

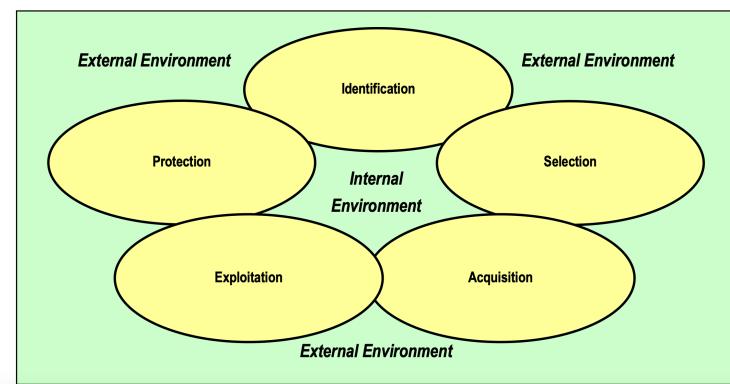
The following provide an indication of what was being looked for in the exam paper, but they do not constitute the “right answer”

Question 1

a) Explain the technology management process framework (ISAEF) and its applications. [30%]

This question requires students to refer to this framework.

There are 5 technology management “dynamic” capabilities



The technology management process framework describes the five fundamental capabilities required to support the management of technology in organisations. This framework includes identification, selection, acquisition, expectation, and protection. These capabilities interlink and allow firms to take technology decisions in support of their strategic, innovation and operation plans and adapt in the face of environmental changes (they are “dynamic” capabilities). Companies have different ways of implementing each of these capabilities, balancing the internal resources and capabilities (Internal environment) with the conditions in the outside world (external environment).

Identification allows companies to stay up to date with science and technological developments to appreciate the risk and opportunities provided by new developments in science and technology. This is done through technology intelligence activities which help to tap different sources of information (people and documents, inside and outside the organisation) to gather insight useful for developing strategic plans, (e.g. identify possible disruptions, technology to acquire and partners who have them or companies who may be interested to buy our technology).

Selection involves choosing which technologies the company should rely on and hence should decide to develop. Selection requires the definition of criteria to assess the opportunity (i.e. prospect of value) and feasibility (risks associated with the technology) provided by new technology. Several quantitative techniques, such as return of investment and net present value, could help companies assess and compare the value of different technologies. However, fundamentally, the evaluation of a future technology is highly speculative exercise, which cannot be reduced to bare calculations, but needs to extrapolate values from market trends and subjective factors.

Acquisition: this is the capability that allows companies to decide whether to develop a technology internally or to acquire it from the outside word. This competence supports a process which firstly deals with the fundamental decision on whether to acquire (motivation). This decision is helped by using criteria such as 1) the importance of the technology to our business and 2) how does our technology compare with other external technology (make versus buy decision). Secondly, acquisition helps deciding the pathway to acquire the technology, including how to collaborate with the partners. This is why companies rely on open innovation approaches to acquire technology from different potential providers.

Exploitation helps firms realise value from their technology. This capability allows firms to choose between different types of business models, such as: sell the technology by selling products, services, into products and services and into products and consumables. However, other ways to gather value include the decision to allow others to use the technology for example via selling or licensing the technology. Also, exploitation hence relates to open innovation approaches because it involves exchanging technologies and knowledge across organisations.

Protection is concerned with the preservation of the technological knowledge to guarantee that companies can maximise the value they can obtain from it overtime. The knowledge to be preserved pertains to different aspects of a technology (e.g. functioning, design, brand, know-how..). Hence protection involves the use of different intellectual property (IPR) rights protection methods (patents, copyrights, trademarks, design rights, etc). IPR is based on systems which balance the interests of the public and society to have innovation disclosed and the interest of those who develop the technology (e.g. individuals or companies).

A good answer will concisely but exhaustively cover all the aspects of the ISAEP framework (will concentrate on the description).

The best answers will shine because the authors manage to cover not just the description of the framework basic details as above but also will be able to explain via demonstrating an understanding of its application and meaning as a reflection gathered throughout the course.

For example, the answer could show:

- Why the ISAEP capabilities can be considered dynamic capabilities
- That the student appreciates the interconnectedness of the various capabilities covered by the framework and across the course.
- Although the question did not explicitly require it, examples which add details and demonstrate a deep understanding of the material covered in the course will be positively evaluated, providing that they are additional to the theoretical explanation.

