients can be received for product demonstrations.

TRAINING
In the thematic labs and general-purpose rooms participating companies can provide training courses in realistic settings for the use of their measurement and analysis tools for the benefit of their employees, resellers and clients.

EXPLOITATION
The thematic labs can be used/deployed by participating companies (or rented by third parties) for paid studies on behalf of commercial clients.

DISSEMINATION
The i3B Lab provides superb opportunities for knowledge transfer activities by fellow professionals or for the general public, in the form of symposia, conferences and seminars.



i3B Animal Labs

The thematic labs in the central i3B Lab in Wageningen will be set up for human applications. Animal testing facilities will be housed at specific '*i3B Animal Labs*', focused on specific animal groups such as rodents (for biomedical research) and livestock animals (pigs, cows, chickens). After all, each group of animals requires specific housing, test facilities, qualified biotechnical personnel and permits. For each animal group a partner will be sought with whom a bilateral agreement can be made. The i3B Animal Labs will also be linked to the central i3B Lab by means of broadband video and data links to ensure that the i3B Lab's communication, demonstration and knowledge dissemination facilities can also be provided for animal applications. These links will allow interested parties to follow demonstrations of technologies for animal research at the central i3B Lab. This is also advantageous from the viewpoint of security, as animal research does not normally benefit from frequent human traffic. Discussions are in progress with a number of potential i3B Animal Labs.

E-science Lab

In the i3B E-science Lab a library of reference data will be built up that can be used by participants for the development and validation of algorithms for automated pattern classification. This collection could grow into a '*virtual laboratory for e-science*', which would open up new opportunities for data-driven research[16]. Access to this data via the web will foster open innovation, both in the Netherlands and abroad. The structured collection of reference data in optimally accessible databases, enriched with continuously developing knowledge and validated application methods, will lead to the creation of a worldwide market for i3B E-science Lab's services. Another aim of

16 Martijn Kriens (National Service Engineering Lab) in S. Verveen (2010). Rapportage Labs Verkenning [Foresight Report Labs] – Creative Lab project. Utrecht: SURFnet.

the i3B E-science Lab is to build up concept development & experimentation (CD&E) facilities (i.e. linked virtual and real environments for the development of models and simulations). CD&E is increasingly being used as an affordable, efficient and more effective approach for accelerating innovation.

i3B will assume responsibility for the setting up, management and exploitation of the E-science lab. As annotated reference data sets are very valuable, the disclosure of these will have to be carefully arranged. In due course a business model will be developed for this in which user rights will be balanced against investments made. The i3B E-science Lab will also seek connections with existing European initiatives in order to strengthen these and avoid unnecessary replication.

The i3B E-science Lab will also make a valuable contribution to education and training. The reference datasets can provide the basis for new (online) forms of education in which new target groups in the Netherlands and abroad can be reached.

Knowledge dissemination

Under the label i3B Press various publications will be issued in print and online. A concrete example is manuals and protocols for carrying out brain/body/behavior research with ICT tools, for which there is a considerable demand in China. As the technologies and tools of several participants will be presented in these publications it is logical to realize this through the i3B organization. i3B Press will also collaborate with existing publishers to link the specialist knowledge of the i3B companies to their large marketing and distribution network so that the added benefits of synergy can be realized. With this approach i3B Press will act as a vehicle for the participants to open up new markets.

Events

An important task for i3B will be the bringing together of people: those directly involved with i3B, the other stakeholders in the value chain, students, prospects and clients. To this end i3B will organize a wide range of events such as:

- I3B CAFÉ
  A monthly event for participants with a serious program (presentations and demonstrations) followed by an informal meet up.
- ANNUAL SYMPOSIUM FOR CLIENTS AND PROSPECTS
  Continuation of the IIP Brain &Cognition valorization event.

- MEASURING BEHAVIOR CONFERENCE
  This biennial event has been organized since 1996 by Noldus Information Technology and has now acquired a loyal worldwide community. Noldus Information Technology is willing to hand over this valuable asset to the i3B initiative.
- THEMATIC WORKSHOPS
  Aimed at a specific technology or application area.
- JOINT DEMONSTRATIONS AT CONGRESSES
  The integrated systems developed by participating companies are ideal for demonstrations at scientific conventions in the Netherlands and abroad. Nowadays many congresses offer space for demonstrations alongside the traditional presentations and posters.
- JOINT TRADE SHOW PRESENTATIONS
  Most i3B participants already have their own calendar of congress and trade fair presentations. However, these do not always yield sufficient leads to make it attractive enough for a company to hire a stand. By presenting ourselves jointly as i3B, or with a selection of the i3B companies, at certain trade fairs and congresses we can make cost savings. As soon as the '*i3B brand*' is strongenough then these presentations will probably attract more attention than those of individual companies.
- THEMATIC SCIENCE & TECHNOLOGY MISSIONS
  The TWA network of the Dutch embassies is available as a partner for the organization of thematic missions for groups of entrepreneurs. The embassies and consulates can open doors locally that remain closed for individual entrepreneurs. A concrete example of this is the interest of the Dutch embassy in Beijing to organize a neuroscience event for Dutch companies in Shanghai. At the Dutch end this can be coordinated by i3B.

Education

Many i3B companies have education and training as part of their services portfolio. Yet this usually remains limited to instruction in the use of products developed by them. However, due to the high-tech character of most i3B tools this is often not enough. A brief training session will only suffice if the client is already a specialist in the technology and the use of the tools concerned; in the majority of cases basic training in the '*ins and outs*' of the relevant research method will be needed. As this material is often not limited to a specific company then a joint approach is the ideal way forward. The provision of training will therefore be a part of i3B's portfolio of activities. Examples are:

- Courses in the basic principles of measurement and analysis for brain, cognition, physiology and behavior. Participating i3B companies can advise their clients to follow these courses prior to using their products. These courses can be developed in collaboration with Wageningen University and/or Stoas University of Applied Sciences, possibly as a minor in the area of brain/body/behavior.

- Courses in the use of the systems present in the i3B Lab. The course is then given by the participating company (in which case i3B only has a facilitating role) or by a fellow company.
- A certification program that is internationally recognized by i3B-related professional associations (*'certified i3B specialist'*).
- Outreach: courses that are offered free of charge to developing countries with the idea of sowing for a later harvest.

Research services

The i3B organization can offer valuable services to its participants that support the research and development process. Concrete examples are:

USABILITY TESTING
The test facilities of the i3B Lab can be used to test concepts and prototypes from product developers for usability and user experience.

RECRUITMENT OF TEST SUBJECTS FOR EXPERIMENTAL STUDIES
i3B can build a database of test subjects who are available for tests in the i3B Lab, which is large enough to obtain representative cross sections from the target group.

These research services will be made available to i3B participants at a reduced rate and third parties at a commercial rate. The income from third parties could be a valuable source of sustainable funding for the i3B organization.

TNO also has funding instruments for knowledge development and transfer, which have been established by the Ministry of Economic Affairs, Agriculture and Innovation for Dutch SMEs. These services will be coordinated by i3B and made available to its participants.

