**ShareBiotech** Report

# Development of a Novel Transnational Model of Technology Core Facilities to Promote Effective Access and a Network of Technology Translators

## Activity 6 Action 5


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# Content

# ACRONYMS

| | |
|---|---|
| AIT | Athlone Institute of Technology |
| CEBR | Council of European BioRegions |
| CFMS | Core Facility Management System |
| CRO | Contract Research Organisation |
| CRM | Customer Relationship Management |
| EI | Enterprise Ireland |
| E&Y | Ernst & Young |
| HE | Higher Education |
| HEI | Higher Education Institution |
| HQ | Head Quarters |
| IP | Intellectual Property |
| LE | Large Enterprise |
| OECD | Organisation for Economic Co-operation and Development |
| OSI | Ordinance Survey Ireland |
| POC | Proof of Concept |
| R&D | Research and Development |
| ROI | Return on Investment |
| SME | Small Medium Enterprise |
| SWOT | Strengths, Weaknesses, Opportunities & Threats |
| TCFs | Technology Core Facilities |
| TT | Technology Transfer |

## 1. Overview of background

The 2012 Ernst &Young Global Biotechnology report provides indicators of the sector recovery, although criteria have also changed since the pre-2008 era, (E&Y 2012). In 2011, biotech companies globally raised US$33.4 billion, second only to 2000, when the genomics expansion was at its peak. The biotech industry's revenue growth rate also returned to double-digit values for the first time since the global financial crisis. R&D grew by 9% in 2011, after being cut in 2009 and grew by a modest 2% in 2010. Revenues of European public biotechnology companies grew 10% to US$18.9 billion and the combined net loss improved significantly from US$568m in 2010 to US$0.3 million in 2011, bringing the industry to the point of aggregate profitability for the first time. Mergers and acquisitions in Europe rose for the second year in a row, with 22 transactions compared to 17 in the two previous years, however this is significantly less than the 37 deals that occurred in the US in 2011. Financing totalled US$2.9 billion in Europe, down from US$3.8 billion in 2010 and consequently still in decline. In aggregate, biotech accounts for approximately 15% of total VC investment across Europe, a slightly higher percentage than in the US in 2011. Three new UK venture funds in 2013 are bringing a total £350 ($543) million to support long-term investments in early stage companies (Nature Biotech 2013).

European companies issued US$393 million in debt in 2012, about two-thirds of which came from Switzerland-based Actelion company.

According to the OECD, the United States still has the largest number of biotechnology companies (6213), followed by Spain (1715) and France (1481). The majority are SMEs and the probability of growth beyond an SME is considerably lower in the EU than the US, although this status is not the same across EU regions. In the US, the highest density of biotechnology companies are in California and in Massachusetts, which supports the belief that firms form clusters and share resources and these locations correlate with the presence of leading universities in molecular biology and related disciplines.

Average, global biotechnology Business Enterprise R&D (BERD) accounted for 6% of total BERD, but Ireland biotech represented 17.9% of BERD – for Ireland this would mostly reflect multinational investment. Conversely Public or State biotechnology R&D is a combination of government and higher education biotechnology R&D with the highest level of public sector expenditures on biotechnology R&D being in Germany, followed by Korea and Spain.

Advanced research is increasingly dependent on the services and specialized core facilities that are too expensive for direct departmental procurement, let alone individual researchers. The accelerated development of new research technologies, their subsequent enhancement, the associated costs and the time involved in generation and acquisition of the necessary skills have all contributed to the driver of establishment of technology core facilities that effectively deliver to a university or specialised research facility. Clustering is therefore considered crucial for biotechnology start-ups which, tend to cluster around research institutions, especially universities and associated Science Parks, (Prevezer & Tang, 2006). Biotechnology research and subsequent exploitive commercialisation has tended to be delivered differently to other main science domains, (Dalpe 2003). The biotechnology sector is consequently characterized by extensive networks of relationships between, public institutions, clinic hospitals, new technology-based firms and large well-established companies such as pharmaceuticals, (Lehrer & Asakawa, 2004). A major factor in developing such networks is technological uncertainty, (Powell *et al.*, 1996). Large firms develop relationships with small innovative firms to diversify and manage their risks. Research partnerships, alliances between private and public institutions, and regional networks incorporating network and knowledge links are essential in the industry, (Rothaermal & Deeds, 2004). Networking that brings the necessary expertise together with a company and participation in a cluster structure are therefore considered crucial for biotech development in all advanced countries, although the nature and structure may differ between them, the principle is common. In part this reflects the very lengthy ROI time relative to other technology disciplines. A dependency on interaction with HE implies that biotechnology commercialisation is dependent in part on significant state investment in research and that the often interdisciplinary complexity cannot always be addressed by an SME. One must recall that the advent of recombinant DNA technology in the 1970s effectively launched biotechnology and reflected significant engagement between HE and industry, which is still a characteristic of the sector, (Dalpé 2003).

European innovation networks consist of specialized relationships between organisations in national clusters (Kogut, 2000). Funding sources have tended to be national, so transnational interactions and broader EU research explorations have proved more difficult, (Enzing & Reiss, 2008). However, apparently, Spanish biotechnology companies have shown a greater propensity for external technology sourcing, both with regard to R&D services and cooperation for innovation, (Holl & Rama 2013).

Sequencing and associated bioinformatics is one of the core facility domains, which does demonstrate active network and collaboration models. The European Sequencing & Genotyping Infrastructure (ESGI) consists of comparable and complementary facilities in France, Germany, Spain, Sweden and the UK (www.esgi-infrastructure.eu). The ESGI is effectively a collaborative structure of prior national facilities, which supports transnational projects and service delivery. As individual facilities with a history, such as Welcome Trust Sanger Institute, they have significant autonomy, but as part of the ESGI, they engage in transnational collaboration and projects, shared expertise and facilities with the ESGI entity as the interface and organiser. ESGI with a large capacity meets the demands of the European research community in sequencing and genotyping and studies can be performed at one or more facilities as required.

In the UK, the majority of life science companies lie within the 'golden triangle' clusters of Cambridge-London-Oxford, (Mueller et al 2012). This will be further enhanced, when Astra Zeneca relocate their research facility to Cambridge in the near future. Overall, the biotech sector has declined in the UK over the past decade due to company take over and failure, but as an EU region it still is the most substantive in terms of VC driven company initiation and development. However, in parallel to the 'golden triangle, over the past decade, a number of biotechnology incubators were created in other regions, which have shown that provision of necessary services and funding are the main initiators of new biotech companies in smaller clusters, (Smith & Ehret 2013).

### 1.1 Some novel approaches to supporting collaboration

Puretech Ventures (www.puretechventures.com) is a US company that initiates and organises new start-up technology companies. In so doing it is inevitably bringing the right people together to deliver and some of its start-ups are themselves focused on aspects of this role. Increasingly these approaches employ web technologies. It has worked with Enlight Biosciences to develop new companies (www.enlightbio.com). There is growing evidence that it is not access to knowledge networks *per se* which affects innovation, particularly in biotechnology, but rather who the network partners are, and especially whether partners bring complementary or related knowledge into the network, (Boschma & Frenken 2010). Two such interesting new US organisations, that aim for this are:

Knode (http://knodeinc.com/) is a business that helps to locate the most appropriate external experts and aims to provide collaboration-minded drugmakers and others with web-based software that connects them to experts both inside and outside of their organisations. The technology aggregates data from millions of scientific journals, patents, clinical trials, grants and other items. With sophisticated semantic mining, big data tools and algorithms, the system is designed to identify the best experts in biomedicine.

Appeering ( http://www.appeering.com/) employs social web sites to analyse conversations and identify key experts.

The internet can of course also be used to attract and raise funding for innovative but risk companies that might not do so by more traditional VC. This has already worked for innovative firms in France where the tax-free scheme Fonds Commun de Placement dans l'Innovation raised over €6 billion from hundreds of thousands of people investing €20,000 or less. Nature Biotech (Editorial 2012) reports that the UK Bioindustry Association wants to establish a similar scheme in Britain.

R&D is innately globalizing and the research world interfacing more extensively, but it is accepted that in the US investors, management and research talent can more quickly and effectively interact.

## 1.2 Diverse Expert Analysis

As part of the overall project and in particular, the Transnational TCF Model, Vincent Walsh conducted a series of extensive interviews with specialist experts that have been involved in biotech sector partnering, collaboration and networking. The associated report and analysis will be published as a stand-alone document, but with specific relevance to transnational models, some key opinions and findings are included in this section, (Walsh 2013).

*Expert List & Specialisation*

All selected experts in addition to their current role have a long history of participating in innovative biotechnology development – full profiles will be included in the interview report. A selected number of key points and an interpretation, analysis and connection with ShareBiotech Atlantic Region is given below.

Prof Horst Domdey (MD of BioM Biotech Cluster Development GmbH), Dr. Martino Picardo (Dir Stevenage Bioscience Catalyst), Mary Skelly (MD Microbide Ltd), Dr. Mario Thomas (Dir Ontario Centre of Excellence), Dr. Terry Jones (Dir One Nucleus), Derek Jones (Dir Babraham Bioscience Technologies Ltd), Dr. Claire Skentelberry (Head of CEBR)

### 1.3 Some Key Points

All parties obviously support and recognise the crucial importance of access to TCFs as part of biotech development. However the view in Germany is that HEIs offering lab services and access to TCFs based on State funding represents unfair competition for CROs and therefore is only permitted, when the HEI possesses unique technology that is not accessible in the private sector. It is true that despite the quality of TCFs and the knowledge of academics, given a choice, many companies would prefer to engage with a viable CRO or R&D department of another large company, but for an SME, such costs are too high. In recognition of innovative research deficits, large pharma companies in all countries are now more willing to collaborate with HEIs, although inevitably this only tends to relate to the small number of world leading HEIs. Science Parks/Clusters provide the TCF support for SMEs and these again work, where the right groups come together.

An eventual reduction in State funding for biotech research in universities encourages HE scientists to collaborate with industry generating start-ups – this is true in Germany and all Atlantic Region partners and in the current economic environment, is happening.

Funding is obviously a major driver of biotech companies and was included in a refined format within A6A5 criteria and as a good example, BioM set up its own investment agency to fund start-ups. Mainstream investment in biotech SMEs in Germany has since declined and VCs are addressing other sectors, so the BioM model contributed significantly to the growth and sustainability of the cluster.

The Association of German BioRegions ensured that clusters did not compete with each other, but rather cooperated and exchanged ideas. Within a country or region, it is an accepted model that clusters should not compete for company attraction, but rather complement and collaborate. This again supports the notion of interaction between complementary TCFs to provide resources and competence not available individually.

Germany has had companies relocate HQ to other countries due to tax differences and this factor should be appreciated in the context of enhanced biotech collaborations across the Atlantic Region.

A successful cluster requires a mixture of high risk and low risk projects ranging from direct tech transfer to open innovation models. It is the case, that for many HEI engagements with the biotech sector, this diversity of funding interaction, does not occur. Open innovation implies very extensive dissemination of information and easy communication, to which advanced conference communication technologies can contribute.

All parties believe a sense of community is vital for cluster development and web services are an important technology that can support and enhance this working environment.

German TCFs retain high technician numbers and this is a metric that inevitably varies across the Atlantic Region partners. Where a TCF has good human resourcing with advanced capability, it is more likely to cope with company approaches seeking work and meeting preferred timelines. HE TCFs in much of the Atlantic Region, do not possess such effective staff numbers and inevitably with current public sector funding cutbacks, this issue becomes worse.

A key driver of a transnational TCF facility should be the provision of facilities and research competence that does not currently exist, but is predicted to be needed based on survey analysis. For example in Munich Eckhard Wolf set up a specialist TCF (porcine) for the pharma sector following discussion with them. New TCFs could therefore impact on biotech and which are not being effectively addressed now

In Germany, logistics are important for cluster development with evidence that SMEs won't access facilities far away, eg a Science Park is very effective. This is negative for transnational TCFs, unless such a model can diminish the logistics issue. However, BioM is very positive about attracting the best researchers/experts from abroad and this relates to effective networking.

Germany has tended to adopt long term business models, compared to the more traditional finance driven models in the UK and US. Benefits of stable government policy and long term rather than short term financial status have a particularly advantage for the biotech sector, which normally does take a long time to generate a ROI. This is a model that should be incorporated in the Atlantic Region.

In the UK, the main components of cluster development are considered to be:

1. The right people
2. Investment

3. IP
4. Ideas – pre IP and exploitation of IP
5. Avoiding unnecessary competition between facilities

Potential complementary companies don't usually collaborate, but maintain competition. To get good knowledge transfer as open innovation, one needs a good cluster led by the right people who can ensure effective communication and engagement with follow-up delivery.

A cultural difference between HE and industry is an accepted problem:

- Knowledge exchange is suited to academic environment and blue skies research for publication purposes
- Academic research is far removed from the commercial and business world
- Academia should interact more with people in industry and there should be an industry presence on university campuses

An industry perspective is that HE Tech Transfer offices usually have the wrong staff and HE metrics such as number of spin-outs doesn't necessarily reflect long term development. This is in keeping with much feedback in the ShareBiotech project that suggests that for an HEI to effectively interact with industry, it needs to set-up a different entity that is effectively a part-company itself to ensure that traditional academic and university governance drivers and culture are not in place.

Again, the UK supports that new TCF model should offer something not currently available, ie novel and it ideally will be integrated with other related resources and research policy:

> Companies and Cluster/Science Parks can provide good and very modern technologies, eg BioCity, Stevenage, GSK
>
> Companies cannot rely on university access to address problems

As a consequence, the ShareBiotech surveys of SMEs and TCFs should ideally have been more focused on asking what they really wanted & needed to confirm this differential and indicate what needs to be done to address it. It is not unusual to recognise deficits at the end of a project, which are consequently addressed in a follow-on study. Dr. Picardo raised the following points:

- The US puts a lot of sustainable state funding into start-ups – far more than EU and the support services try and ensure success
- Biotech entrepreneurs tend to run organisations in the US, ie have the right history and experience

- Lots of different Tech Transfer experience is required. Control by a single organisation like EI (Ireland) does not work
- A TCF should be Tax free
- Cluster/Science Park/TCF should be driven by the people directly involved, not managers or politicians

These points extend beyond the UK and are relevant to how shared resources can be best funded, managed and accessed and rationale for collaborative TCFs including transnational.

The implication is that transnational network of current TCFs organised as a single entity model, should be focused on the development of new TCF facilities required in specific regions that would complement each other and access shared money in different countries. Communication technology becomes a crucial part of the access process and effective but novel models need to be reviewed.

Funding in addition to actual investment in biotech companies and update of TCFs, becomes an issue for SMEs regarding their capacity to cover operational costs, including access to TCFs. The Netherlands introduced a low value Innovation Voucher programme some years ago to facilitate SME start-up, development, collaboration and outcome delivery. The model has since progressed to Ireland, parts of the UK and Germany. In practice, many of AIT pre-cited TCF access projects (Tech Translation) were funded by such Innovation Vouchers. A version of this practice is now being evaluated in the French Atlantic Region. While this does facilitate SME access to TCFs, it must be accepted that it supports SME-HE interaction, when many SMEs might have a preference for other company linkages, where there is no competitive conflict.

The EU would support clusters becoming transnational and international where benefits accrue, but while the favoured view is that viable clusters have to embrace close logistics, there is evidence particularly in biotech, for acquisition of network benefits that are across countries, and these benefits include fundamental R&D (Hendry & Brown 2006). This latter understanding is largely in keeping with ShareBiotech findings, although some key experts were more focused on regional cluster issues and is not in conflict with a tendency for physical location to be always regional – an extreme example being the relocation of Astra Zeneca R&D to Cambridge. What these findings confirm is the importance of the nature, relevance for innovation and complementarity for a network to be functional and beneficial. A critical element of this, is again the effectiveness of communication.

In the ShareBiotech project, the concept of a transnational model relates to two distinct deliveries and outcomes, i. transnational Technology Translator network, and ii. transnational collaboration of complementary core facilities presenting as a single entity. The former arose as a product of regular Tech Translator representative communication and engagement, a review of special web sites set up to provide and transfer Tech Translator knowledge (Tools of Science[1], BiotechKnows[2]) and recognition of the benefits of tech translation delivered by a complementary group rather than an individual. The latter was a consequence of analysis of TCFs across the Atlantic Region and a need to facilitate greater access to novel resources. The EU under Horizon 2020 will continue to fund the set-up of new substantive TCF resources, but these are effectively of global status. It is now recognised that regions, particularly from an SME perspective need greater access to TCFs and associated research competence.

The drivers for a potential transnational TCF model were identified as a product of ShareBiotech research in the initial phase of A6, and these were drivers of A6A5, though not of equal delivery, (Tomkins 2011).

[1] http://www.toolsofscience/converis/publicweb/area/3783
[2] http://www.thebiotechknows.com

## 2. Enabling a Virtual ShareBiotech Transnational/Technology Translator Network

One the objectives of the the ShareBiotech Project (an INTERREG IVB Atlantic European Project) is to transfer knowledge between companies and research centres. Other aims of the ShareBiotech project include; enhancing collaboration, provision of learning support and facilitating access to technology core facilities (TCFs) in the Atlantic region. The partners in the project originate from Ireland, France, Spain and Portugal. Collaborations and networks are sometimes referred to as 'models' and their continuous development are essential to remain competitive in science. These models may differ in the technology they use but the key to their success is how they apply it to engage and motivate participants.

An interpreted objective of the ShareBiotech project is that a transnational model should embrace, i. and ii.

i. Transnational Technology Translator network wherein the role of a technology translator is to translate industrial problems and requirements into key scientific concepts and to source appropriate academic expertise from the HEI knowledge base
ii. Transnational TCF organisation, which provides advanced and beneficial resources beyond national structures. Organised to present as a single entity or structured facility network with enhanced TCF access and associated knowledge support.

The criteria that such a model should meet were defined at the outset:

Firstly, to analyse and review all relevant current projects and models (EU, US & beyond) and to identify which elements of the models would be transferrable with merits to a new ShareBiotech model.

Secondly, to review and analyse selected TCF management software to determine whether this could represent a medium for managing facilities and provide a common web access forum across different partner region facilities that will be part of the proposed collaboration.

Thirdly, to review communication technology, which will promote interaction between the researcher, partner, industry/SME and the transnational core facility and separately the Technology Transfer Network.

Fourthly, to review and analyse all identifiable current and future applications. An outcome should embrace real time/world and virtual technologies that support simple and direct people interaction, TCF depiction and potential instrument access. Finally provision of funding programmes could permit project development and facilitate access to TCFs.

Consequently, to determine how one can create an efficient ShareBiotech Transnational Network we need to identify what technology tools and approaches are currently used in EU, USA and Australian models. For ultimate success we need to:

- Review current relevant transnational models embracing public-public and public-private sector R&D facilities – identify transferrable concepts & evidence supportive of the proposed model

- Define a basis for effective organisation interaction and resource complementary – agreed adoption of common management, cost basis, quality standards

- Develop a web-based platform for accessing and managing resources in the Atlantic area

- Use communication technology to engage and motivate participants

- Establish a sustainable funding model

- Provide a single entity/network to encourage collaboration and eliminate culture and distance barriers

- Secure selected expert opinions on TCF impact on biotech sector and merits of significant novel transnational collaboration models

The analysis of existing transnational models was performed using Rosenberg's 4C's; culture, champions, communication and change and these are discussed in the following sections.[1]

The research for this report included;

- A literature review of existing transnational models
- A preliminary evaluation of suppliers of core facility management systems (CFMS) which will deliver a web-based platform for accessing and managing resources in the Atlantic area
- A review of advanced communication technology to share knowledge and collaborate
- Attending the latest technology conference meetings; 14th International Conference and Exhibition on Virtual Reality and Converging Technologies (Laval, France, 2012) and the HEAnet National Conference 2012 (Athlone, Ireland).

Virtual world models are currently used in many sectors to share knowledge. In this research a proof of concept model was developed to demonstrate how a Unity ShareBiotech Virtual Model could promote easy access to TCFs and offer training and support. Virtual Worlds can facilitate:

- Participation of many users (avatars) in a process at the same time
- Interactions which can take place in real time
- Development, modification and submission of customized content
- On-going communication and sharing of knowledge on a log-in/log-out basis
- The creation of in-world social groups

Virtual World Security is an important factor and procedures can be set in place to protect user identities and confidential TCF documents.

### 2.1 Culture Differences in the Atlantic Area

When enabling a model to meet the objectives of the ShareBiotech project the culture and organisation implications of the intended audience need to be considered. The language of the targeted audience in the Atlantic area includes French, English, Portuguese and Spanish. The cultural differences are important and need to be addressed when implementing a model to network and share knowledge efficiently. Organisational differences within customer sectors (Government, Industry\SME and Academia) and biotechnology sectors (agricultural/food processing, cosmetics, environment, human health, marine biology and nutrition) are recognised and some are more open to implement changes in their current practice.

### 2.2 Champions of Collaboration in Transnational Models

Champions or 'key players' in collaboration and networking were identified to determine the technology and software they use to facilitate access to a service/facility. A key factor in selecting 'champions' was the ability and success of the model to attract small medium sized enterprises (SMEs) to use their services. Four champions were identified among over 30 models reviewed (See Appendix III) based on their transparency and effective marketing of their services and ease of access by SMEs.

- The Victorian Platform Technologies Network - A Gateway to the largest biotechnology sector in Australia providing good communication, promotion of core facilities and will in the near future implement core facility management software http://www.platformtechnologies.org/
- EUMINAfab - Easy access for SMEs and use of SharePoint software to manage projects on-line http://www.euminafab.eu/
- Living Lab Model - effective communication and engagement of communities http://www.openlivinglabs.eu/
- VisionAir - Infrastructure for Advanced 3D Visualisation-based Research http://www.infra-visionair.eu/

The Victorian Platform Technologies Network (VPTN) is a collaborative network of biomedical research facilities that provide state-of-the-art infrastructure and expertise to the biomedical, health and biotechnology research sector. It aims to maximise use of existing resources, minimise unnecessary duplication of services and coordinate planning for future requirements. There are 92 facilities in the VPTN, 59 of which are housed within the Bio21 Cluster node with 56 of those within Bio21 Cluster member organisations.

VPTN is a coalition of approximately 80 labs (research centers) in multiple universities throughout Australia.
The primary purpose of VPTN is to facilitate resource and information sharing between the laboratories and to increase usage of their services and equipment – thereby increasing revenue for the universities. Although individual labs – particularly those with high utilization and high revenues – certainly have the ability to purchase laboratory management solutions independently, VPTN's goal is to have a single solution which will be shared across all 50 laboratories. Having a single solution will further their goals; having multiple solutions will result in chaos. VPTN has received funding from the Australian government to pay for a single solution for all of its members. To summarise the objectives of the VPTN are to;

- Establish a network and build a community of platform technologies facilities across Victoria
- Establish an online database of publicly accessible technologies/ capabilities in biomedical research organisations across Victoria
- Promote Victorian capabilities to the research community (academic and commercial)
- Provide professional development opportunities for facility managers

The second 'champion' model was EUMINAfab

- EUMINAfab was established in 2009
- FP7 funding awarded to bring together the human resources, the infrastructure, the capabilities, the expertise and the knowledge of 12 partners in the area of micro and nanofabrication of functional structures and devices out of a knowledge-based multi-materials' repertoire.
- Access is free for users from EU member states and associated states
- 60 users
- Successful case studies for access by SMEs;
    - Crospon Ltd, Galway, Ireland – An SME (specialising in drug delivery systems) which does not have the benefits of 'neighbourhood' access to core facilities or clusters but requires the need for access to transnational TCFs.
- Use of SharePoint software to manage projects

The third 'champion' model is The European Network of Living Labs (LL). A Living Lab is a user-centred open innovation ecosystem integrating research and innovation processes within a Public-Private-People-Partnership (4P). Living Labs exists for engaging users in R&D and is a champion in public engagement and networking and collaboration. The LL process could be used to improve access to TCFs by designing a SHAREBIOTECH TCF access model following the LL Experiential Design process (Co-creation, Exploration, Experimentation, Evaluation). The development of a SHAREBIOTECH-LL Innovation Network can be realised by:

- Incorporating TCFs into Living Labs
    - Thereby constituting a research & innovation ecosystem with a specific focus on biotechnology application and services
- Inclusion of the necessary stakeholders of specific Research and Innovation projects
    - A multi-disciplinary research team consisting of experts from the different sectors in the biotechnology field
    - A local industrial cluster; Local Enterprises (LEs) & SMEs, public players and communities of users

Living Labs is moving forward with utilisation of advanced communication technology (ICT). This development includes;

- The potential contribution of new ICT technologies for supporting the Living Lab approach – Future Internet, IoT, Web3D
- Adapting CONEX (People-Concepts Networking) software to identify and create connections among diverse people based on the concepts they use in their communication

Future research following the completion of the ShareBiotech project may involve using a modified CONEX platform to engage researchers, TCFs, SMEs, Local Enterprises and Manufacturing Enterprises who are looking for potential connections according to their projects needs. This could ultimately fulfil the role of a technology translator network which was mentioned in Section 1.1. The idea of using CONEX for an experimentation of a more systematic (autonomous) Technology Transfer (TT) for industrial clusters together with research labs may also systematise innovation.

LL sustainability is based on a public-private funding (50:50). Some projects are funded by the Community Initiatives Program (CIP) or region of knowledge programs. On occasions venture capital funds the LL Experiential which would provide learning support to researchers. Other champions include; VastPark Platform (http://www.vastpark.com) and OLIVE Design.

A review of three Virtual Worlds; Multiverse (3D), OpenSim (3D), and Metaplace (2.5D) was carried out by Lapin (2009). It was concluded that Second Life, Active Worlds, The Crocket Project, Open Simulator and Open Source Metaverse Project did not offer the following requirements for an effective Virtual World:

- a freely available platform
- flexible terms of usage and the facility for the user to create the content
- standard hardware and Internet access requirements

- a standalone system which did not require third-party software such as graphics engines
- a virtual world which could be controlled by the developer

The Lapin researchers attempted to develop their own custom-made platform to address the above needs and they continue to be involved in an on-going project requiring extensive financial support. Alternatively the platform Unity can be used to create a custom-made virtual world for the ShareBiotech model which will meet all the requirements listed above which were not met by other Virtual Worlds available on the market. Using commercially available Unity software 3D building block models are created. RealSim Ltd, Galway, Ireland is a company which develops real-time 3D simulation using Unity software. Appendix 1 and 2 explains how the software was used to create a virtual world and replicate a TCF facility by building levels of detail. The internal details such as laboratory design and equipment can also be created as a 3D model or as a simple 360 degree panoramic view.

Virtual Worlds are currently used in industry and academia to encourage collaboration and learning, such as in the Air Force and Medical Sector. Second Life is used in some university courses, for example, for religious education in the MaterDae Institute in Dublin however the graphics are poor compared to those created using Unity. Schools use Virtual Worlds to teach maths and statistics and they have shown to be effective in enhancing learning and collaboration. In Ireland, Mission V is a non-profit organisation which is introducing learning in schools and universities through Virtual Worlds using the platform Open Simulator. Quizzes normally presented with Articulate software and hosted on Virtual Learning Environments (VLEs) such as Moodle and Blackboard are replaced by 'bill boards' in a Virtual World created through Open Simulator in which the student as an avatar can navigate and point at the correct answers. By using a Virtual World and avatars the student has an immersive experience which can reinforce learning. This learning can be expanded to include providing an immersive experience when participating in a virtual tour of a TCF in which users can engage with research staff in avatar mode.

Collaboration and learning through models can also require and involve document sharing, video conferencing, web conferencing and lecture capture. Document sharing can be achieved with different software packages such as SharePoint which in turn can be hosted in the cloud on Office 365. There are a number of video conferencing vendors including CISCO and Vidyo and they offer telepresence which creates a feeling of being in the physical presence of a person who is located in a different room or country. Telepresence does not provide the same immersive experience as Virtual Worlds. Holography is also available which has been used to teach various martial arts classes such Tai Chi but this requires advanced equipment and communication technology.

To support communication technology in any model (especially Virtual Worlds) reliable and efficient network service providers are required to provide the appropriate band width. In Ireland, HEANet is supported by e|Net who provide the Metropolitan Area Networks (MANs). HEANet plan to provide virtual machines in 2013 to facilitate the operation of Virtual Worlds and the safe storage of documents. Using this advanced technology individual TCFs will not be required to maintain their own servers to maintain connectivity to the ShareBiotech model. GEANT is also facilitating the creation of virtual private networks by providing European network support which will encourage collaboration and networking via web-based platforms. The future looks good for utilising Virtual Worlds as a means of sharing knowledge and communication since the underlying network support is improving considerably.

A list of current relevant transnational models subject to analysis in this work are in Appendix III.

### 2.3 Communication Technology in Collaboration and Networks

The analysis of transnational models revealed that customer communication for recruiting and meeting customer needs continues to be one of the biggest challenges. Currently communication can be achieved through;

- Face-to-face meetings
- Teleconferencing
- Video teleconferencing (Skype, Vidyo, EVO, CISCO)
- Social media tools; Facebook, Linked-In and Twitter
- Crowd sourcing platforms
- Emerging Technologies; Scientific Visualisation, Ultra-High Definition, Virtual reality, Collaborative Environments (all technology accessed via VisionAir)

Face-to-face meetings are always important to develop a working relationship, however they are not always necessary on a regular basis. Follow-on communication through teleconferencing can maintain and develop the relationship. Video teleconferencing if available is more effective following an initial face-to-face meeting. There are a number of vendors of software for this type of communication and the costs are varied. CISCO provide the most advanced video teleconferencing software in terms of service cover and equipment. The company offers the facility to build a custom-specific conference room which is designed to provide a sense of co-existence with the persons in the meeting despite the fact that they may be located in different countries or states.

Emerging technologies include Virtual Worlds and these were discussed in the previous section and are identified as a communication tool to enhance collaboration and networking.

The concept of developing a ShareBiotech Virtual World through Unity was presented and communicated in NUIG, Galway on September 25th to the ShareBiotech partners. The proof of concept model was developed in conjunction with RealSim (Galway, Ireland). During the meeting it was suggested that it may be difficult to implement shared software resources such as core facility management software due to different site preferences and government restrictions. A comparison of the different suppliers and their software will be presented later in this report. The demonstration of a Unity ShareBiotech Model was presented in Nantes in October 2012 to a broader audience to include core facility managers.

Table 1 summarises some of the organisations with which transnational models or proposed aspects of such a model were interviewed or discussed.  A separate list of experts were involved in a broader biotech TCF analysis.

**Table 1**. Organisation/Expert engagement as part of model development (in complete)

| **Organisation/Company/Expert** | **No. of Meetings** | **No. of phone engagements** | **No. of other communications** | **Objective of project covered** |
|---|---|---|---|---|
| Cisco Ltd | 1 | 3 | | Communication |
| Vidyo | | 3 | | Communication |
| EVO | | | 2 | Communication |
| iLab Solutions | 1 | 2 | | TCF Management |
| Stratocore | | 5 | 2 | TCF Management |
| Perceptive Software | 1 | 2 | 2 | TCF Management |
| Book-IT Lab | 1 | 3 | 2 | TCF Management |
| Crospon Ltd | 1 | 1 | | Business transnational project models |

### 2.4 Introducing Change in How Knowledge is Shared and How TCFs are Accessed

To consider implementing changes in how knowledge is shared and how TCFs are currently accessed Dewey's theory (Dewey 1933) was applied.  Dewey's theory referred to a reflective cycle of thought which he defined as a creative process that evolved over time.  Through researching existing transnational models communication technology and core facility management software were identified as core elements to deliver a successful service.

Research involved a reflection of the current practice, for example, can social networking, eLearning and emerging technologies enhance collaboration and networking.  The methods currently adapted by existing transnational models to facilitate access to TCFs is discussed in the following sections.

### 2.5 Review of Solution Providers

A review of the current approaches used to share knowledge, provide education and training and facilitate access to TCFs was performed.  Websites such as ShareBiotech, BioNose, Attlas and Tools of Science among others received very few 'hits' by potential users of TCFs. Individual TCFs promote their own services through their own website, however, it was difficult for some customers to locate these resources using search engines such as Google. Some websites are not updated regularly and it is difficult to identify the appropriate expert to address the customer needs.  The Monash e-Research Centre (MeRC) uses the latest information and communication technologies (ICT) to encourage collaborative research. They offer advice and e-research solutions to include;

- High performance computing
- Modelling and simulation facilities
- Storage and management of research data
- Advanced collaboration platforms
- Visualisation platforms
- Specialised server hosting

Monash University (Australia) avails of the Monash e-Research Centre (MeRC) to promote a range of core facilities through their website and provide detailed descriptions of services and contact details of experts. Monash University performed a procurement process on the behalf of VPTN (Section 2.2) and in September 2012 they submitted a tender response for core facility management software to facilitate access to resources across the Victoria State. They reviewed a number of software suppliers including Lexmark (Perceptive Software) among others as listed in Table 2. Perceptive Software became aware of the VPTN project late in the game, approximately 1 year ago. Their primary competitor, iLab, was in the lead and looked likely to win. VPTN agreed to view a demo of their CFMS solution, and then invited them on-site to display it to the individual labs. They were then invited, and successfully conducted, a lengthy evaluation of core facility management systems (CFMS) in three of VPTN's key laboratories. After the POC, all lab managers who had tested this supplier reported that they wanted to use them as their solution. Final contract negotiations completed on March 28th 2013.

The process used to evaluate potential vendors in the ShareBiotech project is shown in Figure 1.

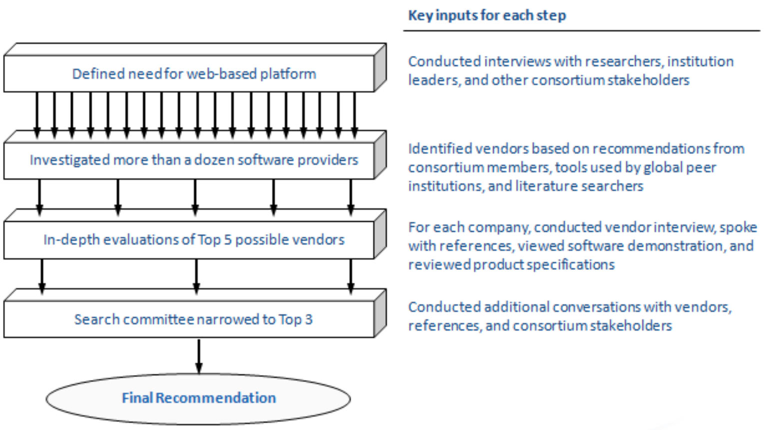


**Figure 1.** Process to Identify and Evaluate Potential Vendors of Core Facility Management Software

A comparison of some of the features of core facility management software from six different vendors is shown in Table 2.

| Area | iLab Solutions | IdeaElan | StratoCore (PPMS) | Coral/ Badger | Lexmark (Perceptive) | BookIt |
|---|---|---|---|---|---|---|
| Company focus | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ |
| Company stability | ✓ | ✗ | ½ | ✗ | ✓ | ½ |
| Expertise | ✓ | ✗ | ½ | ✗ | ✗ | ✗ |
| Hosting model | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ |
| Implementation & Support | ✓ | ½ | ½ | ✗ | ½ | ½ |
| **About the Product** | | | | | | |
| **Area** | **iLab Solutions** | **IdeaElan** | **StratoCore (PPMS)** | **Coral/ Badger** | **Lexmark (Perceptive)** | **BookIt** |
| Equipment Management | ✓ | ✓ | ✓ | ½ | ✓ | ✓ |
| Sample and Project Requests | ✓ | ½ | ½ | ✗ | ✗ | ½ |
| Inventory | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ |
| Billing/Invoicing | ✓ | ✓ | ✓ | ½ | ✓ | ½ |
| Communication & Collaboration | ✓ | ½ | ½ | ✗ | ½ | ½ |
| Reporting | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Accessibility | ✓ | ✓ | ½ | ½ | ½ | ½ |
| Integration | ✓ | ½ | ½ | ✗ | ½ | ✓ |

**Table 2.** A Comparison of Vendors of Core Facility Management Systems.

iLab Solutions, Lexmark (Perceptive Software) and StratoCore were identified as the top three vendors of CFM software by VPTN (see Section 1.3) whom carried out a due delingence test on commercially available systems. StratoCore is the smallest of the two vendors and may not be in a position to offer all the desired characteristics and key features as marketed by iLab (Table 3) to provide a web-based platform to share resources.

| **About the Company** | |
|---|---|
| **Area** | **Desired Characteristics** |
| Company focus | • Exclusive focus on academic research |
| Company stability | • 5+ year company history |
| Expertise | • Live usage by 200+ research shared resources across 50+ institutions |
| Hosting model | • "Software-as-a-Service" model to ensure service and scalability across many institutions |
| Implementation & Support | • Unlimited support for all system end users, including facility customers<br>• One-on-one support for each shared resource, from dedicated implementation team |
| **About the Product** | |
| **Area** | **Desired Features** |
| Equipment Management | • Highly configurable options that can vary by equipment<br>• Ability to track "actual" vs. "scheduled" usage |
| Sample and Project Requests | • Ability to order services from list<br>• Ability to manage long-term, high-cost, non-standardized projects |
| Inventory | • Ability to track inventory location, status, and metadata<br>• Link to bar-coding |
| Billing/Invoicing | • Experience integrating with university financial systems<br>• Ability to set multiple price levels by customer type |
| Communication & Collaboration | • Facilities across multiple campuses are accessible to a defined set of customers<br>• Multiple facilities can work together to complete a single project; the customer and all cores share a single view of the project |
| Reporting | • Dynamic reporting by date range, customer type, service type, and other factors |
| Accessibility/Search | • Web-based accessibility across multiple browsers; optional IP-based restrictions<br>• Ability to browse and searches services and facilities across multiple institutions |
| Integration | • Experience integrating with financial and identity management systems |

**Table 3.** Key features of iLab Solutions, a supplier of core facility management software

iLab was founded by researchers at the Dana-Farber Cancer Institute, an affiliate of Harvard Medical School in 2006. iLab works with over 50 research institutions across North America and Europe, including Johns Hopkins University, Stanford University, MIT, Champalimaud Foundation (LiShareBiotechon, Portugal), and the National Institutes of Health. The company offers a robust suite of shared resource management tools, including multi-institutional searching, cross-facility collaboration, configurability to different kinds of cores, and extensive reporting options. iLab follows a "software-as-a-service" model, including extensive implementation and user support services.

