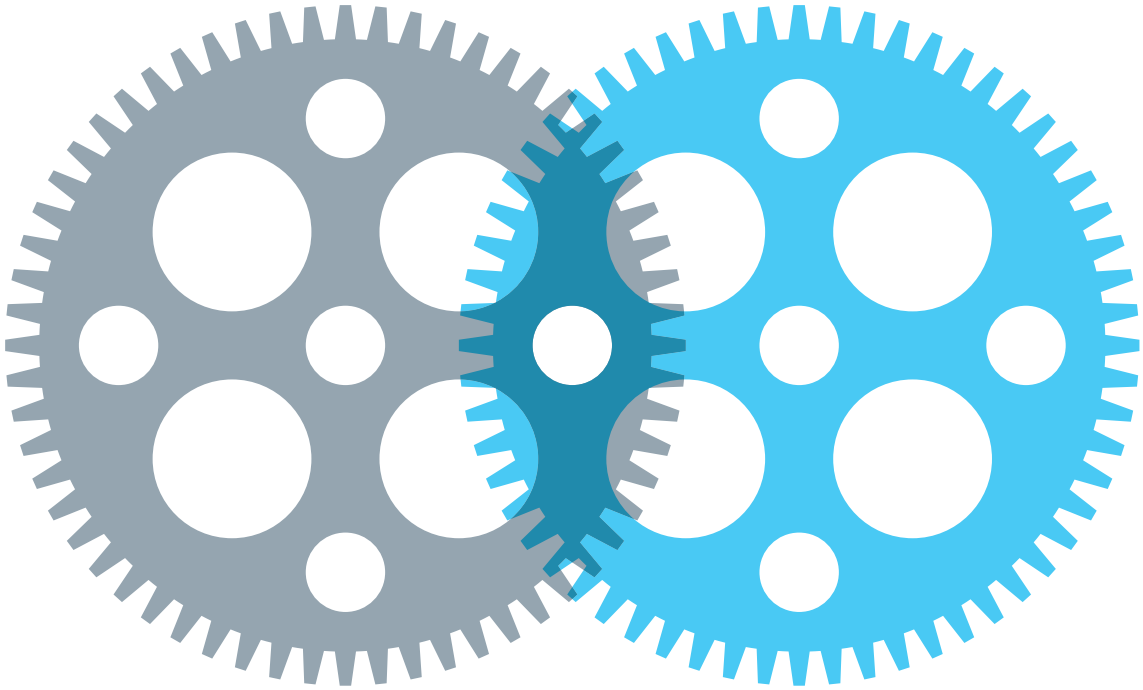
Manufacturing Your Future
High Value Manufacturing at Alconbury Enterprise Campus

Defining the environment and skills High Value Manufacturing needs **locally** to compete **globally**

Final report | May 2015



IfM Education and Consultancy Services

14 May 2015

This report was funded by:

— Huntingdonshire District Council
— Cambridgeshire County Council
— Huntingdonshire Regional College
— Greater Cambridge Greater Peterborough Enterprise Partnership
— Urban&Civic

Version 1.8

Date: 05/05/2015

17 Charles Babbage Road, Cambridge CB3 0FS

Contents

Summary	4
1.0 Objective, Deliverables & Approach	7
2.0 Developing the Vision & Identifying Key Industrial Sectors	12
3.0 Priorities for the Technical & Vocational Centre	16
4.0 Gap Closure Plans	23
5.0 Next Steps	28

Summary

Objectives & Approach

IfM ECS have been working with local industry, Huntingdonshire District Council, Cambridgeshire County Council, Urban&Civic – developers of the Alconbury Enterprise Campus – and the Greater Cambridge and Greater Peterborough Enterprise Partnership (GCGP LEP) to support the development of priorities for the Alconbury Enterprise Campus by:

- Agreeing the strategy and key activities required to provide the environment and skills needed for high value manufacturing (HVM) in this area to compete nationally and globally
- Defining the kind of facility needed to deliver the skills HVM businesses need: which will be delivered through a £10m technical and vocational centre at Alconbury Enterprise Campus
- Providing collaborating companies support to develop their own skills and growth plans in line with the emerging strategy and partner support and funding.

The work took place between December 2014 and April 2015 and included a:

- Desk study to develop an initial 'high level landscape' and potential sector and competency priorities
- Workshop on 5th March 2015 with local industry to further the vision, landscape and gap closure plans.

Outputs were gathered using the Innovate UK National Competency Framework[1] to facilitate integration with national policy.

Further interviews and consultation were carried out to validate and develop the initial outputs with stakeholders unable to attend the workshop.

Vision

The Enterprise Campus will build on key local strengths, particularly its location between the innovation of Cambridge and the manufacturing, cleantech and financial clusters across Huntingdonshire and Peterborough, and exploit future economic developments including energy and resource security, flexible manufacture and lightweight materials.

A key proposition for the Enterprise Campus will be to facilitate market-driven value creation, scale-up and growth, with strong collaboration across specialisms, commercial focus and new business model development:

- Providing support to SMEs and start ups
- Developing and implementing an extensive skills action plan linked to future local need and national manufacturing priorities
- Offering flexible land and bespoke builds with good transport links, at a lower cost than in the immediate Cambridge area.

---

[1] National competency = associated clusters of manufacturing competencies (manufacturing tools, techniques or know-how, whether technical or operational) that support businesses to respond to the key global trends and drivers, be competitive and capture value for the UK in the future.