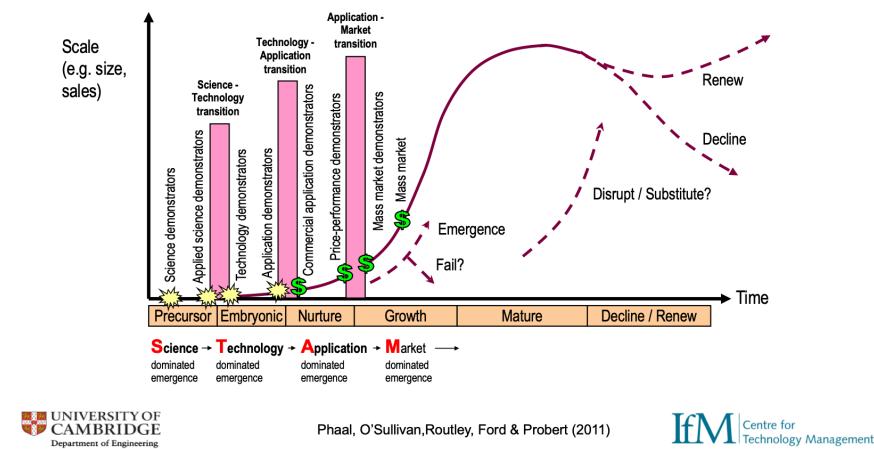
(b) Describe the Industrial Emergence Framework and explain how it can be used by a startup developing advanced battery technology [40%]

To be of highest standard, answers should be balanced in covering both the explanation and the application parts of the question. The quality of the answerer would transpire especially from the application part.

Description of the framework: The framework explains the early stages of the innovation in an industry when early scientific technological research is transformed into an application and eventually reaches the market. The framework expands the early

stages of s- curve and reveals periods where the industry emphasis in the goal to establish the technology is aimed towards firstly scientific advances, followed by technological than application and eventually market developments.

Phases, transitions and milestones of industrial emergence



This framework identifies three transitions between the phases of technology emergence (Science, Technology, Application, Market dominated emergence) so it is also known as the STAM model. The transitions are between science and technology, between technology and application and between application and the market diffusion. Each transition is characterised by demonstrators. The science phase establishes the phenomenon and generates early application demonstrations, which then the technology phase aims to develop to demonstrate the commercial aspects of the technology. The application phase shows the viability of the technology in the market and explores possible exploitation routes. Finally, the market dominated phase starts its diffusion in the market.

Application part of the question: here students should start from the scenario (which sets specific users start-ups/battery technology) and demonstrate an understanding of the potential applications of the model in real life. The answer might include for example (This is not an exhaustive list and plausible explanations of the uses of the framework not listed might be accepted if logical):

- the understanding of the model could help the startup position where they are in the trail of demonstrators of their technology for the industry and hence to plan and clarify what their next steps need to be. Hence this model could help to develop their strategy to take the technology to market. They could do it by starting from their knowledge of battery technology today to “forecast” where the technology might get to eventually (and what demonstrators might be needed). Alternatively, by starting to imagine where their technology could be when it reaches the market they could “backcast” by thinking: if this is the future status, what would be the step before and the one before that, etc.?
- Secondly, the model could also help them understand the broader evolution of the industry which is developing analogue technology (has anyone already created a demonstration for the next transition and moved forward in battery technology compared to us?).

- Thirdly, by doing the strategic thinking supported by the demonstration pathway of the STAM it would become easier to communicate a stronger proposition for developing the technology to investors (e.g. in grant proposals, or to angels or venture capitals).

(c) For innovation management in the context of new product development (NPD), discuss the differences (including strengths and weaknesses) between:

- (i) the Waterfall or Stage-Gate® model and
- (ii) Agile methodologies.

Provide examples to support your answer and explain in what contexts each approach might be more appropriate. [30%]

Basic answers manage to at least describe the two approaches, provide enough details to differentiate between the two, listing some characteristic strengths and weaknesses, where the two might be most appropriate as well as some examples (at least those included in the lecture notes).

The Stage-Gate® model is a structured approach to new product development (NPD) that divides the process into sequential stages, such as discovery, scoping, development, testing, and launch. Each stage concludes with a "gate" where decisions are made about whether to continue, adjust, or terminate the project. This model's strengths include its ability to reduce risks through rigorous reviews and its suitability for complex, high-stakes projects like pharmaceuticals or automotive innovation. However, it can be rigid, making it less responsive to rapidly changing market needs.

In contrast, Agile methodologies emphasize flexibility and iteration. Agile focuses on shorter development cycles (sprints) and frequent customer feedback, making it highly effective in dynamic environments like software development. