EXTERNAL REVIEW REPORT OF NEW PROGRAMMES

<table>
<tr><td>1.</td><td>Title of Programme(s):</td><td colspan="6">BEng in Manufacturing (Apprenticeship Mode)

Higher Certificate in Manufacturing Engineering (Apprenticeship Mode)
(The latter will also act as an exit award for the BEng in Manufacturing (Apprenticeship Mode))</td></tr>
<tr><td>2.</td><td>School / Centre:</td><td colspan="6">School of Engineering</td></tr>
<tr><td>3.</td><td>Duration:</td><td colspan="6">3 years
2 years</td></tr>
<tr><td>4.</td><td>NFQ Level:

ISCED:</td><td colspan="6">Level 7
Level 6
0720</td></tr>
<tr><td rowspan="2">5.</td><td rowspan="2">Type of Review:</td><td colspan="2">New Programme:</td><td>Yes:</td><td>X</td><td>No:</td><td></td></tr>
<tr><td colspan="2">Differential Validation:</td><td>Yes:</td><td></td><td>No:</td><td>X</td></tr>
<tr><td>6.</td><td>Date of Review:</td><td colspan="6">17th February 2017</td></tr>
<tr><td>7.</td><td>Delivery Mode:</td><td>Full-time</td><td>X</td><td>Part-time</td><td></td><td>Blended</td><td></td></tr>
<tr><td>8.</td><td>Panel Members:</td><td colspan="6">Mr Tom Cullivan, Retired HETAC Secretary (Chair)
Dr Claire Broughan, DIT
Dr Kathryn Cormican, NUIG
Mr Aidan Fleming, Johnson & Johnson Vistakon
Dr Jean-Francois Fontaine, IUT Dijon, University of Burgandy
Ms Carmel Brennan, GMIT (Secretary)</td></tr>
<tr><td>9.</td><td>Proposing Staff:</td><td colspan="6">Mr Gerard MacMichael
Dr Carine Gachon
Dr Patrick Delassus
Dr Paul O’Dowd
Ms Denise Carthy, IBEC
Mr Greg Reddin, Johnson & Johnson
Mr Shane Beirne, IBEC</td></tr>
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10	Programme Rationale:	To meet the growing need for technicians and engineers in its member companies, the Irish Medtech Association[1], formerly the Irish Medical Devices Association (IMDA), proposed, in partnership with GMIT as the coordinating provider partner, two new programmes in apprenticeship; a two-year Higher Certificate in Engineering (Level 6) in Manufacturing Engineering and a three-year Bachelor's Degree in Engineering (level 7) in Manufacturing Engineering. While the Medical Device Technology sector is the target sector for these programmes, it is envisaged that graduates from these programmes could be employed in other highly regulated manufacturing sectors. Following a proposal submitted by the Irish Medtech Association to the National Apprentice Council (NAC), a consortium was formed to develop and deliver the accredited programmes, with partners from Ibec, the Irish Medtech Association and Institutes of Technology. Although the proposed programmes are intended to be rolled out across the provider partner Institutes of Technology nationally, it was initially agreed that the programmes will be accredited by Galway-Mayo Institute of Technology. In collaboration with the partners, the proposed programmes have been developed by the Department of Mechanical & Industrial Engineering within GMIT. The proposed programmes will leverage the expertise and physical resources of the apprentice employers (through work experience) as well as those of the provider partner Institutes to provide regional delivery of the apprentice programmes that produce graduate professional technicians and engineers to service the growing demand for these occupations profiles within the medical device manufacturing sector. Approved as a Category 1 apprenticeship (i.e. close to development and delivery) by the NAC, the Irish Medtech Association established the Irish Medtech Association Consortium to develop and run the apprentice programmes. It comprises of cross-functional representation from the Medtech sector, which includes Human Resource Managers and Manufacturing Operations professionals from the Medtech sector, and senior academics from Institutes of Technologies. The Institute of Technology providers that will collaborate in the design, delivery and monitoring of the HC/BEng programmes are shown in Table 1. An MOU outlining the roles and responsibilities of each partner in respect of collaboration towards

[1]The Irish Medtech Association is the business association within Ibec representing the medical devices and diagnostics sector. The Irish Medtech Association has almost 200 members, located throughout the island of Ireland. Irish Medtech Association's broad focus is to promote and support an environment that encourages the sustainable development and profitable growth of our multinational and small to medium size medical device and diagnostic companies. Available at: http://www.irishmedtechassoc.ie/Sectors/IMDA/IMDA.nsf/vPages/About_us~about-the-association!OpenDocument

		the design, delivery and on-going development of the HC/BEng Manufacturing Engineering programmes has been developed.

Table 1 Provider Consortium
Athlone Institute of Technology (AIT)
Cork Institute of Technology (CIT)
Dublin Institute of Technology (DIT)
Galway-Mayo Institute of Technology (GMIT)
Limerick Institute of Technology (LIT)
Institute of Technology Sligo (IT Sligo)
Waterford Institute of Technology (WIT)

According to the industry feedback and discussions through the Irish Medtech Association Steering Committee on Skills in Operational Excellence, the current education system is not delivering sufficient quantities of skilled manufacturing technicians and engineers. Industry believes that the education system itself provides an opportunity to transfer core knowledge, but knowledge itself will not necessarily make a skilled worker.

In addition, many Government reports have also identified the shortage of technicians and engineers for the engineering sectors, specifically the medical technology sector. The Forfás Expert Group on Future Skills Report[2] and the Forfás Manufacturing 2020[3] report both highlight the need for increased levels of skilled technicians and engineers.

The medical technology industry requires appropriately qualified individuals to better meet Ireland's current and future business needs. The current education model is characterised either by a high percentage of third level graduates filling lower level roles; or poorly educated individuals occupying important lower level roles. In addition, employing graduates which occupy technical roles without having the optimal skills for that role is a more expensive option for a business.

The proposed manufacturing apprenticeship programmes will enable companies to recruit individuals with little or no experience in manufacturing, to gain in a cost effective and best-in-class manner, the necessary training and on-the-job experience to become proficient enough to fill technician and engineer roles.

[2] *National Skills Bulletin 2016* available at http://www.skillsireland.ie/Publications/2016/National-Skills-Bulletin-2016-Web-Final.pdf

[3] Forfás*: Making it in Ireland - Manufacturing 2020* available at https://www.djei.ie/en/Publications/Publication-files/Forfás/Making-it-in-Ireland-Manufacturing-2020.pdf

		Furthermore, these programmes will provide a clear career path for individuals to progress within a company through a structured, practical learning mechanism, with dedicated on-the-job mentoring. While technicians and engineers will always be required through the traditional full-time education route, there is a real opportunity for apprenticeship programmes in manufacturing to transfer and integrate the on-campus education and on-the-job skilling for this highly technical and regulated industry. The Medtech sector is passionate about creating an opportunity for individuals who may have excellent practical aptitude that will be nurtured though an apprenticeship approach.
11	Potential Demand for Entry:	It is proposed to initially offer 20 places per intake, with two blocks planned in the first year of the programme.
12	Stakeholder Engagement:	In 2014, the Irish Medtech Association carried out an initial member survey on the proposed number of apprentices required. A total number of 47 technicians and 22 Engineers were required at that time. Based on member feedback, it is expected that majority of the apprentices in years 1 and 2 will arise from the upskilling of existing staff. Following initial meetings, the Irish Medtech Association Consortium created 2 sub-groups, viz., the HR Subgroup and Technical Subgroup. The relevant subgroups groups convened at regular monthly meetings to develop the programmes. The consortium consists of Irish Medtech Association industry members and provider members.
13	Graduate Demand:	Manufacturing is expected to grow by 43,000 jobs over the period 2011-2020 (Ireland's National Skills Strategy 2025, Dept. of Education and Skills)[4]. Enterprise 2025 identifies the potential for growth in Irish owned manufacturing and services exports of between 6 and 8 percent annually to 2020 (Enterprise 2025, Dept. of Jobs, enterprise and Innovation). Enterprise 2025 has identified the need to build on existing strengths in complex manufacturing - in areas such as Medical Devices, pharma/bio engineering, food and packaging (Enterprise 2025, Dept. of Jobs, Enterprise and Innovation). Growth in the complex manufacturing sector is resulting and will result in skills shortages for Professionals and Associate Professionals across sectors in Engineering.

[4]Dept. of Education and Skills, 2016, "Ireland's National Skills Strategy 2025"
http://www.education.ie/en/Publications/Policy-Reports/pub_national_skills_strategy_2025.pdf

		The shortage of manufacturing engineers is not just confined to Ireland. In the USA, 33% of executives in manufacturing reported a "severe or high" shortage of engineers in 2014, and 48% predicted a "severe or high" shortage in 2020. (The Skills Gap in U.S. Manufacturing - 2015 and Beyond, The Manufacturing Institute and Deloitte, 2015)[5] In April 2014, the Irish Medtech Association conducted a skills-needs survey of its members organisations. The 28 responding companies had 577 current vacancies, with a further 563 positions available over the following 12 months. Of these, 35% were for level 7/8 Manufacturing Engineers/ Technicians. Extrapolating to all Irish Medtech Association member companies, the survey suggests that there are 600 positions available on a yearly basis for manufacturing technicians in the medical devices sector alone (Irish Medtech Association, 2016). Graduates from these two Programmes in Manufacturing Engineering programmes will have the skills and experience necessary to become self-employed or to build a career in one or more of the following fields: • Manufacturing Engineering • Quality Engineering • CAD / CAM and CNC • Lean / Six Sigma Engineering • Production and process Engineering • Operations management, production planning and supply chain engineering • Project management • Maintenance and safety
14	Entry Requirements:	The candidate applies directly to the SOLAS-approved employer and is selected using the employer's standard recruitment process. Then the employer requests Apprentice Approval from SOLAS. If successful, SOLAS will register the student and the student will sign a contract. The consortium will then be informed by the SOLAS Apprenticeship Officer, and it will compile a viable list of candidates for the appropriate regional academic partner. *School leaver applicants:* The minimum Leaving Certificate requirements for entry into the proposed programmes is a pass (Grade O6 or better) in five leaving certificate subjects with a minimum of 250 points, or equivalent.

[5]The Manufacturing Institute and Deloitte, 2015 "The skills gap in U.S. manufacturing - 2015 and beyond" http://www.themanufacturinginstitute.org/~/media/827DBC76533942679A15EF7067A704CD.ashx

		FETAC applicants: FETAC applicants can also choose to apply following the same procedure. *Mature applicants:* Mature applicants do not have to meet the leaving certificate entry requirements for the programmes, and they are assessed based upon their previous education and work experience pending a demonstration of their ability and competence to undertake the programme.
15	Programme Structure:	The programmes proposed are not craft apprenticeship but cognitive ones. Cognitive apprenticeship is a "learning-through-guided experience" process. It focuses on cognitive skills (thinking, learning, reasoning) and metacognitive skills (planning, problem-solving, monitoring, self-assessing), as well as the "hard" technical skills required by engineers and technicians. The Programme board decided that, as per Kolb's cycle, the first stage of the Programmes was to be a "Concrete Experience". Following a short induction (a day or so) in GMIT, students will integrate their company for an 11 weeks' induction block. It is expected that being in-situ will trigger an interest in specific skills inherent to the Programmes, such as those of manufacturing and automation. This stage will foster intrinsic motivation which will allow for an easier integration into the subsequent Academic Block. Intrinsically motivated students will also engage more readily in self-learning activities. Considering that the Academic component of the programmes is of 15 weeks' length per stage, as opposed to the traditional 26 weeks, self-learning is essential to the successful completion of both Programmes and justifies reducing overall contact hours in some modules. Working in a highly-regulated industry, the students will also experience the importance of "Quality", which is one of the first Academic Block modules. They will also be expected, as part of the LIS module, to compile a short Induction Report and Presentation on their company. During the 11 weeks, the students will have access to online materials in GMIT's "Academic Success: Skills for Learning, Skills for Life" Moodle package, which includes a preparatory module on "What is Higher Education For?".

Academic Blocks

During the Academic Blocks, more traditional teaching and learning strategies will be used such as lectures, tutorial and laboratories, and will apply to generic engineering modules such as Mathematics and Engineering Sciences. However, more discipline-specific modules, such as Quality, will take advantage of the "Concrete Experience" acquired in the industry, and concentrate on the "Reflective Observation" and "Abstract Conceptualisation", giving them the knowledge, skills and guidance necessary to progress through Kolb's cycle, and preparing them for the "Active Experimentation" phase. At the end of each Academic Block, four of the modules will continue into the Industry Block where students must complete a project, facilitating the "Active Experimentation" phase of the cycle.

Industry Blocks

The learning strategy of the industry module is centred around the Cognitive Apprenticeship Theory framework, with the Industry Mentor providing Modelling, Coaching, Scaffolding, Articulation and Exploration for the student.

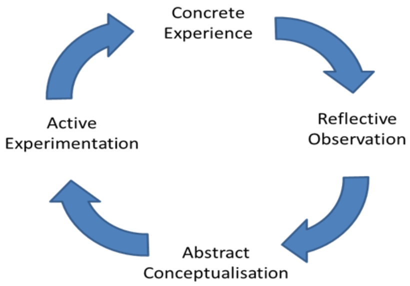
The Industry Modules also take into consideration the student Zone of Proximal Development as defined by Vygotsky[6].The role given to the apprentice will be incremental and as follows:

- *Industry Module 1:* Trainee Technician
- *Industry Module 2:* Technician
- *Industry Module 3:* Trainee engineer

In these modules, students will be expected to, not only develop skills, but also competences. Transferring the acquisition of skills and competences into the workplace is essential to the programme since it allows the programme to be taught in significantly fewer academic hours than a traditional one.

To accelerate and enhance the development of their competence, as part of the Industry Modules assessment, students will have to complete a Reflective Logbook. It is expected that, in the early stage of the programme, students' observation entered in the logbook will be mainly descriptive, and the reflective part must be integrated in the subsequent academic modules. However, with the support of their Academic Supervisor, students will develop their reflection skills and, by the end of their programme, in particular for the level 7, they will be able to critically reflect on both their work and learning. This will allow them to become self-regulated learners and ready to continue the Experiential Learning cycle on their own.

[6] Vygotsky, L.S. (1978), *Mind in Society.* Cambridge, MA: Harvard University Press

16	LTA:	The Teaching and Learning strategy of the proposed programmes revolves around Kolb's Experiential Learning Theory[7] in general, and the Theories of Situated Learning[8] and Cognitive Apprenticeship[9] in particular, in transferring the acquisition of some of the skills and most of the competences to the workplace. In his theory of Experiential learning, Kolb argued that learning is most effective when following the cycle presented in Fig. 1.  ***Figure 1 Kolb's Experiential Learning Cycle*** The first element of the cycle is "Concrete Experience", referring to the fact that students learn better by "doing". In traditional Programmes of education, work experience is offered at the end of the curriculum and used as a capstone rather than an experience to be built on. In the model presented here, students are working in the Industry Blocks from the beginning, providing them with an ideal "Concrete Experience". Lave and Wenger (1991) also argued, with their "Situated Learning Theory", that students learn better when immersed in an environment relevant to their learning. Accordingly, the Industry Blocks will give context, facilitate "Abstract Conceptualisation", and offer extended opportunities for "Active Experimentation". "Abstract Conceptualisation" is particularly important for this new model of apprenticeship, where students will be expected to, not only acquire practical skills, as the traditional apprenticeship would have been, but also develop cognitive and metacognitive ones (in particular at Level 7). This type of apprenticeship was defined by Collins et al. (1989) as "Cognitive apprenticeship". They argued that Cognitive apprenticeship also fosters intrinsic motivation by developing learning goals, which

[7]Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development* (Vol. 1). Englewood Cliffs, NJ: Prentice-Hall

[8]Lave, Jean; Wenger, Etienne*(1991). Situated Learning: Legitimate Peripheral Participation. Cambridge: Cambridge University Press. ISBN 0-521-42374-0.*; first published in 1990 as Institute for Research on Learning report 90-0013

[9]Collins, A., Brown, J. S., & Newman, S. (1989). Cognitive apprenticeship: teaching the crafts of reading, writing, and mathematics. In L. B. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 453-494). Hillsdale, NJ: Erlbaum

		result in more relevant motivation than performance goals[10][11]. Students are more motivated if they understand the value of the skills they are learning. In designing the programme, the programme design team considered the balance between formative and summative assessments. They have also ensured that a range of assessment methodologies are utilised as appropriate to assess the module and programme learning outcomes, including the development of transferable skills. In preparing the assessment strategy, the programme design team reflected again on Kolb's experiential learning cycle. If the Industry Module could clearly provide a "concrete experience", and the Institute facilitate the "abstract conceptualisation", the two other elements of the cycles were not as straight forward. There is a need for students to develop their reflective skills as well as their ability to implement "active experimentation". To guide students through the "active experimentation process", each year, as well as the Industry Module, up to five academic modules will continue on into the Industry Block. In these modules, students will have to complete assessments that will assist their active experimentation. In order to reduce the workload and to highlight the relationship between some of the modules, some of the assessments will be integrated. The experiential learning assessment is therefore divided in four distinct type of assessments: 1. HR performance evaluation for the Concrete Experience 2. Reflective Logbook for the Reflective Observation 3. Project for the Active experimentation 4. Process Study also for the Active experimentation
17	ATP:	It is possible that apprentices may transfer to other provider consortium members if the contract of apprenticeship is transferred to another company in the catchment area of the provider. Graduates from the Higher Certificate in Engineering in Manufacturing Engineering apprenticeship program may progress to the Institute's Bachelor Degree (Level 7) in Engineering in Manufacturing Engineering non-apprenticeship programme (in development) or other cognate level 7 non-apprenticeship programmes.

[10]Elliot, E.S. & Dweck, C.S. (1988), "Goals: an approach to motivation and achievement", in *Journal of Personality and Social Psychology*, 54, pp.5-12
[11]Dweck, C.S. & Legget, E.L.(1988), "A social cognitive approach to motivation and personality", in *Psycholical Review*, 95, pp.256-273

		Graduates of the Ordinary Bachelor Degree in Engineering in Manufacturing Engineering apprenticeship programme may progress to cognate one-year add-on or final year of relevant Bachelor (Level 8) Degree in Engineering programmes.
18	Resource Implications:	Two additional staff members are required to run two sequential groups in an academic year. The present reference library stock and journal subscriptions need to be increased to reflect the specific requirements of Manufacturing Engineering. The estimated cost of this material is €5,000. However, the e-learning resources (subscription or reference databases etc.) should be sufficient and appropriate for the proposed programme. It is envisaged that a budget of €250,000 to purchase equipment and upgrade laboratories will be required, for use by this and the department's others programmes.
19	Synergies with existing programmes:	It is not envisaged that the cohort of students on this proposed programme will share common modules with other programmes due to the starting timeline and the apprentice delivery mode.
20	Findings and Recommend-ations:	The panel are recommending approval of the proposed programme, subject to the following recommendations:
		Special conditions attaching to approval (if any):
		• None
		Recommendations of the panel in relation to award sought:
		• Develop a learner agreement/charter to be used with all apprentices and issue all apprentice learners with a customised project handbook. • Articulate contingency arrangements for instances where industry mentors leave their company to ensure a continued positive mentoring experience for apprentices. In addition, clarify how the participating companies and their wider staff will be educated about the apprenticeship programme. • Annually review the programme in the early years of delivery taking remedial action, as relevant. In addition, the programme structure and modules should undergo a comprehensive programmatic review in accordance with GMIT's schedule, based on the programme board's

		experience of delivering the programme and considering the views of all stakeholders. • Quality 1 module should be more focussed on manufacturing than on design. This may involve a redistribution of material between Quality 1 and Quality 2. Emphasise documentation and risk management in Quality 1. Include an increased emphasis on validation in Quality 2. • Articulate the process by which students will learn how to reflect on their learning as they progress through the programme. • The programme board should consider carefully the profile of external examiners to be recommended to the Registrar, perhaps using an appropriate educationalist and an industry expert who will assist in the development of this unique programme as it rolls out. It would be useful to have an international external examiner with experience of the apprenticeship mode of learning. • Consider how best to ensure maximum student engagement with essential elements of assessment, thereby confirming that the learning outcomes are achieved. • Articulate clearly the progression routes open to graduates of these programmes, and ensure communication of same to applicants.	
22.	FAO: Academic Council:		
		Approved:	
		Approved subject to recommended changes:	X
		Not approved at this time:	
	Signed:		
		Chair	Secretary