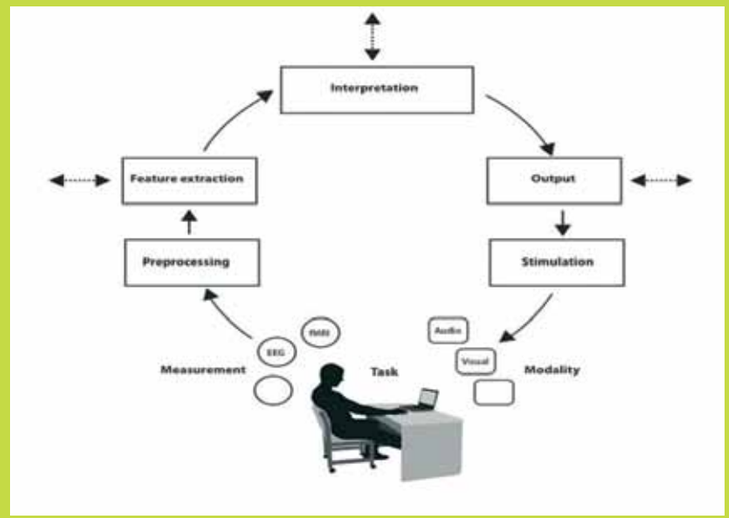
Business development

As a network of more and less experienced SME entrepreneurs, i3B can play a useful role in various forms of business development:

OEM AND VAR RELATIONSHIPS
Development of OEM and value-added relationships between participating companies. Not every i3B participant has the ambition to develop integrated end products. Among the launching participants there are also companies who want to concentrate on R&D that leads to components and subsystems, whereas others want to market end user systems worldwide. Partnerships arise between these companies in which the one as an Original Equipment Manufacturer (OEM) integrates the end product and the other functions as a supplier. i3B can play an advisory and intermediary role in this.

COMMERCIAL CONTRACTS
The i3B cluster can acts as a single company towards external parties and profile itself to large companies who want to do one-stop shopping when outsourcing R&D in the area of brain/body/behavior. i3B can act as a nego-

Smart reasoning systems for wellbeing and safety at work



A healthy workforce is a happier and more productive workforce. Keeping people healthy and at work has obvious benefits: promoting a better quality of life and allowing people to make the most of their potential. Conversely, being out of work can exacerbate physical and mental health problems and increase the chance of social exclusion. The objective of the SWELL project is to develop user-centric sensing and reasoning techniques that help to improve well-being in a work context. Wellbeing at work can be defined as 'being and feeling in control', with a positive impact on work efficiency and effectiveness, work pleasure, mental and physical health status. Activity, health status and information access patterns of individuals will be monitored by a series of sensors: webcam, microphone, key presses, mouse clicks, etc. The resulting model, which will be continuously learning from and adapting to and individual, can subsequently be used to provide input for an unobtrusive coach or assistant based on robust reasoning techniques, thereby increasing the individual's sense of feeling in control. The same measurement techniques can also be used to detect human errors in the operation of complex systems, such as medical instruments, which is the topic of the project PATRIA2. The results of this project will contribute to better training of medical staff and increased patient safety.

Technologies
Activity monitoring
Emotion measurements
Pattern classification
Reasoning
Feedback

Partners
Noldus IT
VicarVision
Philips
TNO
Ericsson
University of Twente

Projects
GATE
COMMIT (SWELL)
PATRIA2

tiator in this process or even as a prime contractor and then engage one or more i3B participants as subcontractors. To facilitate this form of business development one or more BVs can be set up under the i3B foundation.

NEW VENTURES
Encouraging and supervising the start-up of new companies by researchers and developers involved in i3B. With this approach, i3B can generate new companies that might later be assimilated by existing i3B companies or larger companies. This could make the output of i3B even more tangible.

Parties involved

i3B is an initiative in which many parties are involved to a greater or lesser extent. These are divided into the categories described below. The names of the organizations are listed in Appendix 2 (page 55).

Initiators

The i3B initiative has been devised and developed by Lucas Noldus, Huib Pasman and Frits Grotenhuis, members of the board and working group *'Ways of Working'* of the ICT Innovation Platform Brain & Cognition (IIP B&C). This document has been jointly produced with and for parties behind IIP B&C. This business plan also incorporates the recommendations from many representatives of companies and institutions with whom discussions about the i3B initiative have been held over the past year (see Appendix 5, page 65 for an overview).

Small and medium-sized enterprises

The i3B initiative is primarily a venture for and of SMEs. It concerns technology providers with a proven capacity for innovative technical research and/or product development at the interface of ICT and brain, cognition, physiology and behavior. Participating companies have the desire and willingness to share knowledge and technology with each other and to integrate their hardware and software into complete measurement and analysis systems. Service providers who do not have their own R&D do not belong to the intended participants in the i3B initiative. i3B will start with about 15 participating SMEs who have expressed the intention of making a substantial investment in the i3B Lab.

Knowledge institutions

For universities the i3B Lab provides an opportunity for intensifying collaboration with market parties and for realizing knowledge transfer. Via i3B measurement concepts and software algorithms from the knowledge providers can find their way to SMEs. This also applies to research institutes such as TNO and the Holst Center: for them the i3B Lab is a logical partner for the further development of new technologies into working commercial products. For higher education institutions in the region (Wageningen, Nijmegen, Arnhem, Utrecht) the i3B Lab is also an attractive location for interns and graduate students.

Large companies

For large companies, both Dutch companies and Dutch operations of foreign multinationals, the i3B Lab provides a superb opportunity for gaining access to the technology of a large number of high-tech SMEs. The labs of the large companies frequently form the next link in the i3B value chain. By collaborating with i3B, these companies can gain a leading position as a launching customer that can evaluate the i3B tools before these are introduced to their own laboratory. Large pharmaceutical companies form a separate category. They are currently downscaling their preclinical research in the Netherlands, and might be interested in collaborating with the i3B Animal Labs. Such a collaboration would give them access to new test methods and tools for in vivo pharmacological and toxicological research. That would also contribute to their wish to reduce, refine and replace animal experiments (the 3 Rs).

Domain-specific field labs

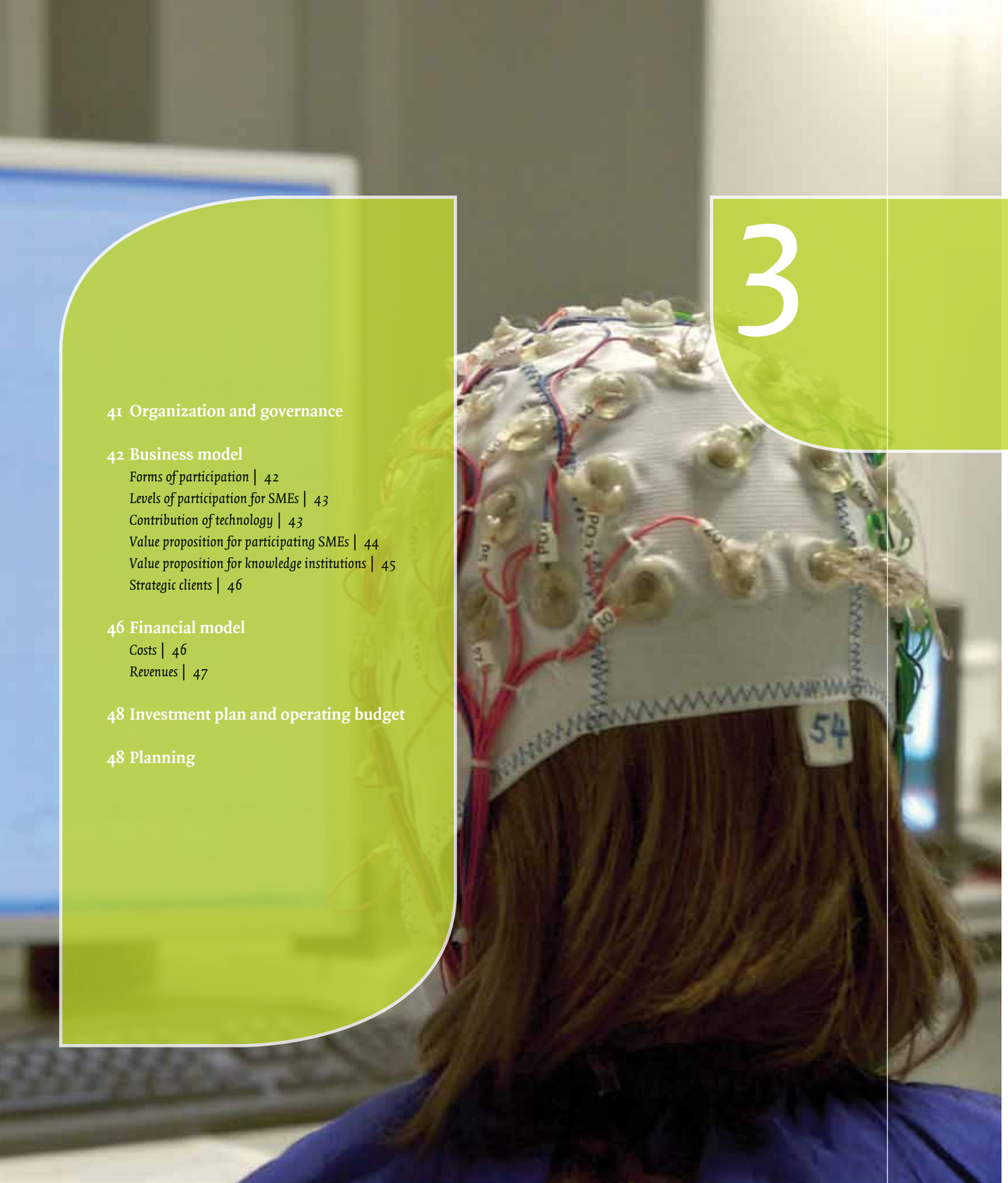
As explained on page 18 (*'International context'*), the i3B initiative complements a range of existing or planned domain-specific field labs elsewhere in the Netherlands. Where these labs are active in the area of brain/body/behavior they normally form the next link in the value chain: the measurement and analysis systems developed in the i3B Lab can be used in the domain-specific labs and validated in a realistic context. Several of these labs have explicitly stated their support for the i3B initiative.

Foreign companies

i3B is a national initiative with an international horizon. Although the initial participants are Dutch companies, we are also open to participation by foreign companies. During the first year after our establishment we will further elaborate the rules for admitting foreign firms. Foreign defense companies with an obligation to provide compensation orders to the Netherlands have a special role to play: by collaborating with i3B they can achieve a greater multiplier than via trade with an individual SME. Negotiations with several such companies are already taking place.

Network and sector organizations

This category comprises network organizations, platforms and associations that support the i3B initiative. First of all this concerns the IIP Brain & Cognition, from which the i3B plan arose supported by the National Initiative Brain & Cognition (NIBC), but also other IIPs active in the area of brain, body & behavior such as IIP Sensor Networks and IIP Create.



3

Realization

41 Organization and governance

42 Business model
- *Forms of participation* | 42
- *Levels of participation for SMEs* | 43
- *Contribution of technology* | 43
- *Value proposition for participating SMEs* | 44
- *Value proposition for knowledge institutions* | 45
- *Strategic clients* | 46

46 Financial model
- *Costs* | 46
- *Revenues* | 47

48 Investment plan and operating budget

48 Planning

Organization and governance

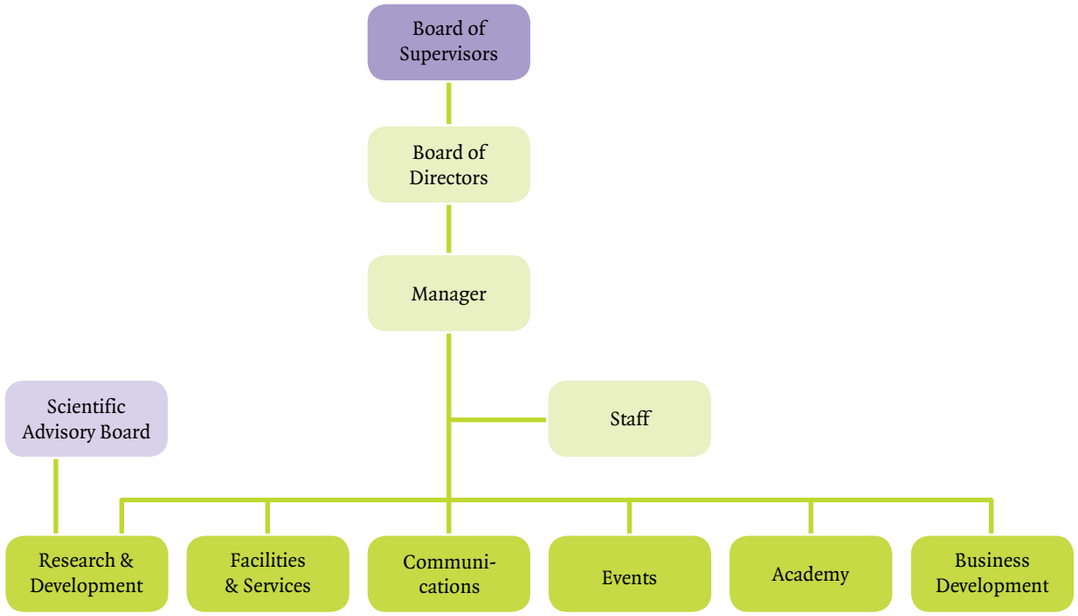
i3B's activities will fall under the Foundation ICT for Brain, Body & Behavior (abbreviated: i3B Foundation, in Dutch: Stichting i3B). The status of a '*stichting*' (foundation) makes it clear that the i3B initiative is not-for-profit and is not owned by the participating companies. The definitive organizational structure and legal status is still being investigated.

The acronym i3B (pronounced '*I triple B*') alludes to IEEE, which according to www.ieee.org is '*the world's largest professional association dedicated to advancing technological innovation and excellence for the benefit of humanity*' and the originator of well-known ICT standards (such as IEEE 1394, i.e. FireWire). i3B's ambition is to become an incubator for ICT innovations for brain, body & behavior. The web domain www.i3b.org has already been registered.

The compact acronym is not just ideal for a powerful logo but can also serve as the brand for a wide range of labels covering the various activities, such as i3B Lab for the central laboratory, i3B Press for the publisher, i3B Café for the monthly network event, i3B Academy for the training activities, etc.

The Board of Directors of i3B Foundation will be made up of representatives from the participating companies and knowledge institutions. Care will be taken to ensure that the most important skills and disciplines are represented on the Board. The Board will be accountable to a Board of Supervisors, which will have a balanced representation of the stakeholders, i.e. companies and knowledge institutions, and a neutral chair. A Scientific Advisory Board made up of experts in the relevant scientific and technological disciplines will be appointed for supervision of the research agenda.

The day-to-day activities will be realized by a small staff consisting of a manager and communication officer employed by i3B Foundation, supported by administrative staff who will be hired in as and when required. Together they will be responsible for the realization of the various activities. The organogram of i3B Foundation is shown below.



Business model

Forms of participation

A crucial aspect of the i3B business plan is how the companies and other parties can participate in the i3B initiative. For i3B to be successful, the rights and privileges of the participants must be properly arranged. There must be no misunderstandings concerning the mutual expectations. For the time being we assume that organizations can be involved in i3B as follows:

- SMEs that satisfy the profile can become a participant of i3B Foundation. There will be three levels of participation with the associated packages of benefits. These are stated on the next page.
- Knowledge institutions (universities, universities of applied sciences, research & technology organizations) can also become participants in i3B Foundation. Individualized agreements will be concluded with them.
- Large companies can enter into a partnership with i3B Foundation or one of its limited companies (BVs), either in the context of a specific project or in the form of an umbrella agreement for purchasing certain services over a given period of time.

Levels of participation for SMEs

Three levels of participation are available to SMEs: bronze, silver and gold. For each level the associated current benefits are stated.

Bronze level

- Right to use i3B logo in corporate communications
- Company logo placed on i3B digital and printed media
- Company news published on i3B website and other media
- Invitation to monthly i3B Café
- Invitation to i3B technical seminars and scientific events
- Invitation to science and technology missions
- Subscription to i3B newsletter
- Shortlisted for commercial contracts
- Shortlisted for subsidized projects
- Input in annual research program

Silver level

Same as Bronze, plus:

- Use of i3B Lab (human, animal) for product demonstration (showroom), exposure to visitors
- Receive sales leads from i3B Lab
- Invite customers to i3B Lab
- Use of i3B Lab facilities for sessions with customers and prospects
- Exhibition space in joint booth at a reduced rate
- Free access to training courses
- Free access to Measuring Behavior conference (2 persons)
- Free access to i3B E-science Lab (data repository)
- Free access to business development consultancy (X[17] hours/year)

[17] Still to be determined.

Gold level

Same as Silver, plus:

- Free use of fully equipped workspace (desk, computer) for students (X person-months/year)
- Free use of usability lab (X days/year)
- Free access to test subjects for usability tests (X persons/year)
- Free exhibition booth at Measuring Behavior conference
- Assistance with product certification (X hours/year)
- Assistance with product localization (X hours/year)

Contribution of technology

The SME technology providers shall contribute technology (background IP) in the form of software and hardware. This will enable us to equip the i3B Lab and the i3B Animal Labs with a range of measurement and analysis equipment. The market price for these products represents the size of their initial investment. Bilateral agreements about this will be concluded between i3B Foundation and the participating company. Prior to it being placed in the i3B Lab, the techno-

logy's maturity will be assessed by i3B Foundation: only technology of a sufficient level will be placed. The equipment contributed will remain the property of the participating company so that they can cover the depreciation costs in projects. If other i3B participants wish to make use of the equipment outside of projects the owner participates in then special tariff agreements will be concluded. The owner is expected to keep this equipment in the i3B Lab up to date and to ensure the installation of new hardware or software releases within 12 months of these becoming available. Participants will carry out R&D activities in the i3B Lab and foreground IP will therefore be developed. Per project agreements will be reached concerning the extent to which this IP will be shared with other participants. Various SMEs have already made commitments for the contribution of products with a total value of more than 500 k€. Details are available upon request.

Due to the added value of co-location for R&D by the participating companies, the hardware and software contributed will be placed in the central i3B Lab as much as possible. However, this is not possible for all systems, for example due to the physical dimensions of the equipment or the link to a specific i3B Animal Lab. We therefore anticipate that besides the central i3B Lab and the i3B Animal Labs, one or more i3B Satellite Labs will develop elsewhere in the Netherlands.

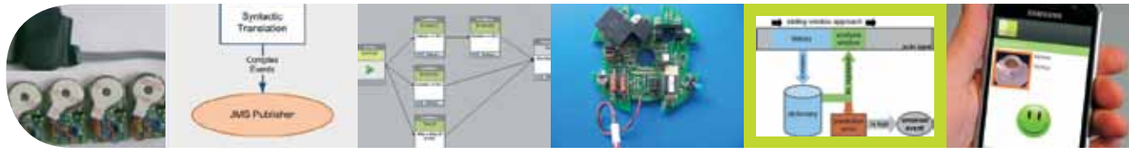
Value proposition for participating SMEs

i3B in no way wishes to give the impression that it will force participating companies to transfer their creative activities to the i3B Lab. Companies should first and foremost continue the creative process in their own environment. However, the i3B Lab will offer services and facilities to which they have no access or that they could not afford to finance themselves. This approach has a proven track record elsewhere[18]. The i3B Lab offers the participating companies unique added value:

- The i3B Lab encourages and simplifies the process of collaborating with other companies, from research and development to system integration and business development.
- The i3B Lab will offer a high-value infrastructure for testing hardware and software in a realistic environment that participants do not have themselves: flexible labs that can be configured, digital video and audio, sensor networks, ICT network facilities, data storage capacity, remote access, etc.
- Via i3B participating companies will gain access to interns and graduate students for whom the i3B Lab forms an attractive research environment.
- Participating companies can carry out experiments in the i3B Lab that are not possible at their own location.
- Participating companies can make use of a range of services, at a reduced fee, which are valuable for the development and commercialization of their product
- The costs will be kept as low as possible due to low overheads and an SME style of management. Staff services will be hired on an as needed basis from one of the participating companies.
- It is expected that the i3B Lab will attract a continuous stream of visitors, including potential buyers of the installed products. This will allow participating companies to benefit from each other's marketing and sales efforts.

[18] Rob van Lambalgen (VentureLab Twente) in S. Verveen (2010): Rapportage Labs Verkenning [Labs Foresight Study Report] – Creative Lab project. Utrecht: SURFnet.

- In addition to the facilities and services offered by the i3B Lab, participants will also benefit from the many other services offered by the i3B organization, as well as the knowledge, experience and assistance from fellow entrepreneurs in the i3B network. This will facilitate and accelerate both R&D and business development.

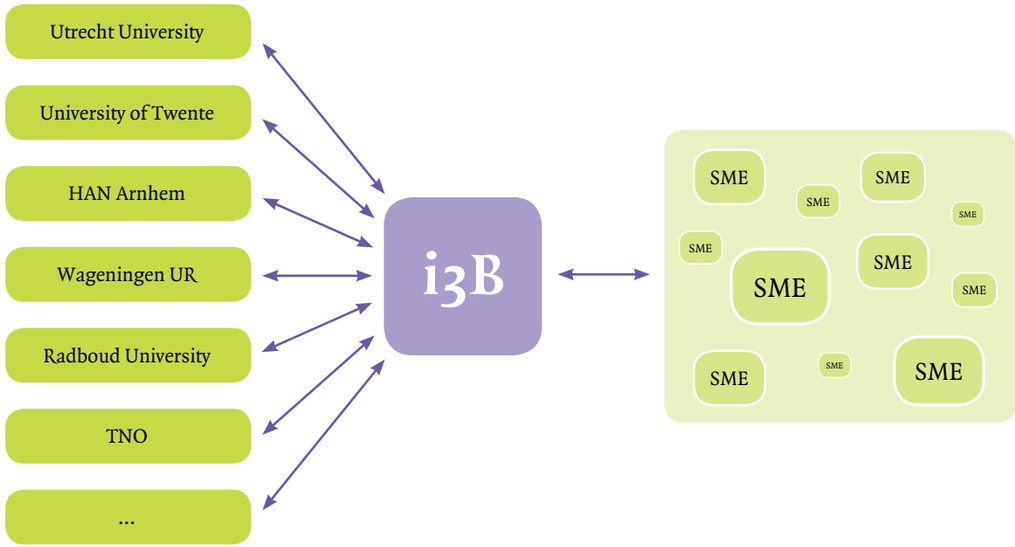


Value proposition for knowledge institutions

We anticipate the following added value for participating knowledge institutions:

- Collaboration with i3B companies simplifies the industrial co-funding of public-private partnership (PPP) projects at both a national and international level. It also increases the chances of success for project proposals in the domain brain/body/behavior.
- Sparring with SME entrepreneurs helps institutions to discover new ways of translating knowledge into '*cash*' in addition to just patents or courses. This collaboration also gives universities the opportunity – via a business school – to improve the entrepreneurial side of all participating parties and to enable young people to develop their entrepreneurial skills further.
- Revenues in the form of PhD premiums due to dissertations emerging from research carried out in the i3B Lab.
- Joint contract research in the sectors food, pharmaceuticals, animal sciences and high-tech.
- Product development based on IPR of a knowledge institution will lead to revenues in the form of royalties.
- Joint export of research methods, techniques and tools to emerging markets.
- Revenues from training and consultancy with respect to the use of new methods, techniques and tools in research and practice.
- Education: the i3B Lab offers high-value facilities for MSc students, PhD fellows, postdocs and post-academic education.
- For RTOs this is a superb opportunity for collaboration with respect to market-oriented knowledge development with SMEs as the final producers and end users, and valorization of technology in the direction of the innovative SMEs.

The additional revenues due to participation in i3B can amount to more than € 1 million per year for knowledge institutions (see Appendix 4, page 64, for a worked out example). Just as important is the function i3B can provide as the link between a knowledge institution and a cluster of specialized SME companies of different sizes, which are often difficult for a knowledge institution to approach individually. i3B also forms a bridge to complementary disciplines in other knowledge institutions. The figure on the next page is an attempt to visualize this.



Strategic clients

Various user models will be developed for the intended purchasers of i3B services, in the form of subscriptions, licenses, etc. For products and services that will have their own lifespan a limited company (BV) can be set up under i3B Foundation to generate revenues that will in turn benefit the organization.

Financial model

Costs

In the costs of the i3B plan a distinction is drawn between the initial investments, fixed operational costs and variable costs.

Infrastructure

- Costs of setting up the i3B Lab: furniture, furnishings, lighting.
- Investments in equipment and software for the i3B Lab and the i3B Animal Labs. This concerns the equipment for the general-purpose rooms (computers, network server, audio/video, cabling) and the basic facilities in the thematic labs (video, audio). The specific measurement and analysis systems will be contributed by the participating companies.

Operation

- Salaries of permanent staff: manager, communications officer
- Hiring in office services: reception, secretariat, financial administration, network management, web design
- Accommodation i3B Lab: rent, cleaning, security, etc.
- Data storage and communication: web hosting, data transfer, etc.
- General costs

Other costs

- Events
- Publications
- Educational courses and training sessions

Revenues

i3B Foundation has the ambition, after a start-up period of several years, to realize an exploitation that covers its costs based on the contributions of participants and revenue from services and exploitation. Various forms of government funding will be applied for to cover the start-up costs. This model has demonstrated its effectiveness elsewhere[19].

[19] TNO (2010). Samenwerken in fieldlabs: Focus op wederzijdse versterking [Collaboration in field labs: Focus on reciprocal strengthening]. PowerPoint slide show, 10-11-2010.

Contributions and partnership fees

- SMEs: annual contribution (gold, silver, bronze level), dependent on company size (micro, small, medium)
- Knowledge institutions: annual contribution (bilateral agreement)
- Large companies: partnership fee (bilateral agreement)

Revenues from services and exploitation

- Events (such as Measuring Behavior conference): registration fees, exhibition fees, sponsoring
- Exploitation of i3B E-science Lab (data repository): fees for access to data sets, protocols
- Consultancy & test services: usability testing
- Education: revenues from courses, training sessions, publishing
- Exploitation of i3B Lab: use in grant-funded projects (Agentschap NL, EU FP7, etc.), leasing to third parties
- Revenues from NL and EU grant-funded projects: remuneration for coordination, project management, etc. (for example, IPC projects)
- Revenues from contract R&D for large companies: remuneration for negotiation, prime contractorship, etc.

Grants and credits

- Starting grant or innovation credit from the national government
- Contribution from regional governments

Other contributions

- Funding instruments that are made available by the Dutch government within the framework of supporting SMEs with accelerating innovation such as knowledge transfer projects within TNO's SME program, the SME Technology Cluster program as well as the co-financing scheme for knowledge development in high-risk applied scientific research.

Investment plan and operating budget

It is foreseen that after 2-3 years, i3B will be able to cover its annual budget through a balanced mix of contributions and partnership fees, revenues from services and exploitation and other contributions. An initial subsidy will be requested in order to finance the start of the i3B organization, to cover salary costs for the first two years, and to get up to speed. We will also explore collaboration with financial institutions such as banks and insurance companies, venture capital funds and consulting firms, in particular those with a special interest in life sciences and technology. A detailed investment plan and operating budget are available upon request.

Planning

The i3B plan will be realized step-by-step in the following phases:

PHASE 1
Current collaborative projects (see Appendix 3, page 60) that could have benefited from the i3B facilities (2011-2012).

PHASE 2
New collaborative projects (see Appendix 3, page 62) that will benefit from the i3B facilities (2012-). To this end the following thematic labs will be set up first:

- User Experience Lab
- Tracking Lab
- Automotive Lab
- Virtual Reality Lab

PHASE 3
Establishment of the business model, securing funding, recruiting participants, starting up the i3B organization, construction of the i3B Lab, setting up of the i3B Animal Labs (2012-).

PHASE 4
Expansion of the portfolio of i3B activities and services (2013-).

The growth of i3B will be determined by the market's response to this initiative!

Wildlife behavior recognition from GPS tracks

Technologies
Satellite tracking
EGNOS
EDAS
Trajectory analysis
Pattern recognition

Partners
Noldus IT
AeroVision
BioTrack
Wageningen UR
NIOO
IZW Berlin

Projects
E-Track

For many years, scientists and wildlife managers have used radio and satellite tracking to follow the movements of animals in the wild. However, existing technology suffers from limited temporal and spatial resolution: positioning data are too coarse to determine how animals behave relative to their environment and each other. In other words: one can measure where an animal approximately is, but not what it is doing. Current GPS-based tracking systems are not able to track moving objects at short time intervals. Furthermore, software tools capable of processing large volumes of GPS data and converting those into meaningful metrics describing animal behavior are missing. The E-Track project concerns the development of a system for measurement and analysis of movement, behavior and interactions of wildlife. The system will take advantage of EGNOS and EDAS data enhancement services to provide adequate resolution for behavior analysis. Integration with data from additional sensors (acceleration, ambient temperature, etc.) will provide detailed insight in animal movement and behavior. Data processing will include data aggregation, trajectory analysis, pattern classification and behavior recognition. The project will develop a fully working end-to-end system for scientific research and wildlife management.

51 Existing field labs relevant for i3B

55 Organizations involved in i3B
Small and medium-sized enterprises | 55
Knowledge institutions | 56
Related field labs | 56
Foreign technology providers | 57
Network and sector organizations| 57
Government | 57

60 i3B projects
Current projects| 60
Possible future projects | 62

64 Financial returns for a university

65 Acknowledgements
Contributions | 65
Illustrations | 66

Image courtesy | Wageningen UR

Appendices

1. Existing field labs relevant for i3B

Below you will find a non-exhaustive compilation of field labs in the Netherlands and elsewhere in Europe that are relevant for the i3B initiative. They serve as a source of inspiration regarding the practice of a Living Lab ecosystem. Some of the field labs are logical candidates for inclusion in our network.

Restaurant of the Future, Wageningen

www.restaurantofthefuture.nl

This is a facility for research into healthy food choice and consumption. It is an initiative of four parties: Wageningen UR (the most important stakeholder), Sodexo, Kampri Group and Noldus Information Technology, each of which has made substantial investments in the facility. In addition to this there are about 40 participants, companies and non-profit organizations, who pay an annual contribution in exchange for information tailored to their needs and research services they can purchase. Research tools from various i3B parties are used in the Restaurant of the Future. Its requirements are illustrative for the need for an i3B Lab: the Restaurant of the Future only wants to install integrated measurement and analysis systems once the manufacturers have realized the integration and resolved the technical problems. For i3B, the Restaurant of the Future is therefore a next link in the chain: user of i3B tools for R&D in their domain of food, nutrition and health.

InnoSportLabs

www.innosport.nl/nl/InnoSportLabs

InnoSportNL, the organization for sports innovation founded by NOC*NSF and TNO, has set up several test and research facilities for certain sports. The current InnoSportLabs are in Eindhoven (swimming), Heerenveen (skating), Den Bosch (gymnastics) and The Hague (sailing), while a new lab in Papendal (20 km from Wageningen) is being set up. Sports practitioners, knowledge institutions and companies work together in these labs on innovations aimed at improving sports performance. Several of the i3B participants are involved in InnoSportLabs. At present hardware and software manufacturers must integrate, test and validate their systems in the InnoSportLab under the eyes of the sports people. This is not always desirable as end users being confronted with bugs can lead to mistrust and showing prototypes too early can lead to unrealistic expectations. It is therefore better if the technical integration of measurement systems takes place outside of the InnoSportLab so that end users can use robust tools straightaway. The i3B Lab would seem to be the ideal location for this.

CSI Lab, The Hague

The CSI Lab, located within the Forensic Field Lab, the research and training facility of the Netherlands Forensic Institute (www.forensicinstitute.nl), was designed and set up within the research project CSI The Hague (www.csithehague.com). A consortium of companies (including i3B participants) and knowledge institutions has integrated existing equipment and software in an innovative manner, which has resulted in a unique lab for the development and validation of forensic research methods and tools. The innovation mainly lies in the use of the forensic research and less in the actual tools. These have been incorporated as they are after completing technical tests elsewhere (i3B Lab would be the ideal place to do this). The CSI Lab is funded by a combination of the partners' own contributions and a grant from the government and The Hague city council. The consortium is now examining possibilities for the commercial exploitation of the lab.

DevLab, Eindhoven

www.devlab.nl

DevLab (Development Laboratories) arose in 2004 from the Development Club, a group of about 50 companies in industrial electronics. DevLab started with 12 member companies. The first activities started in 2005. At present there are 10 members. DevLab is a cooperative with the participating companies as members. The board is made up of 5 directors from the participating companies. The management is one person who works full time for the cooperative. Each member pays an annual contribution fee equal to 1% of the total wages. This is used to pay the manager and the rent for the DevLab office. DevLab is located at the campus of Eindhoven University of Technology in the Laplace building. About 160 m² is available for the manager's office, a meeting room and about 10 workplaces. In addition to this use can be made of the university rooms such as the lecture theatre. Only precompetitive research is carried out in the DevLab and no product development takes place, as members can also be competitors of each other. All members can freely use the knowledge and technology developed within DevLab. On every last Friday of the month members come together for the DevLab Café: presentations about current research projects followed by socializing. Once a year a members' meeting held in Lemmer: a day of serious presentations and meetings followed by a day of sailing with in-between an evening of fun. DevLab does not undertake any marketing or promotional activities. Neither does the lab function as a showroom for its members' products. The members are so diverse with respect to the application areas that this would have no added value. DevLab is now in its eighth year and only now will the subject of IPR be placed on the agenda. According to Lex van Gijssel, DevLab manager, if IPR had been negotiated and agreed upon in detail right at the start then DevLab would not have gotten off the ground. DevLab developed because its members had always had a relationship of trust with each other. This has been a vital factor underlying its success.

D-CIS Lab, Delft

www.d-cis.nl

D-CIS Lab is a collaboration between Thales Nederland, three universities (Delft, Amsterdam and Twente) and Stichting Neurale Netwerken. The lab's activities consist of fundamental and applied research, networking, communication and demonstrations. The research focus is on Actor-Agent Communities, and the main application area is Disaster and Crisis Management.

Philips ExperienceLab, Eindhoven

www.research.philips.com/focused/experiencelab

The ExperienceLab of Philips Research is a building on the High-Tech Campus, set up for observing the interaction between users and *'consumer lifestyle'* concepts and prototypes. As the website says: *'In the ExperienceLab, multi-disciplinary teams including psychologists, sociologists and designers can observe people and monitor their behavior and interactions with the innovative concepts. ExperienceLab provides an ideal environment in which user-centered research can be performed. This state-of-the-art facility enables researchers to investigate user interactions with new technology, observing and recording the interaction by means of embedded electronics and ambient intelligence, unobtrusively built into the surrounding environment. This allows researchers to gain valuable insights into the needs of customers, their behavior and their response to new product concepts and scenarios. ExperienceLab can be applied to diverse application domains such as lifestyle, healthcare, retail and hospitality.'* The ExperienceLab was originally designed as an internal test facility for Philips Research. Later it opened its doors to outside parties but that decision has now been reversed. The ExperienceLab is once again solely intended for internal studies of Philips Research. Within the Philips ExperienceLab research tools are used that have been developed by SMEs involved in i3B. Therefore with respect to i3B, Philips ExperienceLab is a next link in the chain: not a developer but a user of i3B tools to assist research in their own application area.

TNO Field lab Greenhouse Horticulture, Honselersdijk

www.tno.nl/glastuinbouw

A collaboration between TNO, DLV Plant, InHolland University of Applied Sciences, Fytagoras BV and Demokwekerij Metazet. TNO makes scientific knowledge from various disciplines inside and outside of agriculture applicable here to strengthen the competitive capacity and innovative character of the glass horticulture industry.

Other relevant labs in the Netherlands

- **Wetsus**, Leeuwarden (www.wetsus.nl)
- **ThermoPlastic Research Center**, Enschede (www.tprc.nl)
- **Field lab for Client Centered Care**, Enschede (www.fieldlab.eu)
- **Smart eXperience Lab**, Enschede (smartxp.ewi.utwente.nl)
- **Public Security Innovation Center**, The Hague (www.psic.eu)

European inspiration

The initiators of i3B are also familiar with various Living Lab projects that are taking place at the European level and which serve as a source of inspiration for the i3B Lab. A highly relevant organization is EIT ICT Labs (www.eit.ictlabs.eu), one of the three Knowledge & Innovation Communities (KICs) of the European Institute of Innovation & Technology (EIT). EIT ICT Labs has defined several '*nodes*' in Europe (e.g. Berlin, Eindhoven, Helsinki, Paris, Stockholm), plus a number of '*innovation hotspots*' outside of the nodes. Several Living Labs in Europe are allied to EIT ICT Labs (see knowledgecentre.openlivinglabs.eu), and these could be interesting collaborative partners:

- Berlin | SensHome
- Berlin | Smart Energy Systems Experience Labs
- Budapest | ELTE Living Lab facilities
- Eindhoven | Philips Experience Lab
- Eindhoven | Smart XP Lab
- Eindhoven | SEL-D, Smart Environment Lab, TU Delft
- Helsinki | OTASizzle
- Paris | GerHome
- Stockholm | Center for Health and Building
- Stockholm | Mobile Services Media Lab
- Trento | Trento H&WB Territorial Lab
- Trento | Triton
- Trento | e-Campus Territorial Lab

2. Organizations involved in i3B[20]

[20] Preliminary list, subject to change. All organizations in Appendix 2 have expressed their interest to be involved with i3B and a number have already confirmed their participation.

Small and medium-sized enterprises

Participation confirmed

Artinis Medical Systems
www.artinis.com

Delta Phenomics
www.deltaphenomics.com

Eagle Science
www.eaglescience.nl

Eagle Vision Systems
www.eaglevision.nl

Green Dino
www.greendino.nl

Inertia Technology
www.inertia-technology.com

Maars Holding
www.maars.nl

Metris
www.metris.nl

Motek Medical
www.motekmedical.com

Noldus Information Technology
www.noldus.com

SmartPosition
www.smartposition.nl

T2C
www.t2c.nl

TeleMetronics Biomedical
www.telemetronics.com

TMS International
www.tmsi.com

VicarVision
www.vicarvision.nl

Interested

Almende
Chess
E-Semble
Limez
Neurasmus
Re-lion
Sound Intelligence

Knowledge institutions

Wageningen University and Research Center
- *Agrotechnology & Food Sciences Group*
- *Animal Sciences Group*
- *Environmental Sciences Group*
- *Plant Sciences Group*
- *Social Sciences Group*

Radboud University Nijmegen
- *Donders Institute for Brain, Cognition and Behavior*

Eindhoven University of Technology
- *Department of Mathematics and Computer Science*

HAN University of Applied Sciences
- *Faculty of Engineering*
- *Faculty of Health and Social Studies*

Utrecht University
- *Faculty of Science*

UMC Utrecht

University of Twente
- *Center for Telematics and Information Technology*

TNO

Holst Center

Related field labs

Wageningen UR
- *Restaurant of the Future*

Dr Leo Kannerhuis
- *Autism lab*

Philips
- *ExperienceLab*

Netherlands Forensic Institute
- *CSI Lab*

InnoSportNL
- *InnoSportLabs*

Siza
- *GROW House*

Foreign technology providers

Alpha Omega Engineering (Israel)
Biopac Systems Inc. (USA)
Data Sciences International Inc. (USA)
Electrical Geodesics Inc. (USA)
Future-Shape GmbH (Germany)
Guger Technologies OG (Austria)
Infusion Systems Ltd (Canada)
Mindware Technologies Inc. (USA)
Plux Engenharia de Biosensores, Lda. (Portugal)
SensoMotoric Instruments GmbH (Germany)
Smart Eye AB (Sweden)
Tobii Technologies AB (Sweden)

Network and sector organizations

Automotive NL
Food & Nutrition Delta
Food Valley
Health Valley
ICT Innovation Platform Brain & Cognition
ICT Innovation Platform Sensor Networks
ICT Innovation Platform CREATE
InnoSportNL
Technological Top Institute Green Genetics
Top Institute Food & Nutrition
Top Institute Pharma

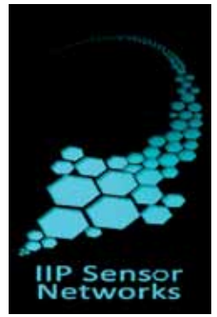
Government

City of Wageningen
Oost NV – East Netherlands Development Agency
PPM Oost – Participatiemaatschappij Oost Nederland NV

Small and medium-sized enterprises

Knowledge institutions

Network and sector organizations



Government

3. i3B projects

Current projects

A selection of projects using existing funding that are currently in progress within the domain of i3B are listed. These projects would benefit from i3B facilities. Several projects (COMMIT, WPSS, ADVICE, FOCOM) have only started very recently and can hopefully make use of the i3B Lab in the future. For each project, the participating Dutch SME companies, knowledge institutions, large companies and end user organizations are listed, as well as associated field labs.

GUARANTEE

Development of technology for detection of high-risk behavior and prevention of incidents for the elderly and young children in and around the house

SME companies
Eagle Vision Systems, Noldus IT, Sound Intelligence

Knowledge institutions
University of Twente

Field lab
SmartXp Lab

Large companies, end user organizations
Philips

NeuroBasic PharmaPhenomics

Development of tools for the automatic measurement of behavior and physiology in rodents for the purpose of preclinical neurological and psychiatric medicinal/pharmaceutical studies

SME companies
Delta Phenomics, Neurasmus, Noldus IT

Knowledge institutions
Erasmus MC, VU University Amsterdam, Netherlands Institute of Neuroscience

WPSS

Development of technology for the automatic following of people and the detection of suspected or criminal behavior

SME companies
Cameramanager.com, Eagle Vision Systems, Noldus IT, VicarVision

Knowledge institutions
TNO

InnoSportNL

Various projects for the development of sensors and software for measuring, analyzing and visualizing the performance of athletes

SME companies
DTI, MobiHealth, Noldus IT, Q-ray

Knowledge institutions
VU University Amsterdam

Field labs
Various InnoSport field labs

Large companies, end user organizations
Various sports associations

FOCOM

(a) Development of a Virtual Shop Simulator, tools for the measurement of viewing and choice behavior and the brain response of consumers in a virtual shop

(b) Development of a Food Cognition Simulator, tools for measuring physiological response of consumers upon seeing food products: eye movement, EEG, ECG

SME companies
Artinis, Essensor, Green Dino, NIZO Research, Noldus IT, TMSi

Knowledge institutions
Radboud University, Wageningen UR

Field labs
Restaurant of the Future

Large companies, end user organizations
Heinz

PATRIA2

Development of an intelligent computer workplace with automatic registration of behavior, facial expression and line of sight of the user for the automatic detection of errors in the use of a system, to support training and improve the level of safety

SME companies
Noldus IT, VicarVision

Knowledge institutions
University of Twente

COMMIT

Various subprojects such as the development of an intelligent workplace that responds to the cognitive load and emotional state of the user (project SWELL)

SME companies
Noldus IT, VicarVision

Knowledge institutions
TNO, University of Twente

Field labs
SmartXp Lab

Large companies, end user organizations
Ericsson, Philips

SenseWell

Development of tools for the automatic measurement of animal welfare

SME companies
Delta Phenomics, Metris, Noldus IT, TeleMetronics

Knowledge institutions
Utrecht University, Wageningen UR, TU Delft

ADVICE

Development of tools for the automatic registration of behavior, line of sight, physiology and performance of car drivers in driving simulators and test vehicles

SME companies
Green Dino, Noldus IT, TMSi, VicarVision

Knowledge institutions
HAN University of Applied Sciences, TU Delft, TNO

Field labs
HAN Automotive Lab

Large companies, end user organizations
TomTom

CSI The Hague

Development of tools for measuring behavior and task performance of forensic professionals at a simulated crime scene

SME companies
Chess, Eagle Vision Systems, E-Semble, Noldus IT

Knowledge institutions
TU Delft, TNO

Field labs
CSI Lab

Large companies, end user organizations
Capgemini, Netherlands Forensic Institute, Philips

Possible future projects

A selection of possible projects in the domain of i3B, which will benefit from the availability of i3B research facilities, are listed. The companies and institutions named are possible partners of these projects.

People tracking & automatic behavior recognition

Following the movements and behaviors of people (individuals or groups) using various sensor technologies, such as computer vision, WiFi/smartphones, wireless sensor nodes

i3B facilities needed
Tracking lab: spaces (indoors and outdoors) fitted with video cameras (stereo cameras, movable dome cameras), calibrated WiFi access points, RFID receivers, etc., and tools for observational annotation and analysis

SME companies
Chess, Eagle Vision Systems, Noldus IT, SmartPosition, Inertia Technology

Knowledge institutions
Dependent on possible knowledge gap

Field labs
Dependent on application area

Large companies, end user organizations
Dependent on application area

Emotion recognition in disabled persons

Automatic recognition of emotions and experiences of disabled persons based on facial expression, vocal sound and physiology

i3B facilities needed
Home lab: living room with video (display and recording), audio (sound and recording) and physiological sensors in the furniture

SME companies
Noldus IT, Vicar Vision, Sound Intelligence

Knowledge institutions
Dependent on possible knowledge gap

Field labs
GROW House

Large companies, end user organizations
Siza

Mobile e-coach

Development of a mobile e-coach for (dementing) elderly people based on automatic detection of movement, behavior and location (outdoors)

i3B facilities needed
Tracking lab (see above), to select, develop and validate the optimal tracking technique

SME companies
MobiHealth, Noldus IT, SmartPosition, Inertia Technology

Knowledge institutions
Dependent on possible knowledge gap

Field labs
Still to be determined

Large companies, end user organizations
Healthcare institution

Mobile coach for autism patients

Development of mobile coach for autism patients based on automatic detection of movement, behavior and location (both indoors and outdoors) and specific feedback

i3B facilities needed
Tracking lab (see above), to select, develop and validate the optimal tracking technique

SME companies
Noldus IT, SmartPosition

Knowledge institutions
Radboud University

Field labs
Autism lab Doorwerth

Large companies, end user organizations
Dr Leo Kannerhuis

Physiology & performance of aircraft pilots

Development of tools for automatic registration of behavior, physiology and performance of aircraft pilots

i3B facilities needed
Simulator lab: flight simulator in i3B Lab is not feasible, therefore use car simulator for sensor integration

SME companies
Noldus IT, TMSi

Knowledge institutions
Still to be determined

Field labs
Flight simulator (still to be determined)

Large companies, end user organizations
Aircraft manufacturer (still to be determined)

E-monitoring the brain

Translational techniques and tools for measuring behavior and cognition in test animals and people for the purpose of psychiatric and neurological research: EEG, ECG, biosensors, behavior

i3B facilities needed
Human lab with EEG, ECG and video registration. Animal lab for rodents with instrumented PhenoTyper set ups

SME companies
Delta Phenomics, Metris, Neurasmus, Noldus IT, TeleMetronics

Knowledge institutions
UMC Utrecht, VU University Amsterdam, Radboud University, Wageningen UR

Field labs
CABS, Schaijk

Large companies, end user organizations
Philips, pharmaceutical industry

Empathic products

Consumer products, information systems, appliances and devices that adapt themselves and respond to the user's context, mood and emotions

i3B facilities needed
Home lab: room with video (display and recording), audio (sound and recording) and physiological sensors in various devices. Tracking lab: to assess user context

SME companies
Sound Intelligence, VicarVision, Noldus IT

Knowledge institutions
TU Eindhoven

Field labs
Philips ExperienceLab, others

Large companies, end user organizations
Philips

Welfare monitoring in pigs

Development of tools for automatic monitoring of behavior and welfare of pigs

i3B facilities needed
Animal lab for pigs (WUR campus)

SME companies
Noldus IT, TeleMetronics, Delta Phenomics, Eagle Vision

Knowledge institutions
Wageningen UR

Field labs
Pig Innovation Center Sterksel

Large companies, end user organizations
Still to be determined

4. Financial returns for a university

Possible additional revenues for a university as a consequene of participating in the i3B initiative are itemized below.

SOURCE OF REVENUE	ESTIMATED VOLUME	ANNUAL REVENUES
Partnership with i3B companies facilitates industrial co-financing of PPP projects both national and international), increases propability of acceptance of proposals in brain, body, behavior domains	10 companies with total co-financing capacity of € 1M/year, assuming 50% funding, so equal amount for university resulting in extra project income	€ 500,000
Revenues from completed PhD disserations	5 extra PhD dissertations per year	€ 300,000
Joint contract research in relevant industrial sectors	5 extra projects per year, 100K each, 50% for university	€ 250,000
Joint product development: royalty stream for university	2 succesful products per year, € 2M sales, on average 10% royalties for university	€ 200,000
Joint export of research methods, techniques and tools (e.g. projects in emerging markets	1 project per year, 100K consultancy each	€ 100,000
Training and consultancy	2 training courses per year 3 consultancy projects per year	€ 100,000

5. Acknowledgements

This business plan is a product of the ICT Innovation Platform Brain & Cognition (IIP Brain & Cognition). We acknowledge the financial support of the National Initiative Brain & Cognition for IIP Brain & Cognition and its dissemination and valorization activities. At the time of writing, the board of IIP Brain & Cognition is constituted as follows:

- *Emile Aarts, chairman*
- *Stan Gielen*
- *Lucas Noldus*
- *Peter Werkhoven*

Supported by Frits Grotenhuis, program manager IIP Brain & Cognition

Contributions

The following people have contributed to the realization of this business plan by providing valuable comments, input and feedback:

- *Harry Ankoné, LimeZ*
- *Peter Apers, CTIT, University of Twente*
- *Raoul Bino, Agrotechnology & Food Sciences Group, Wageningen UR*
- *Cees Buisman, Wetsus*
- *Petra Caessens, CAT-AgroFood*
- *Wim Cofino, EIT-KIC Climate*
- *Tom Cornelissen, Oost NV*
- *Daan Crommelin, TI Pharma*
- *Aalt Dijkhuizen, Wageningen UR*
- *Ernst van den Ende, Plant Sciences Group, Wageningen UR*
- *Frank Eetgerink, Oost NV*
- *Jan van Erp, TNO*
- *Gerard van Essen, TeleMetronics Biomedical BV*
- *Theo Föllings, Oost NV*
- *Anton Franken, Radboud University Nijmegen*
- *Bernard de Geus, TTI Green Genetics*
- *Marchel Gorselink, Consumer Science & Intelligent Systems, FBR, Wageningen UR*
- *Marcel de Graaf, Maars Holding BV*
- *Marc Grootjen, Eagle Science*
- *Lex van Gijssel, DevLab*
- *Rob Heinsbroek, National Initiative Brain & Cognition*
- *Lex Hoefsloot, Gemeente Wageningen*
- *Roger van Hoesel, Food Valley*
- *Leo Hoogendoorn, TMS International BV*
- *Michel Holewijn, TNO*
- *Ruud Huirne, formerly at Social Sciences Group, Wageningen UR*
- *Jan Jonker, Oost NV / Health Valley*

- Frans Kampers, Wageningen UR
- Thea van Kemenade, Radboud University Nijmegen
- Leon Kenemans, Utrecht University / National Initiative Brain & Cognition
- Boy Kodde, TNO
- Martin Kropff, Wageningen UR
- Jorrit Kuipers, Green Dino BV
- Herma van Kranenburg, Field lab for Client Centered Care
- Kees Lokhorst, Livestock Research, ASG, Wageningen UR
- Jan Maat, TI Food & Nutrition
- Menno van Manen, Animal Sciences Group, Wageningen UR
- Jaap Lombaers, Holst Center
- Lars Nieuwenhoff, Siza
- Kees Nieuwenhuis, Thales Research & Technology Netherlands / D-CIS Lab
- Lars Oosters, Province of Gelderland
- Joop Pauwelussen, HAN University of Applied Sciences
- Rudy Rabbinge, Wageningen UR
- Eefje Rondeel, Thales Research & Technology Netherlands / D-CIS Lab
- Gitte Schober, Wageningen UR
- Martin Scholten, Animal Sciences Group, Wageningen UR
- Wilco Schoonderbeek, PPM Oost
- Martin Schuurmans, formerly at European Institute of Innovation & Technology
- Kees Slingerland, Environmental Sciences Group, Wageningen UR
- Berry Spruijt, Delta Phenomics BV
- Arend van de Stadt, Eagle Vision Systems BV
- Paul Timmers, DG Information Society & Media, European Commission
- Peter Tindemans, Global Knowledge Strategies & Partnerships
- Hans van Trijp, Marketing and Consumer Behavior, Wageningen University
- Paul Volleman, City of Wageningen
- Rob van Vollenhoven, Oost NV
- Albert Willemsen, Noldus Information Technology BV

Illustrations

- AMC Amsterdam (page 17)
- Andrea Kölzsch (page 34)
- Artinis Medical Systems BV (page 33, 45)
- Cruden BV (page 12)
- CURE (page 17)
- Eagle Science (page 45)
- Eagle Vision Systems BV (page 30)
- Green Dino BV (page 12, 23)
- IIP Brain & Cognition (page 37)
- Metris BV (page 33)
- MobiHealth BV (page 30, 45)
- Motek Medical BV (page 17)
- National Aerospace Laboratory NLR (page 24)

- Noldus Information Technology BV (page 12, 17, 18, 30, 33, 34, 45, 49)
- Radboud University Nijmegen (page 17)
- Richard Hazlett (page 24)
- SensoMotoric Instruments GmbH (page 8, 27)
- TeleMetronics Biomedical BV (page 24)
- TMS International BV (page 24)
- Tobii Technology AB (page 27)
- Utrecht University (page 27)
- VicarVision (page 27)

i3B Foundation
P.O. Box 268
6700 AG Wageningen
The Netherlands
Phone: +31-317-473300
Fax: +31-317-424496
E-mail: info@i3b.org

www.i3b.org