The Enterprise Campus will support this vision through:

- Facilitating the development of a skilled and expert workforce for HVM
- Offering scale-up facilities for investor companies, including university spin outs
- Building a local innovation community with mechanisms to link the needs of both established and emerging 'spin out' businesses to local, national and international research
- Marketing to attract inward investment and co-location/relocation of businesses to the site.

Key Industrial Sectors Identified

Key sectors identified during the work, as potentially being attracted to the Campus's offering, include the following:

- Biotechnology
- Agricultural technologies
- Medical technologies
- Composites
- Renewable energy
- Nuclear
- Oil and gas
- Modular construction
- 'Smart' products
- Digital economy

It should be noted however that this is not intended as a limiting list as many smaller and medium-sized companies contribute in a variety of end-use value chains.

Priorities for the Technical & Vocational Centre

The table below summarises the emerging HVM competencies, and identifies the approximate timing when skills may be required to deliver value in the market place.

Immediate (2015–20) priorities include	Longer-term (2020+) priorities also include
Energy generation, storage, management and security	Design and manufacture for sustainability and through life
Design and manufacture for lightweight vehicles, structures and devices **(including composites)**	Biotech, biological and synthetic biology processing
'Plug and play' manufacturing **(including modular construction)**	Understanding, designing and manufacturing formulated products
Process engineering capability and efficiency across food, pharmaceuticals and chemicals	Design and manufacture for small-scale and miniaturisation
Systems modelling and integrated design/ simulation	Novel mechanical conversion processes for scale, economy and efficiency
Automation, mechanisation and human machine interface	Smart, hybrid and multiple materials
Additive manufacture	Intelligent systems and embedded electronics
Net and near net-shape manufacture	Development and application of advanced coatings
Building new business models to support HVM	Managing fragmented value chains including distributed manufacturing to support HVM

Key: Items in **bold** were identified by delegates at the 5th March 2015 workshop as particularly important

Offers should include: education and awareness courses/short courses and workbooks; apprentice-level training; current degree content; seminars, etc. to engage with university research. Emphasis should be placed on leadership and management as well as awareness of the potential for multiple technologies in combination and the ability to integrate them in addressing market and customer needs. A separate annex provides more detail of the associated education offerings.

High level education and training priorities have been proposed, which include:

- Developing educational offerings directed at 'transition and growth' for micro- and small enterprises and their leaders who are seeking to grow and exploit new markets
- Linking to the High Value Manufacturing Catapult-based National College for Advanced Manufacturing (NCAM) for competency-based technical skills and basic business skills development and to the National College for Digital Skills (NCDS).

Gap Closure Plans

Specific plans, with input to the priorities of the technical and vocational centre were developed at the workshop on 5th March 2015 in the following areas: industry/academic collaboration alignment; production automation; modular construction; 3D printing (additive manufacturing) and nuclear energy.

Subsequent interviews have developed similar inputs in the following fields: food, lasers; composites; systems modelling; new medtech products and smart products.

Next Steps

Immediate next steps identified to take forward the priorities identified in this report include baselining skills delivery, benchmarking and network building. Specific actions include:

- Mapping of current local/regional training delivery – perhaps using Skills Funding Agency (SFA) 'Cube' data to which the LEP has access
- Learning from relevant projects elsewhere – for example, Torbay Electronics and Photonics Innovation Centre allied to South Devon College
- Developing the HVM community through, for example events, including a large-scale event/conference in Summer 2016 in the new Club Facility (itself due for completion early 2016)
- Industrial Venture Centre and/or IfM partnership.

Longer term themes to be developed in support of education provision include:

- Developing educational offerings directed at 'transition and growth' for micro- and small enterprises and their leaders who are seeking to grow and exploit new markets
- Linking to NCAM for competency-based technical skills and basic business skills development
- Linking to NCDS.

1.0 Objective, Deliverables & Approach

1.1 Objectives

This report summarises the work to support the development of strategic priorities for the Alconbury Enterprise Campus. IfM ECS have been working with local industry, Huntingdonshire District Council, Cambridgeshire County Council, Urban and Civic and GCGP LEP to:

- Agree the strategy and key activities required to provide the environment and skills needed for high value manufacturing (HVM) in this area to compete nationally and globally
- Define the kind of facility needed to deliver the skills HVM businesses need, which will be delivered through the Alconbury Enterprise Campus
- Provide support to collaborating companies to develop their own skills and growth plans in line with the emerging strategy and partner support and funding.

A key development for the Enterprise Campus is the £10 million secured by GCGP LEP to develop a bespoke technical and vocational centre onsite to support manufacturing, engineering, management and leadership skills in the region.

1.2 Deliverables

The deliverables of the work were to:

- Affirm the sub sectors/target sectors for the Enterprise Campus, in support of the HVM aspects of the local economy
- List the key activities required to prepare the regional innovation structures (including links to education establishments in particular the technical and vocational centre)
- With reference to the technical and vocational centre specifically, define the kind of facility and associated outputs, including higher level apprenticeships, required for 'winning' in HVM
- Identify short-, medium- and long-term strategies for business capability development in the context of the Innovate UK HVM strategy and UK manufacturing practice
- Provide collaborating companies with an opportunity to start planning specific developments in line with the emerging strategy.

1.3 Approach

The work, which took place between December 2014 and April 2015, employed the Innovate UK National Competency Framework for High Value Manufacturing (developed with IfM support 2011–12) in order to facilitate integration of the work with national policy. A national competency is a cluster of associated manufacturing competencies – manufacturing tools, techniques or know-how, whether technical or operational – that support businesses to respond to the key global trends and drivers, be competitive and capture value for the UK in the future. Table 1 shows the twenty-two national competencies, grouped by strategic theme.

Strategic theme	National competency
Securing UK manufacturing technologies against scarcity of energy and other resources	• Energy generation, storage, management and security • Design and manufacture for sustainability and through life • Biotech, biological and synthetic biology processing • Design & manufacture for lightweight vehicles, structures and devices
Increasing the global competitiveness of UK manufacturing technologies by creating more efficient and effective manufacturing systems	• Understanding designing and manufacturing formulated products • 'Plug and play' manufacturing • Design and manufacture for small-scale and miniaturisation • Process engineering capability and efficiency across food, pharmaceuticals and chemicals • Novel mechanical conversion processes for scale economy and efficiency • Systems modelling and integrated design/ simulation • Automation, mechanisation and human machine interface
Creating innovative products, through the integration of new materials, coatings and electronics with new manufacturing technologies	• Smart, hybrid and multiple materials • Intelligent systems and embedded electronics • Development and application of advanced coatings
Developing new, agile, more cost-effective manufacturing processes	• Flexible and adaptive manufacturing • Combining product development steps in parallel/concurrent engineering • Additive manufacturing • Net and near net-shape manufacture
Building new business models to realise superior value systems	• Managing fragmented value chains including distributed manufacturing to support HVM • Building new business models to support HVM • Developing and retaining skills to support HVM • Managing risk and resilience to support HVM

Table 1. HVM national competencies A landscape for the future of high value manufacturing in the UK (IfM for Technology Strategy Board (TSB), 2012)

The work developed – through a series of stages involving different stakeholders – an HVM 'landscape' relevant to the Enterprise Campus showing potential priority sector developments and associated priorities for competencies development by the technical and vocational centre. The stages of the work comprised:

1. A desk study to create a first-pass HVM landscape to identify target sectors and competency priorities

2. Presentation of emerging target (sub)-sectors and competency priorities to key stakeholders

3. Local industry input to further develop vision, landscape and competency requirements

4. Additional stakeholder input and validation through interview and report circulation

Figure 1 shows the components of the landscaping process.

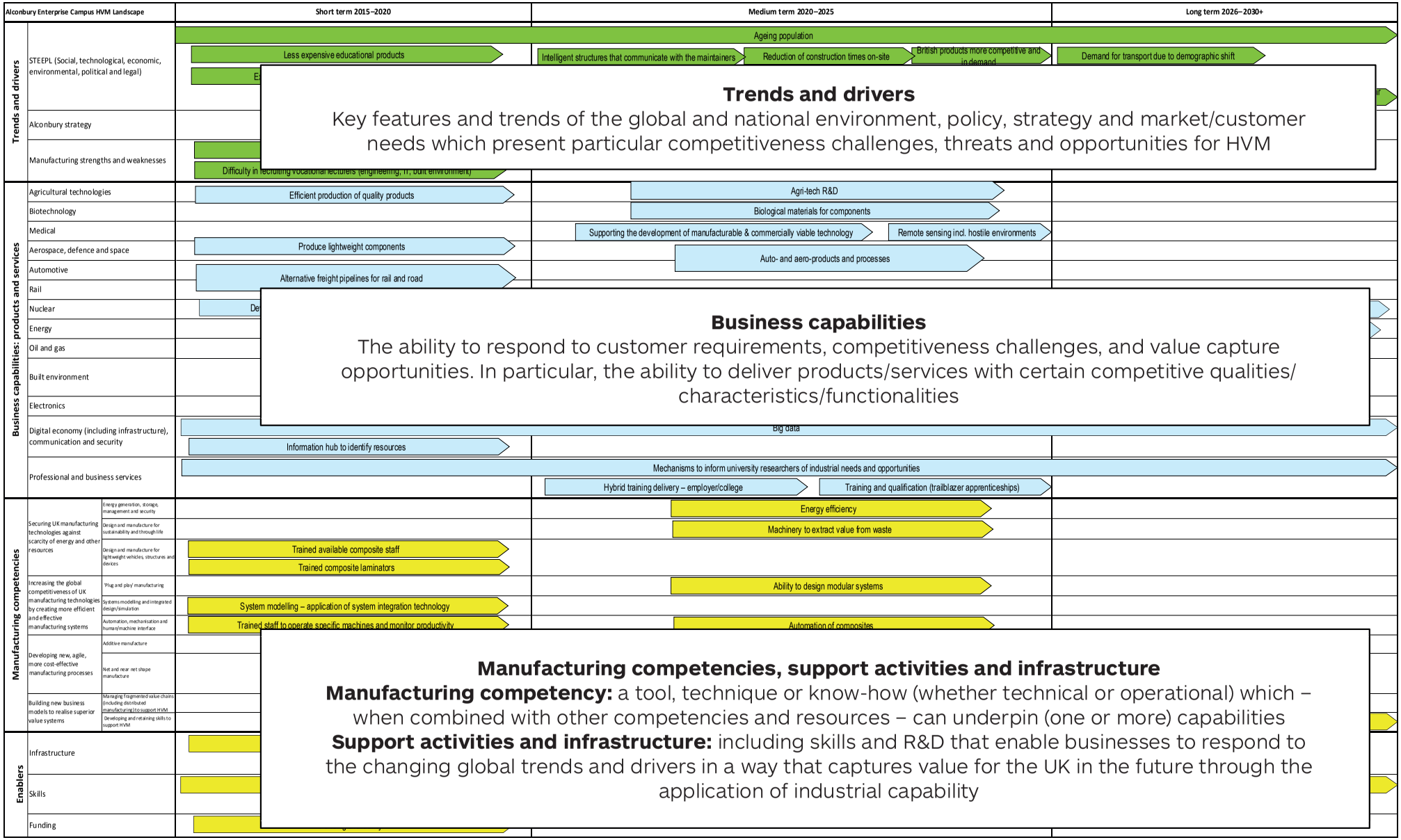


Figure 1 - Illustrative HVM Landscape showing structure: trends and drivers, business capabilities, and manufacturing competencies, support activities and infrastructure

Table 2 outlines the focus for each phase of the work, stakeholder involvement and deliverables.

Activity		Deliverables
Phase 1	• Desk study generating output in the form of a 'high level landscape'	• Draft local HVM priorities for the region showing how priority developments in the HVM sector and industrial competency developments might potentially be linked • First-pass indication of the educational impact of the identified national competencies
Phase 2	• Presentation to programme partners	Brief PowerPoint presentation to key stakeholders summarising the work to date and confirming: • Key stakeholders based on first-pass identification of potential opportunity areas • Approach to phase 3
Phase 3	• Workshop with collaborating companies to refine landscape and develop skills gap closure plans • Draft report	• Draft vision statement for HVM in the region • Updated landscape with confirmation of key gaps and priorities that the technical and vocational centre should address • Business cases and high level roadmaps for the closure of key gaps • Individual action plans developed by participating companies as 'takeaways' in return for their input to the process
Finalisation	• Selected follow- up interviews • Finalisation meetings	• Validated report • Additional interviews inputs where Identified priorities were not developed in the workshop

Table 2 - Staged deliverables, Alconbury Enterprise Campus project, December 2014–April 2015

Phase 1: desk study

The desk study was a four-step process:

1. Employing initial data sources[2], trends and drivers were identified which will have significant impact on the Alconbury Enterprise Campus.

2. Sectors of potential interest were examined, alongside possible products and services, which might match the future of the Enterprise Campus. This was done largely through interviews[3], as well as research on current activities in the region.

3. Links to the existing HVM competencies were made with a combination of the information used above and work done by the IfM for BIS and other LEPs. An initial landscape was developed – a first pass at representing these outputs in a single document.

4. First-pass education requirements were summarised from initial IfM work in this area.

An interim report and review meeting confirmed the results of the desk study in preparation for phase 2.

Phase 2: presentation to key stakeholders

The initial landscape developed by the desk study and presented to key stakeholders on 5th January is shown in the Appendix on page A3.

Confirmation of first-pass opportunity areas enabled the design and planning of the phase 3 workshop to refine HVM vision, landscape and key gaps and priorities for the technical and vocational centre.

Phase 3: workshop and draft report

The workshop with collaborating companies and other key stakeholders took place on 5th March. The main outputs of this phase are described in the following sections:

- Vision and key industrial sectors identified (see 2.0)
- Priorities for the technical and vocational centre (see 3.0)
- Gap closure plans (see 4.0)

The Appendix gives further details about the workshop (pages A3–A23): delegates; structure; landscape and linkage chart development; detailed gap closure plans (syndicate outputs); delegate feedback.

Phase 4: finalisation

Follow-up interviews during March and April gathered the views of workshop invitees who had been unable to attend. A mid-April finalisation meeting of key stakeholders reviewed the combined workshop and interview outputs and confirmed contents for the final report.

---

[2] *Including Huntingdonshire District Council Huntingdonshire Economic Growth Plan 2013–20123 (July 2013); Alconbury Enterprise Zone Implementation Plan (November 2011); Alconbury Enterprise Zone Skills Action Plan: Skills Make Huntingdon Grow (final draft, undated); Huntingdonshire District Council Local Economic Assessment (Deloitte, November 2012); Greater Cambridge & Greater Peterborough Enterprise Partnership website: www.gcgp.co.uk/*

[3] *Principally with: Tony Raven, CEO Cambridge Enterprise; Philip Guildford, Director of Research and Finance, University of Cambridge Department of Engineering (CUED); Tom Ridgman, Director External Education, CUED; Tim Minshall, IfM Open Innovation; Derek Ford and Nicky Athanassopoulou, IfM ECS SME local team*

2.0 Developing the Vision & Identifying Key Industrial Sectors

2.1 Vision

Draft vision

The Enterprise Campus will build on key local strengths linked to its location between the innovation of Cambridge and the manufacturing, cleantech and financial clusters across Huntingdonshire and Peterborough, and maximise the benefits of future economic developments in the Cambridge – Peterborough area including flexible manufacture, lightweight materials and energy and resource security.

To support this vision, the Enterprise Campus will deliver on skills, facilities, innovation community-building and inward investment:

- Facilitating the development of a skilled and expert workforce for HVM
- Providing scale-up facilities for investor companies, including University spin outs (including but not exclusively from the University of Cambridge)
- Building a local innovation community with mechanisms to link the needs of both established and emerging 'spin out' business to research both locally and nationally
- Marketing the Campus to attract inward investment and co-location/relocation of businesses to the site.

2.2 Swot Analysis

This HVM vision is informed by key stakeholder analysis of strengths, weaknesses, opportunities and threats for the Enterprise Campus as a whole[4]:

Strengths

- Proximity to the A1 and A14
- Low cost land, relatively close to high-cost Cambridge
- At the heart of agriculture and the food industry.

[4] *Review meeting, end of phase 1, 1st December 2014*

Weaknesses

- A broad vision but not enough detail for industrial/academic engagement
- No surrounding infrastructure/critical mass of companies
- Lack of good east/west transport links (road and rail)
- Gap in the medium-sized business sector.

Opportunities

- Flexible provision of manufacturing-based industry facilities
- SME start-up and scale-up
- Established companies' expansion
- Enabling university spin-outs to expand for production
- Providing university facilities where space is tight in Cambridge.

Threats

- Potential reluctance of Cambridge IP to migrate from the immediate Cambridge area
- Draw of competing special zones, for example on the East Coast
- Decline in manufacturing employment as traditional companies change their manufacturing footprint and profile.

The Campus has the opportunity to attract and support HVM industry across the spectrum from spinouts and start-ups to established companies, with particular emphasis as a 'location that interfaces between innovation and commercialisation'[5].

[5] *GCGP LEP Strategic Economic Plan, p.53.*

2.3 Strategy

A key proposition for the Enterprise Campus will be to facilitate market-driven value creation through scale up and growth, with strong collaboration across specialisms, commercial focus and new business model development.

The SWOT analysis confirms that the overall strategy for HVM at the Enterprise Campus should:

- Exploit local strengths in skills and established manufacturing base to provide support to SMEs and start ups
- Develop and implement an extensive skills action plan linked to national manufacturing priorities
- Employ as its unique selling point (USP) the advantage of lower cost land than in the immediate Cambridge area, combined with flexible use (no limit on the size of an entity or cluster of entities, and bespoke builds).

2.4 Key Industrial Sectors

Table 3 shows key HVM sectors identified by the desk study as first-pass areas of opportunity. The comments in the second column summarise how the sector relates to the Enterprise Campus USP, including:

- Proximity to Cambridge
- Lower cost of land compared to the Cambridge City area
- Flexibility in size of entity
- Good transport links, particularly North/South
- Located at the heart of UK arable agriculture
- Offering effective innovation, prototyping and scale-up facilities.

HVM sector	Links to Enterprise Campus USP and other key selling points
Agricultural technologies	Close to leading research in agritech, and potential proving ground to new 'precision agriculture' deployment in arable farming
Food*	Well placed to provide a proving ground for the 'field to fork' agenda and food industry sustainability and efficiency
Biotechnology	There is space for biotreatment 'clean technology' developments; bio based waste may be attractive as may facilities for smarter, automated sifting of waste
Medical	IP-related developments will be clustered immediately round the Cambridge Biomedical Campus (Addenbrooke's site), but pilot and scale-up plants may be established at Alconbury
Composites	Local manufacturers are already strong in this field, supplying the aerospace and automotive sectors

Transport	Local companies have strength in new, unconventional transport developments[6]
Nuclear	National nuclear rebuild (Sizewell C) and decommissioning offers supply chain opportunities for local companies
Energy	Renewable energy generation and equipment design and build, supporting offshore wind, etc. and energy storage such as battery installations and hot gravel beds
Oil and gas	There is a specialised oil and gas industry cluster in the Ely area
Built environment	This includes smart infrastructure and modular and factory build, new ways of managing construction sites, augmented reality test beds and piloting on new building sites. There is significant infrastructure build in the local area.
Retail, entertainment and consumer goods	Retail facilities with 'essential services' and conference and meeting facilities
Digital economy (including information, production control, 'smart products', infrastructure, communications and security)*	May offer opportunity for 'new tech' production facilities and the site could showcase leading examples of digital economy. Interest from small software developing companies which are small/start up and as incubators.

Table 3 - Key HVM sectors identified, Alconbury Enterprise Campus 'Manufacturing Your Future', IfM desk study, 2015.
Key: *Subject to further validation

While these sectors may potentially be attracted to the Campus, companies in other sectors will be attracted too. It is important not to create a closed list of sectors, which thereby potentially limits the HVM strategy for the Campus. Many small and medium-sized companies contribute in a variety of end-use value chains.

Having identified these sectors in the desk research phase of the project, companies across those sectors were particularly targeted for engagement in the subsequent phases of the project, although care was taken not to make this exclusively the attendee list to avoid a 'self-fulfilling prophesy' in what may inevitably be a potentially broad focus for the campus.

[6] *E.g.: transporting freight by magnetic propulsion (Mole Solutions)*

3.0 Priorities for the Technical & Vocational Centre

3.1 Workshop Delegate Priorities

Delegate priorities were derived from the workshop's landscape development process. Delegates identified that opportunities are driven by a number of trends and needs, especially by:

- Energy security and need to reduce energy usage
- Ageing population
- The need to develop cost effective lightweight structural components
- UK nuclear programme (including decommissioning)
- Joining up presently disconnected training and employment opportunities.

The need to provide effective links between, and support to, companies in the region was also stressed:

- Extending the 'Cambridge phenomenon' facilitating effective networking
- Creating an international draw and reputation
- Working with national institutions (KTN, Innovate UK, Catapults)
- Developing the supply chain and the associated systems integration to strengthen innovation.

Delegates emphasised that the opportunities identified/confirmed at the workshop require significant development of manufacturing competencies, most of these aligned with national priorities. Particular attention was drawn to:

- Systems modelling and integration
- Automation and human machine interface
- Additive manufacturing/3D printing
- Modular system design
- Productivity monitoring
- Big data
- Electronics and materials engineering
- Technology integration
- Mechanical and production engineering
- Business and integration skills for value capture

Their exploitation will require an expert workforce with cross-functional and business skills:

- Different skills, knowledge and attitudes are required across the range of size and innovation maturity of firms, and this needs to accommodated in the building of workforce skills
- The education agenda should develop the identified manufacturing competency requirements, readiness for work and employability, leadership and management and a positive attitude to working in manufacturing

- Cross-functional/technical discipline studies, with business management are important in generating the necessary potential to generate real value from technology

- Offering clear links to job and career opportunities with industry reaching out to schools and 'through career' development.

Delegates further stressed that the Enterprise Campus should support manufacturing scale up and integrate the supply chain linking research, industrial needs (of both existing and spin out companies) and the national innovation infrastructure:

- Existing companies need to collaborate in addressing common issues and join with spin outs and access the national innovation infrastructure

- Spin outs will emerge from the 'Cambridge Phenomenon' and require continued links to the University, networking and supply chain integration with existing companies as well as demonstrating the value of research

- Provision of 'scale up' and innovation facilities will greatly support these needs.

Further details of workshop delegate input to the landscape are shown in the Appendix on pages A6–A10.

3.2 Mapping Local Priorities to National HVM Competencies

Table 4 (page 18) shows the HVM competencies prioritised by collaborating companies and other stakeholders together with additional ones identified by the IfM desk study. The competencies were identified by mapping the outputs from the desk study and landscaping workshop onto the national HVM competency definitions. It also identifies the approximate timing of when related skills may be required in place delivering value in the market place.

Table 5 (page 19) indicates how these priority competencies are spread across key industrial sectors identified by the work.

Competency/Technology	Short term: 2015–20	Medium term 2020–25	Long term 2025–30
Energy generation, storage, management and security			
Design and manufacture for sustainability and through life			
Biotech, biological and synthetic biology processing			
Design and manufacture for lightweight vehicles, structures and devices **(including composites)**			
Understanding designing and manufacturing-formulated products			
'Plug and play' manufacturing **(including modular construction)**			
Design and manufacture for small scale and miniaturisation			
Process engineering capability and efficiency across food, pharmaceuticals and chemicals			
Novel mechanical conversion processes for scale economy and efficiency			
Systems modelling and integrated design/simulation			
Automation, mechanisation and human machine interface			
Smart, hybrid and multiple materials			
Intelligent systems and embedded electronics			
Development and application of advanced coatings (and materials)			
Additive manufacturing			
Net and near-net shape manufacture			
Managing fragmented value chains including distributed manufacturing to support HVM			
Building new business models to support HVM			

Table 4 - Emerging national HVM competency focus of the technical and vocational centre and timing
Key: Red = 5th March workshop and desk study output; Dark amber = desk study output. Column 1 items in **bold** were also identified by delegates as particularly important

National competencies	SAgritech, Food, Biotech	Nuclear, Energy, and Transport, Oil & Gas	Built Environment, Retail & Digital
Energy generation, storage, management and security			
Design and manufacture for sustainability and through life			
Biotech, biological and synthetic biology processing			
Design and manufacture for lightweight vehicles, structures and devices (including composites)			
Understanding designing and manufacturing-formulated products			
'Plug and play' manufacturing (including modular construction)			
Design and manufacture for small scale and miniaturisation			
Process engineering capability and efficiency across food, pharmaceuticals and chemicals			
Novel mechanical conversion processes for scale economy and efficiency			
Systems modelling and integrated design/simulation			
Automation, mechanisation and human machine interface			
Smart, hybrid and multiple materials			
Intelligent systems and embedded electronics			
Development and application of advanced coatings (and materials)			
Additive manufacturing			
Net and near-net shape manufacture			
Managing fragmented value chains including distributed manufacturing to support HVM			
Building new business models to support HVM			

Key: HVM national competency focus of the technical and vocational centre by sector cluster, updated post 5th March 2015 workshop. Competency focus shown in red

3.3 Education & Training Requirements

In the separate annex IfM have presented high level education and training proposals, which include:

- Developing educational offerings directed at 'transition and growth' for micro- and small enterprises and their leaders who are seeking to grow and exploit new markets
- Linking to the High Value Manufacturing Catapult-based 'National College for Advanced Manufacturing' (NCAM) for competency-based technical skills and basic business skills development and to the National College for Digital Skills (NCDS).

As regards offerings directed at 'transition and growth', these are summarised in Table 6 below which segments company types and their potential high-level requirements. It should be noted that this summary is a 'straw man' subject to further development in the next stage of the programme.

Factor	Maturity	Education requirement
Multinationals	Typically of high maturity	Development of product, process, service business process and business model innovation processes and external benchmarking for 'best practice'. Location analysis, network design and management, change programme design and management
Mid-size firms (i.e. £50 million – £1 billion turnover)	Typically fairly high maturity at the top end, with low levels exhibited at the lower end	Top end as above plus multi-site management processes, integration and trade-offs between site/functional strategies and overall strategy. Bottom end require strategy and organisation development to integrate innovation and commercial priorities
Small/medium-size enterprises	Usually low maturity	Strategies for growth, functional process improvement, product and process innovation, sales and market development, support/infrastructure improvement
Early stage ventures stage three: Scale-up	Low	As below but in greater depth and with investor exit strategies, supply networks, logistics, process optimisation, growth management, scale-up of the business model (this includes the whole business, not just production)
Early stage ventures stage two: Start-up	Low	As below but in greater depth and with business basics – company law, finance, infrastructure, HR, operational process design. Validate the business model through successful trading
Early stage ventures stage one: Concept development	Low	Development of the business model, comprising the customer and other (e.g. investor) value propositions; configuration of key capabilities (resources and processes); and financial models Market and Customer Value proposition, investor value proposition, business model/ case development, pitching and networking

Table 6 - Straw man educational requirements for innovation: Source IfM desktop review

As regards linkages to NCAM and NCDS, these would facilitate the development of educational programmes aimed at supporting the key national competencies identified in this study. The annex shows in more detail how local education offerings associated with each national competency are identified, together with an analysis of educational inputs (apprenticeships, short courses, workbooks, etc.) to be offered by the technical and vocational centre.

Workshop delegates agreed that the offers by the technical and vocational centre, together with other local providers and partners (principally the University of Cambridge) should include:

- Education and awareness courses/short courses and workbooks
- Apprentice training
- Adapting current degree content
- Seminars, etc. for those needing to be aware of what is available in university degrees and university research.

Table 8 on pages 24 and 25 outlines delegates' recommendations for specific actions in these areas.

Emphasis should be placed on leadership and management skills as well as awareness of the potential for applying multiple technologies in combination and the ability to integrate them in addressing market and customer needs.

A significant need was noted for the composites sector for lightweighting competencies, as was the potential for the Enterprise Campus to support its selling point of 'scale-up and market-driven innovation' across a wide range of new technologies by means of a broad-based education and training offer.

Table 7 shows a first-pass mapping of education and training requirements against priority national competencies over the short, medium and long term.

Competency/Technology	Required timing S = 2015–20 M = 2020–25 L = 2025–30	First-Pass Education Requirements			
		Education and awareness courses/short courses and workbooks	Apprenticeships (additional to traditional)	Current degree content	Still in research (seminars, etc.)
Energy generation, storage, management and security	S				
Design and manufacture for sustainability and through life	M-L				
Biotech, biological and synthetic biology processing	M-L				
Design and manufacture for lightweight vehicles, structures and devices (including composites)	S				
Understanding designing and manufacturing formulated products	M-L		Little Available	Little Available	Little Available
'Plug and play' manufacturing (including modular construction)	S				
Design and manufacture for small-scale and miniaturisation	M-L				
Process engineering capability and efficiency across food, pharmaceuticals and chemicals	S				
Novel mechanical conversion processes for scale economy and efficiency	M-L				
Systems modeling and integrated design/simulation	S				
Automation, mechanisation and human machine interface	S				
Smart, hybrid and multiple materials	M-L				
Intelligent systems and embedded electronics	M-L				
Development and application of advanced coatings	M-L				
Additive manufacturing	S				
Net and near net-shape manufacture	S				
Managing fragmented value chains including distributed manufacturing to support HVM	M-L				
Building new business models to support HVM	S				
Developing and retaining skills to support HVM	S				

Table 7 - Implications for education and training of emerging HVM competency focus of the technical and vocational centre updated from desk study following 5th March 2015 workshop. Education requirements are shown in red

4.0 Gap Closure Plans

Specific plans, with input to the priorities of the technical and vocational centre, were developed at the workshop on 5th March 2015 in five areas: industry/academic collaboration alignment; production automation; modular construction; 3D printing (additive manufacturing) and nuclear energy. Summaries of these plans are shown in Table 8 below. Plans are shown in full in the Appendix on pages A11–A21.

Similar inputs in the following fields: Food; lasers; composites; systems modelling; new medtech products; and smart products were gathered by consultation with industrial stakeholders following the workshop. These are summarised in Table 9 (pages 26–27) and shown in full in the Appendix, pages A24–A30.

Topic	Opportunity/Benefits	Key Priorities For The Technical & Vocational Centre	Recommended Actions
Industry/ academic collaboration alignment	• Expand 'Cambridge' brand beyond research and beyond Cambridge, to include manufacturing and commercialization • Align local research and industrial needs and opportunities to generate value (GDP, jobs, exports, foreign direct investment)	• Awareness of potential local employment opportunities • Broad technical engineering, manufacturing and ICT systems integration • Business capability development across value chain (across the full range of Technology Readiness Levels) • Accessibility of services with tailored, bite size if appropriate offers • Information services to publicise opportunities more effectively • Set up mechanisms (national, local, individual research projects) to align research and industrial needs and opportunities	• Industrial venture centre to provide focal point for industry-research (e.g.: 'anchor projects(s)') • Technical and vocational centre to provide training and industrial project-based learning for new products and processes • HVM Catapults to have local representation
Production automation	• Improve production efficiency and sustainability through automation and human machine interface (HMI) • To make local industry/ business efficient, and more successful long term with sustainable employment and growth	• Student projects to develop small scale automation and sustainability opportunities • Leadership and management, ISO9001/ HTS/data analysis • Apprenticeships in automation/HMI, sustainability and related fields • Right skills for support industries: maintenance/breakdown cover	• Investment in educational • Links to national research bodies if available to invest in renewable energy application developments • Grant funding as available to support 'full automation' implementation programmes
Modular construction	• Increase national use of modularised systems in construction industry • Create a national Centre of Excellence in Alconbury	• Cross skilling from other disciplines - Production - Design - Logistics • Support developments to address perceived quality and economics issues	• Invest in manufacture of modular construction systems, perhaps through patron client (i.e. Council and/or joint venture?) • Develop products and improve stakeholder perception