Figures 2-4 describes three case studies were iLab software has been successfully implemented.

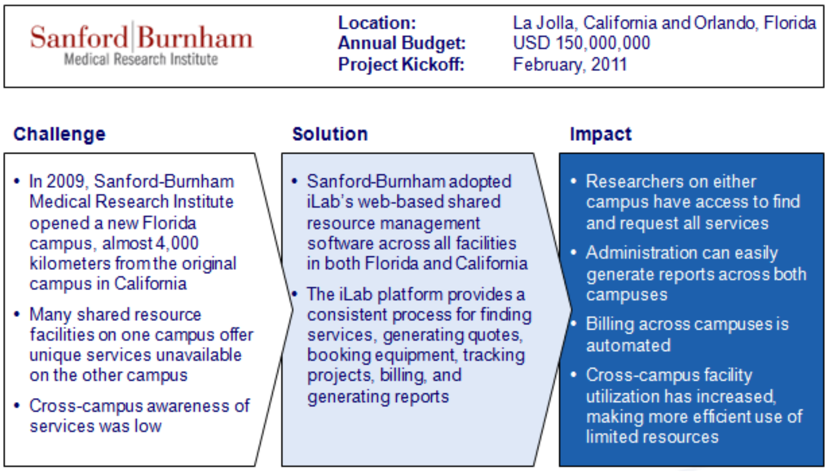


**Figure 2.** Case Study 1: Streamline collaboration between California and Florida campuses of Sanford-Burnham Medical Research Institute

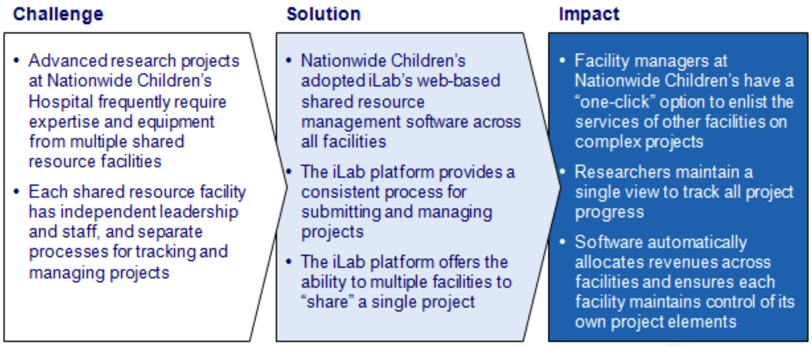


**Figure 3**. Case Study 2: Enabling complimentary facilities at Nationwide Children's Hospital to efficiently manage shared projects

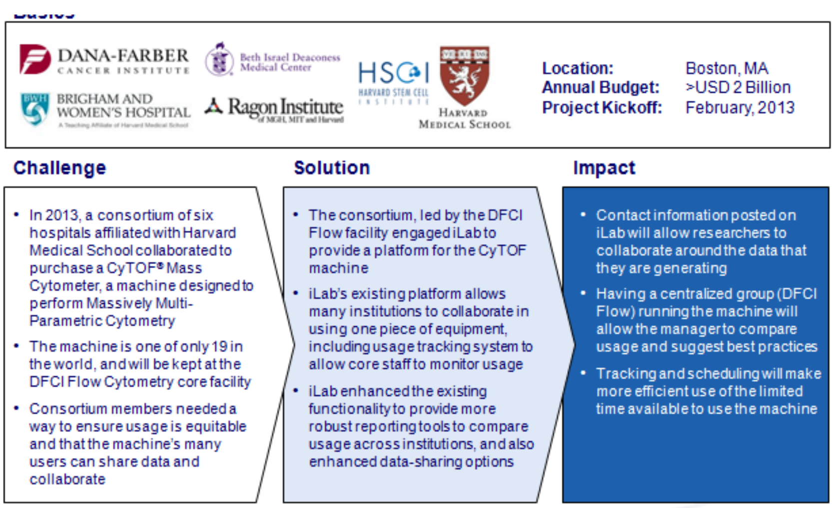


**Figure 4.** Case Study 3: Track usage and increase collaboration across Harvard hospital consortium sharing CyTOF machine

The other choice of vendor of CFM software is Lexmark (Perceptive Software). Perceptive Software was founded in 1995 in Kansas City and provides process and content management software and solutions. It is one of the 10 largest providers in the world and has sold $100M in software licenses over the past 3.5 years. It was acquired by Lexmark International in June 2010. In the last year Pallas Athena (BPM), Brainware (Intelligent Capture), ISYS (Enterprise Search) & Nolij (Web & Mobile Solutions) have been added to the Perceptive family.

Perceptive Software's Core Facilities Management System is a generic solution for research institutes. It can be supplied 'off-the-shelf' in a standard package which can be easily installed and deployed or alternatively it can be tailored to the specific characteristics of individual cores, researchers, students, devices, products and processes. Such customisation can be done by authorised users without the help of IT or Perceptive Software. This makes CFMS unique in its kind. CFMS is a fully web-based solution that is built on top of a Business Process Management Suite which provides advanced tools for process design, execution, monitoring, work distribution and integration capabilities. It is used by a variety of organisations, including banks, federal organisations, insurance companies and universities. CFMS is based on a solution that was developed by Einstein University in New York. Currently more than 1,000 staffers, researchers and students use this solution in their day to day work. CFMS has in the meantime been introduced at Florey, taking no more than two weeks to be fully operational, from installation and configuration to deployment and end-user training. Although CFMS is a relative new solution, it has proven itself in practice as the underlying BPM platform has existed for over a decade.

Part of the CFMS philosophy is the continuous monitoring of processes, financials and devices. CFMS visual analytics dashboard allows Core Directors to continuously monitor measure and maintain process efficiency, device utilisation, financial KPI's and other required features. BPM can be integrated with hundreds of standard or bespoke systems, based on many years of experience in a wide variety of environments.

Lexmark and Perceptive Software claim to be committed to the CFMS solution. Lexmark is a four billion dollar company with an excellent financial position, and both Perceptive Software and Lexmark have a long history in providing Higher Education Solutions. They have delivered proven solution in higher education in more than 700 higher education institutions and over 1,100 campuses worldwide. Their solutions are deployed at more than thirty percent of the US News and World Report's America's Best Colleges list, including five of the top ten. Currently they are building up resources globally to support CFMS and have invested heavily in creating, marketing and supporting this unique solution.

### 2.5.1 Reflection of Current Practice in Transnational Models

To solve the problems identified on reflection of current practice the need to introduce engagement and interaction into a future ShareBiotech model was realised and it was acknowledged that the type of technology used was not the most important thing. This complied with Marc Prensky's views on the importance of pedagogy (Prensky 2010). It is how we use the technology to engage and motivate participants which is the key to success and not the technology itself. The technology available to engage and motivate researchers includes; Screencast, Camtasia, Echo360, Adobe Presenter, Course Lab, Articulate, Wikis, Blogs & RSS, Podcasts, Social Networks (FaceBook, LinkedIn, Twitter) and Wimba. However, these technologies are not immersive and do not create a sense of 'in-line activity' but one of simple on-line communication. Virtual Worlds such as Second Life offer such an experience and they have shown success in education, government and the private sector. However, as discussed in the previous sections some Virtual Worlds have limitations, however, those created using Unity appear to address those limitations.

The majority of transnational models do not facilitate access by SMEs since they stipulate publication of research results which is not in the interest of commercial customers. A few champion models were identified which attempted to accommodate SMEs and these were mentioned in Section 1.3.

### 2.5.2 Examination of the Concept of Using a Unity ShareBiotech Model Based on Previous Knowledge

Literature was reviewed to determine the most appropriate technology to use in a future ShareBiotech model platform. A range of technology is currently used to engage users in different sectors to include; universities, colleges, government and private enterprises. This included SharePoint software to facilitate document sharing and provide training. Sharing statistical knowledge in particular has proved difficult in the past however advances in communication technology and virtual platforms has improved this process. For example, the Virtual Statistical System is an online resource for national statistical offices, data producing agencies, data users, policy makers, academics, students, researchers or persons interested in official statistics.

### 2.5.3 Action Plan

RealSim were chosen to develop a proof of concept model for this project. They provide business and educational solutions using Unity software. The main challenge to be addressed was how to communicate the scale and size of the vast numbers of TCFs in the Atlantic Region. One approach was to represent the TCFs as one contingent entity.

The first pilot project to address this challenge was the creation of a website which incorporated a conceptual virtual space linked to CFMS software.
(http://danu2.it.nuigalway.ie/multimediadevelopment/ShareBiotech/floorplan.html).

A conceptual tower block was created where each floor in the building represented a service. Microscopy was chosen as the example service and a colour coded floor plan of different types of microscopes was created.

The second pilot project aimed to create a more full 3d virtual world environment. It was felt that placing large scale buildings on a European map would give the same impression of scale and number whilst also communicating the geographical location of each facility. 3d buildings for NUI Galway and Queens Belfast were already created by RealSim in previous projects. Two additional buildings were modelled on the Athlone IT East Campus, thus

giving AIT a new digital asset. RealSim specialise in geospatial virtual worlds by using 3d survey data as their base component. It was decided rather than spending time creating a complex model of the inside of a lab which can just as effectively be communicated by a picture, time was spent acquiring lidar data from the Ordinance Survey Ireland, who had previously surveyed the Athlone area. The following movie shows the Athlone IT data and how it can be used to create powerful campus simulation solutions.
http://www.youtube.com/watch?v=14_eAdeXfjs&feature=share&list=UUJLZditaChmwLUKSCDbkADg

The objectives of the second pilot project included;

- Providing a visual representation of the large number and geographic spread of entities (TCFs) in the regions represented by the ShareBiotech partners
- Promoting the business benefits of using virtual worlds with an emphasis on enhancing collaboration, meetings, training and education
- Facilitating easy access to TCFs through iLab or Perceptive software

The above objectives can be achieved by;

- Assembling 3D content for the virtual ShareBiotech campus
- Demonstrating user cases

A virtual campus was created using the platform Unity which represented some of the TCFs located in the Atlantic region. Two of the member buildings, the Martin Ryan building at NUI Galway and a Queens University Belfast (QUB) Building were modelled by RealSim in prior projects. The following TCFs were added to the virtual campus;

1. Two Athlone IT buildings
2. One NUI Galway Building
3. One Queens University Belfast (QUB) Building having a detailed medical building in 3d

Each building will only have external details modelled with the exception of the QUB building. Buildings from other countries will be modelled with reference to what can be seen on Google Streetview and their respective websites. Buildings will be superimposed on a map of Europe, showing where they are in the EU. The model will be scaled such that all buildings will be very close to one another just as would be the case in an actual campus. Within the QUB building additional detail will be added to one of the laboratories and the meeting room. Any full follow-on development will capture realistic internal 3D images of all relevant laboratories with detailed equipment. Avatars will be inserted in to both models. Ideally this content could be ported in to a virtual world platform that is ready made for virtual meetings, collaboration and learning. However, our initial research shows that although there are some platforms that claim to do this, they are few and far between and would involve an amount of time getting to know the programming and content requirements for each. Therefore, animation of the functionality will be carried out in a movie maker which will show how the virtual world would operate.

### 2.5.4 Hypothesis Testing

The concept of using a Unity ShareBiotech Model to facilitate access to TCFs was presented to the ShareBiotech partners at two ShareBiotech meetings. The model was assessed by Athlone IT and will be included in their website to promote their own TCF. Figure 5 below shows the entry page of the ShareBiotech Virtual 3D Campus created by RealSim Ltd and presented by Dr Patricia McAlernon at the final event. The simulation can be viewed on-line at the link http://www.realsim.ie/ShareBiotech.html and was advertised in the ShareBiotech Newsletter (March 2013).


**Figure 5**. A ShareBiotech Virtual 3D Campus Simulation (RealSim Ltd) (http://www.realsim.ie/ShareBiotech.html)

### 2.5.5 Impact

Through this work Athlone Institute of Technology can compile a fully developed digital campus model to be used by students and visitors as shown in the RealSim Campus movie in the link above. Implementation of a CFMS platform which can be accessed as a web-based platform has the potential to enhance the sharing of resources in the Atlantic region and in turn have financial impact on the TCF as described in Table 4.

| Revenue increase | | | | |
|---|---|---|---|---|
| *Lever* | *Relevant revenue base (millions)* | *Maximum impact* | *Total Impact (millions)* | *Notes* |
| Increased demand | €15 | 10% | €1,5 | Relevant to facilities that have significant spare capacity (i.e., not fully booked ahead of time), lack an on-line booking system easily accessible to new users, and can potentially draw in new customers (internal and external) |
| Billing actual equipment usage | €10 | 20% | €2,0 | Relevant to facilities that lack usage tracking method, and have large deviation of actual vs scheduled usage |
| Freed up equipment capacity | €10 | 3% | €0,3 | Relevant to facilities that are at capacity (i.e., fully booked ahead of time) and do not already have advanced reservation management and usage tracking tools |
| Unpaid invoices reduction | €3 | 50% | €1,5 | Relevant to facilities that do not yet have the ability to capture grant numbers upfront, check their validity, easily issue invoices in a timely manner, and easily track payments |
| ***Total annual revenue increase opportunity*** | | | ***€5,3*** | |
| **Cost reduction** | | | | |
| *Lever* | *Relevant cost base (millions)* | *Maximum impact* | *Total Impact (millions)* | *Notes* |
| Decreased administrative burden for core staff | €3 | 80% | €2,5 | Relevant for facilities which run administrative processes manually and have the ability to monetize the freed up staff capacity by doing more billable work for their users or reduce labor costs (e.g., reduce overtime, contractors, staff) |
| Decreased IT costs | €0,5 | 100% | €0,5 | Relevant if facilities will be able to eliminate the cost of its current reservation and request management system (e.g., licenses, hosting, system administration, custom developments). |
| Institution's administrative cost reduction | €1 | 90% | €0,9 | Relevant for institutions which run billing and reporting manually, will integrate system with its financial system, and will be able to monetize free up capacity by reducing labor costs (e.g., reduce overtime, contractors, staff) or do more valuable work. |
| ***Total annual revenue increase opportunity*** | | | ***€3,9*** | |
| Estimated maximum potential financial impact | | | | €9,200,000 per year |

**Table 4**. Potential Financial Impact of a CFM system in a ShareBiotech Model

Overall the Unity ShareBiotech Model will facilitate the access of SMEs to TCFs by creating an engaging platform to identify their technology needs by utilising avatars and communication technology such as CISCO.

### 2.6 SWOT Analysis

A SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis on the proposal to enable a Unity ShareBiotech Model was carried out and is discussed in the following sections.

#### 2.6.1 Strengths

The attributes of the proposal included the involvement of EU partners in the project who were familiar with the culture and organization of their region or country and with local research activities, TCFs and sources of funding for a sustainable model. The partners had the advantage of local links with all the sectors in the biotechnology area. Virtual World Platforms like Unity already exist which have proven success stories and they are now very commonly used in the commercial and tourism sectors to promote services and facilities. Communication technology is well advanced and CISCO are very experienced in the area. CISCO is based in Galway, Ireland in the same locality as RealSim Ltd, the experts in 3D real-time simulation. The close proximity of CISCO and RealSim facilitates working together to deliver an efficient platform for the ShareBiotech model. The CISCO software can be easily integrated into the Unity ShareBiotech Model which offers the option to have live engagement with TCF managers and experts. The integration of, a CFMS into the model will make access to TCFs more efficient for SMEs and other users. In addition the use of a web-based platform to share TCF resources will increase the usage and financial turnover of individual TCFs. The model will allow TCF managers to monitor the usage of individual equipment in their facilities and thereby identify redundancy and potential for new projects.

### 2.6.2 Weaknesses

As mentioned in Section 1.3 research groups have attempted to set up similar Virtual World Platforms to enhance collaboration and failed due to lack of funding. The true impact of Virtual Worlds on research collaboration has not been determined. The sustainability of funding for the Virtual World Platform management is uncertain and remains to be investigated. The project is limited to the Atlantic region which in turn limits the scope of the model since it does not include America, a country advanced in their usage of models and networks. The Virtual World Platform would have to be developed specifically for ShareBiotech which would require time and money. On-going maintenance of the platform would be required to include language software translation costs, development and updating. There is some potential resistance to downloading the Unity webplayer to access the Unity ShareBiotech Virtual campus. However, alternative browser based technologies like Flash and Html5 have not been able to match the functionality of such virtual world environments. Whether it is Google Earth, Second Life, or Microsoft Flight Simulator, all virtual environments require an application download. The Unity platform is used by over 1.5 million developers across the world and played on many more million devices both PC and mobile around the world.

### 2.6.3 Opportunities

It is clear there is a lack of knowledge transfer in the biotechnology sector due to competitiveness and lack of funding. Currently it is an exciting future for biotechnology research in all sectors, however it requires efficient collaboration and networks to facilitate development. Through a Unity ShareBiotech Model there are opportunities for new services such as; identifying and improving access to core facilities, identifying the needs of individual research projects to advance biotechnology, setting up virtual facilities for data analysis and transfer of knowledge between biotech sectors.

### 2.6.4 Threats

External roadblocks to a Unity ShareBiotech Model include; cultural and organisational differences, language barriers, reluctance to share knowledge and data protection issues. In addition, public perception of Virtual Worlds and security issues associated with them is an on-going concern issue.

## 2.7 Conclusions

On reviewing the SWOT analysis there was a clear path identified to enable a Unity ShareBiotech Model as determined by Athlone Insitute of Technology. There were strengths and opportunities recognised which could deliver a sustainable Virtual World.

In relation to the choice of CFMS, Perceptive Software and iLab Solutions were considered the two best choices of vendor. iLab support approximately 450 TCF's in 5 countries, TCF's

at 49 institutions; of these, 29 institutions have deployed iLab as an enterprise-wide solution, supporting all TCF's. All of these institutions are scientific research organization. Key limitations with the other preferred CFMS suppliers were identified. Perceptive Software is a large company, and sell a lot of software to universities and they have very few projects (fewer than 5) that are truly targeted to scientific research facilities. The only Perceptive project which seems to be relevant is that referred to as 'Albert Einstein'. Perceptive are reported to sell a lot of software for solutions in enrolment management, tuition management, and document management. However, the winning of the contract by Perceptive Software to install their CFMS in the VPTN was a crucial achievement. Since VPTN has already been identified as a champion in networking and they have some of the same objectives and model elements as a future ShareBiotech model their choice of Perceptive Software as their CFMS platform is a very important.
Stratocore, one of the three top choice CFMS suppliers serve TCF's, but they have little experience in providing large scale enterprise-level solutions. Instead, their usage appears to be for primarily single facilities. In addition, given their young age (founded 2011), limited staff (under 5 people), and limited revenue there is a question about their longevity and ability to execute a project of considerable size.
A Virtual World using Unity software was identified as a feasible option for promoting TCFs. This was on the basis that existing transnational models despite having reasonable web-sites were not achieving a satisfactory level of engagement by users. Virtual Worlds have been suggested as an alternative to enhance collaboration and networking. The ability to visit a TCF in a virtual mode as an Avatar is very attractive both in terms of finance and time. Currently Virtual Worlds are popular in the tourism industry to promote visits to tourist attractions. It is envisaged this approach will be adapted by TCFs in the future. Users could potentially be involved in the live engagement in Avatar mode or real-life communication with core facility managers and experts using CISCO or other similar communication technology.

Agreed core essentials for successful clustering and technology collaborations, particularly regarding biotechnology, are: viable and innovative development plan, access to the right expert people to address questions and problems, associated effective networking and allied communication, access to necessary facilities, and sustainable funding and investment that doesn't risk premature conflict with ownership. Biotech product development from initial research always consumes considerable time, but the progression should meet valid outcomes. The traditional engagement of HE research in biotech product development and commercialisation again requires effective dissemination and communication with complementary experts. There is a further appreciation that with significant and growing costs associated with core facilities, SMEs and indeed selected HEIs need to be part of necessary relationships to access these as required and by viable means. Accessing private TCFs (eg CRO) is only likely to be possible when the client has adequate funding, reflecting high demand services.

The core concept that A6A5 would pilot a model that brings together complementary TCFs to generate a novel and required TCF within the Atlantic Region, that overcomes access and logistic deficits by organising and presenting as a single and structured entity, demanded new approaches as to how a single entity model can genuinely present and how associated interface communication technology can be implemented and can work easily and readily. It is accepted that the pilot work undertaken as part of this model description and evaluation does only represent a structured indicator of what is possible and what could work with a positive impact on the nature of shared TCFs and their access by company and HE biotech researchers.

Ultimately an on-line 3D depiction of a joint facility must be highly representative of reality and employ real time software that is very easy to access and use. The imaging, information transfer and associated communication should be accessible on a smart phone and tablet as well as a PC, without incurring any time delays. Ultimately this model must provide very rapid and effective access to the right person to engage with to discuss TCF needs and how they can be addressed. Part of this communication maybe considered as Technology Translation, but when it works internally, the solution will be provided by the joint entity. A key aspect of this technology transnaltion process is the quality and effectiveness of the communication means – incurring full trust and understanding is known to be largely influenced by real time face-to-face engagement.

Video conferencing has evolved over the past decade, but the most effective form, telepresence is expensive to acquire and operate and usually requires a dedicated network, (Hyun & Kang 2011). The presumption was, that in the ShareBiotech transnational TCF model, advanced but cost effective telepresence will be included and that approved clients and external network experts would also receive a version of such technology. Telepresence is defined (www.ivci.com), as a video conference in which local and remote participants appear to be in the same room, sitting at the same table. Each person experiences a life-size image of the remote attendees, with easy to use technology effectively out of sight. The resulting nature of communication and interaction is very realistic. This has been a continuous growth product for companies such as Cisco and Polycom and the former were obviously interviewed as part of this project work. However, there is evidence now that the escalating costs of this technology are negatively impacting on adoption and clients are increasingly seeking lower cost communication technology, which has stimulated growth of competitive companies such as Vidyo. Any further progression of the transnational TCF model and indeed technology translation, will have to facilitate the development and implementation of effective but significantly lower cost telepresence technology, (Budihal et al 2011, Scott & Nelson 2012). Holographic telepresence systems can project realistic, full-motion, real-time 3D images of remote people and objects into a room, together with real-time audio communication, with a level of realism that clearly rivals real physical presence. This may well be a future generation of telepresence technology, but again the user costs have to be realistic. Holographic telepresence would in addition allow very effective remote access to and actual utilisation of core facility equipment.

As a manifestation of successful cluster culture, a unique transnational TCF entity will be part of a network package that potentially brings other requirements together such as management and finance. To manage collaborative, business and legal differences across the

Atlantic Region, these must all be prior identified and handling and agreement methods incorporated into the single entity – for this to ultimately happen, the tangible benefits of setting up and delivering a joint TCF must be very clear and supported by other biotech agencies and bodies, including grant funders.

The recent PwC report, while restricting biotech to biopharma, proposes that the primary mechanism for addressing sector growth problems, must be addressed by enhanced collaboration models, (PwC 2010). The prediction that the $21^{st}$ C would be led by life science research has yet to fully and convincingly manifest. This is in part associated with the operational and financial difficulties of initiating and progressing biotech innovation. This continuous post 2008 financial crisis negativity is confirmed by the most recent PwC MoneyTree Report of the US economy, which relates to the beginning of this document (PwC MoneyTree 2013). Venture capitalists invested $5.9 billion in 863 deals in the first quarter of 2013. Quarterly venture capital (VC) investment activity fell 12% in terms of dollars and 15% in the number of deals compared to the fourth quarter of 2012 when $6.7 billion was invested in 1,013 deals. The Life Sciences (biotechnology and medical device industries combined) and Clean Technology sectors both saw marked decreases in both money and number of deals in the first quarter. Conversely, there was a notable increase in investment in the Media & Entertainment industry with the Software sector accounting for 40% of the first 2013 quarter. This shift to investment in software and associated sectors is also happening in Europe and reflects reduced capital requirements and much faster ROI relative to biotechnology.

Horizon 2020, even if subject to a budget reduction, will have a significant and positive impact on biotechnology research in the EU and will enhance collaboration, but it cannot contribute to confidence that viable commercialisation of biotechnology and subsequent significant company growth will occur over the next decade with corresponding positive impacts on human health, food, environment, energy and waste management. ShareBiotech has generated significant new information regarding biotechnology in the Atlantic Region and proposed sub-sectors for development (A6A1) and new models for core facility access and management, including transnational resourcing. These strategies potentially contribute to reduced capital costs and enhanced cluster network communication for biotech researchers and entrepreneurs, but this must ultimately be part of a much more substantial and novel culture and governance to ensure the biotech sector recovers from the financial crisis and truly and significantly grows

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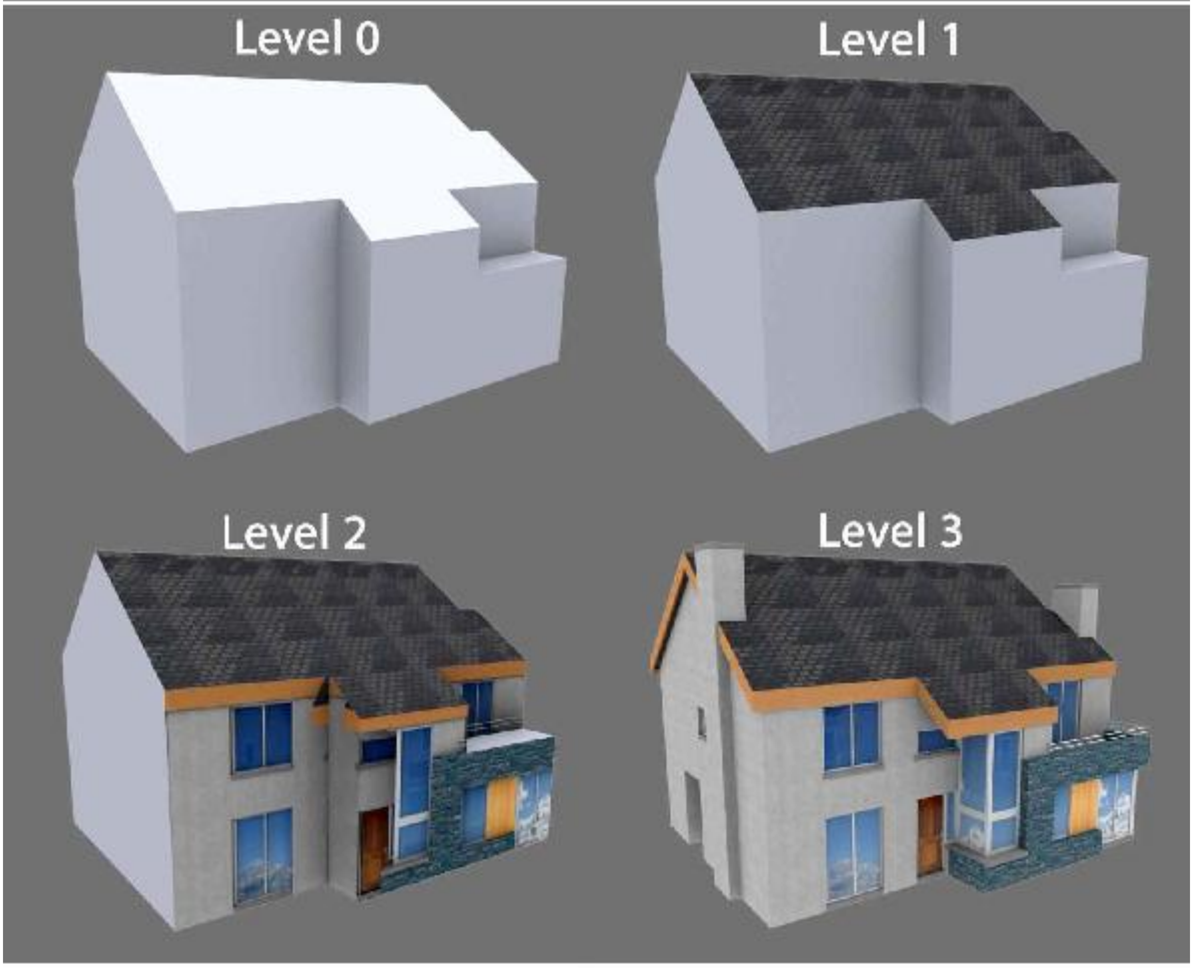
**Appendix I**: Building Levels of Detail Using Unity Software to create a Virtual World or replica of a TCF building.

realsim
REALTIME 3D SIMULATION

## Building Levels of Detail




3D building block models are geo-referenced and geometrically accurate in building shape, height and roof profile. Most city models consist of buildings modelled to different levels of detail, determined by their importance and budget considerations.
RealSim has 4 main levels of building detail;

**Level 0:** Untextured model extracted from aerial survey data (photogrammetry or lidar).
**Level 1:** Level 0 model with roof texture.
**Level 2:** Level 1 model with photo-textured facades.
**Level 3:** Additional level of 3d detail extracted from CAD files or with reference to street photography. May include awnings, chimneys, railings, balconies, window ledges and other architectural features.
**Level 4:** Not shown here but includes building internals modeled.

COMMERCIAL-IN-CONFIDENCE

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Galway, Ireland
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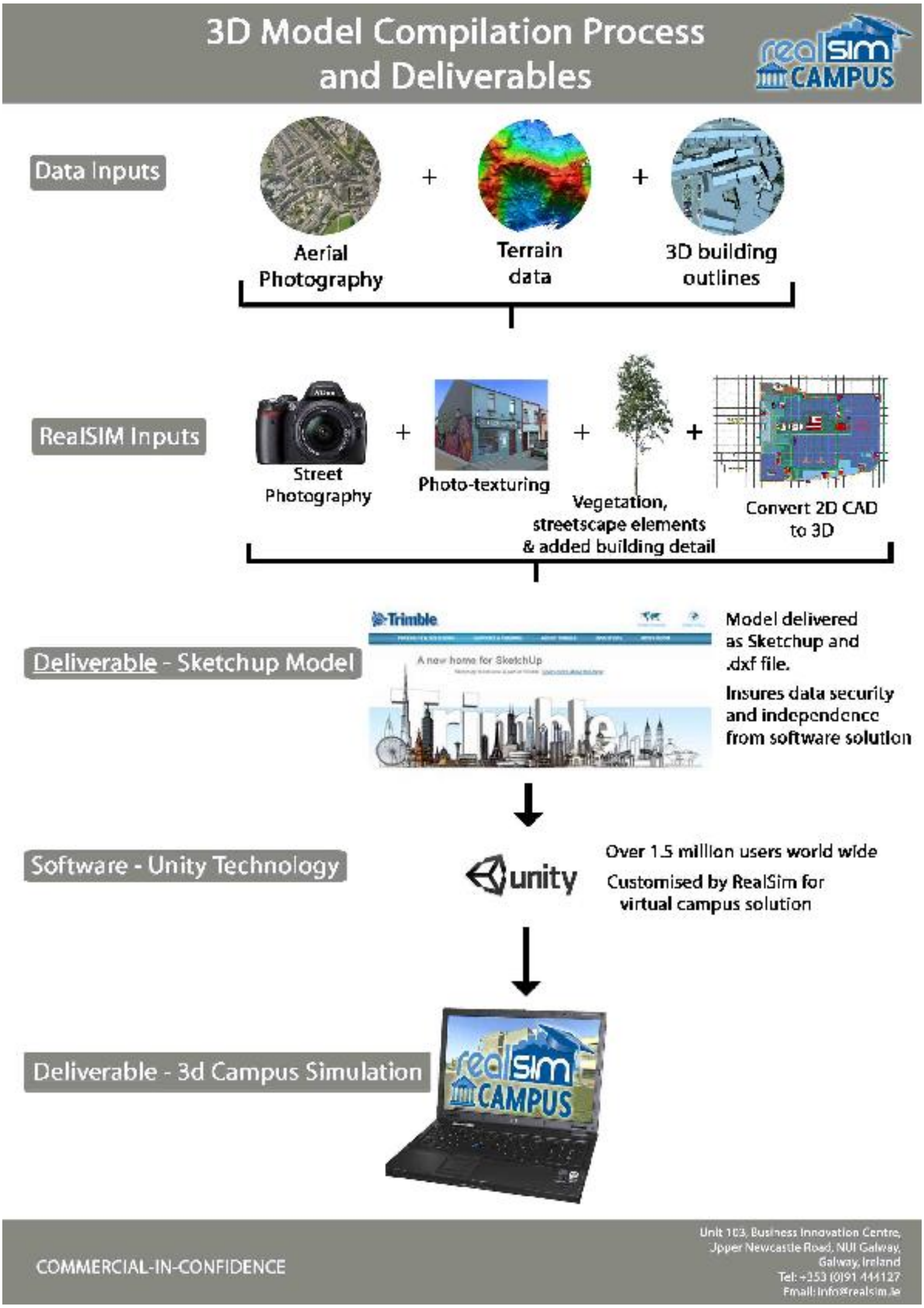
**Appendix II**: 3D Model Compilation Process and Deliverables



## **Appendix 111**: List of sources of relevant transnational models

| Models | URLS | Project Contact List |
|---|---|---|
| Pan-European Research Infrastructure on High Peformance Computing for 21st C Science | http://www.hpc-europa.eu | Marco Betz [betz@nmr.uni-frankfurt.de]; |
| Vision Advanced Infrastructure for Research | http://www.infra-visionair.eu | Regitze Thoegersen [regitze.thoegersen@euvaccine.eu] |
| Multinational Advancement of Research Infrastructures on Ageing | http://www.share-project.org/t3/share/index.php?id=512 | Carl Steinbeisser [Carl.Steinbeisser@gabo-mi.com] |
| Support of Public & Industrial Research Using Ion Beam Technology | http://www.spirit-ion.eu/Start.html | johann.habakuk.israel@ipk.fraunhofer.de |
| Project MicroKelvin | http://www.microkelvin.eu | R.G.J.Damgrave@utwente.nl |
| Distributed Infrastructure for EXPErimentation in Ecosystem Research | http://www.expeer.fr | ebambury@crospon.com |
| European Network of Vaccine R&D | http://www.transvac.org | szemereki@sztaki.mta.hu |
| The Network of Animal Disease Infectiology Research Facilities | http://www.nadir-project.eu/nadir_project/ | frederic.noel@grenoble-inp.fr |
| Research Capacity for the Implementation of Genetic Control of Mosquitoes | http://www.infravec.eu | Michael Wacker [Michael.Wacker@glycovaxyn.com] |
| Proteomics Research Infrastructure Maximising Knowledge Exchange & Access (XS) | http://primexs.eu | Brian Nisbet (Network Operations Manager) (brian.nisbet@heanet.ie) |
| European Sequencing & Genotyping Infrastructure | http://www.esgi-infrastructure.eu | Anson, Susan (NANOMIK) |
| Servicing the EU Biomedical Research Community: Archiving & Dissemination of Mouse M | http://www.emmanet.org | Kopcko, Steven [Steven.Kopcko@Kronos.com] |
| European Consortium for Microbial Resource Centres | http://www.embarc.eu | Meyers, John Alexander [johnm@bu.edu] |
| Enhancing Access & Services to East European Users Towards an Efficient & Coordinate | http://www.east-nmr.eu | Elizabeth Iorns [elizabeth@scienceexchange.com] |
| NMR for Structural Biology | http://www.bio-nmr.net | Amir Bokovza [amir@prog4biz.com] |
| Association of European Marine Biological Laboratories | http://www.assemblemarine.org | jmminiere@virtuasense.com |
| QNano Integrating Activities | http://www.qnano-ri.eu | Jump, Paul [Paul.Jump@tsleducation.com] |
| Integrating European Research Infrastructures for Micro-Nano Fabrication of Functional St | http://www.euminafab.eu | Claudia Alen Amaro [claudia@strubi.ox.ac.uk] |
| INSTRUCT | http://www.structuralbiology.eu/ | Joan Spivak [spivak@amdec.org] |
| EuroBioBank | http://www.eurobiobank.org/ | William Palumbo [mailto:williamp@amdec.org] |
| NAP, Tyndall | www.tyndall.ie/nap | |
| Eurotrans bio | http://www.eurotransbio.eu | |
| Living Labs | http://www.openlivinglabs.eu/ | |
| Science Exchange | www.scienceexchange.com | |
| US-Boston University | http://www.bu.edu/cores/ | |
| AMDeC F.I.R.S.T.™ | http://amdecllc.com/amdec-first/ | |