3D printing	• Alconbury as a Centre of Innovation in additive manufacturing (AM) • Enable innovators to make the right thing at the right time at the right price using high speed and accurate 3D printers and associated materials	• Connect businesses to the industry and research • Skills training (apprentice and graduate) - Software design - Printer development and application - Product design	• Partnering with the national innovation infrastructure in AM • Finding the right products to drive the technology • Design of high speed and accurate printers and 'inks'
Nuclear energy	• Capitalise on the nuclear market, particularly in UK, maximising the role of innovation from UK companies - National nuclear new Build - Decommissioning - Life extension	• Commercial skills • Project management skills • Leadership and management • Quality assurance: a key issue – cross cutting to Aerospace and MedTech	• Gauge interest and appetite for local industry • Development of potential collaboration • Identification of specific needs

Table 8 - Summary of gap closure plans, Alconbury Enterprise Campus workshop, 5th March 2015

Topic	Opportunity/Benefits	Key Priorities For The Technical & Vocational Centre	Recommended Actions
Lasers	• Enabling UK context (national strategy for laser-based manufacturing linked with the UK additive manufacturing national strategy) • Major trend towards tool-less, non-contact, flexible and high-precision manufacturing	• Raising awareness and understanding of what lasers can achieve (boundary-pushing approach) to educate people about lasers' possibilities in numerous sectors, e.g. in design	• Investment supporting the commercialisation of the novel ideas explored at the lab level (UK currently loses ground to countries which are better at capitalising on their laser-related research like the US, Germany or even Italy)
Advanced materials (particularly composites)	• Pre-existing UK strategy for composites (e.g. National Composites Centre, investment from the UK government) • Increased demand for composite materials	• Training to support the skills base necessary for applying advanced and specialist composite technologies • Exploring re-training opportunities (e.g. people designing in steel re-trained to design with polymer composites)	• Raising the profile of plastics engineers
Systems modelling	• Addressing the increased requirement of 'making it right the first time' • Risk reduction in the industrial process	• Development of a course teaching the 'extremes' of Excel to support systems modelling (financial and engineering) • Development of a course inspired by the British Computer Society (BCS) course on systems modelling	• Raising the profile of systems modelling and explaining where it fits into the design process • Stressing its key role in reducing uncertainty in industry
New medtech products	• High turnover & strong contribution to UK employment, with med tech companies generating a turnover of £18.1bn and employing 88,000 people[7] • Delivery of better healthcare	• Large range of issues/priorities given the diversity of the industry and value in focusing on a particular sub-sector (e.g. wound care as fastest product segment; in-vitro diagnostic for employment) • Raising awareness about existing structures (KTN, etc.) • Supporting better engagement and cooperation with local communities	• Assistance to companies in generating clinical data to validate their diagnostic tests (e.g. Academic Health Science Networks-type initiative) • Setting up of a unique portal that companies could go to get information about NHS needs, e.g. unmet clinical needs

[7] *BIS, Strength and Opportunity, 2014.*

Smart products	• Global challenges due to changes in demographics, wealth, mobility and availability of resources • Robust cleantech-related expertise and supporting technologies in the Cambridge area	• Information-sharing platform about range of existing financial resources and procedures to access them • Raising interest among students to become lab technicians (see good practices from the University Technical College (UTC) Cambridge)	• Launching of a national initiative inspired by the Cambridge Cleantech approach (community building & networking, business support) • More public investment in support of the portfolio of diverse technologies involved in the development of smart products
Food	• Constantly developing and hiring sector • Pressure towards cheaper, healthier, and more responsibly sourced products	• Training of a diverse and skilled workforce, from engineers and high-ability operators to food manufacturing plant technicians and health-and-safety managers	• Advertising how high-tech and innovative the food industry has become • Development of teaching programmes embracing the full spectrum of skills required in the food industry

Table 9 - Summary of gap closure plans, technical and vocational centre, post-workshop consultation

5.0 Next Steps

Immediate next steps identified to take forward the priorities identified in this report include skills deliver baselining, benchmarking and network building. Specific actions include:

- Learning from relevant projects elsewhere – for example, Torbay Electronics and Photonics Innovation Centre allied to South Devon College
- Developing the HVM community through, for example, planning events, including a large-scale event/conference in Summer 2016 in the new Club Facility (itself due for completion early 2016)
- Developing connections to both the National HVM and IT Colleges
- Industrial Venture Centre and/or IfM partnership
- Developing links further with the University of Cambridge.

In addition to the specific educational priorities identified by delegates and interviewees during the engagement process, IfM has developed a general summary of the educational priorities for the technical and vocational centre. In a context of linking with the University of Cambridge, particularly IfM but also potentially Cambridge Judge Business School and other institutions, for example Lord Ashcroft International Business School, these priorities divide into three themes:

- Developing educational offerings directed at 'transition and growth' for micro- and small enterprises and their leaders who are seeking to grow and exploit new markets
- Linking to NCAM for competency-based technical skills and basic business skills development
- Linking to NCDS.

Institute for Manufacturing
Department of Engineering
17 Charles Babbage Road
Cambridge CB3 0FS
United Kingdom

T: +44 (0)1223 766141
E: ifm-enquiries@eng.cam.ac.uk

IfM Education and Consultancy Services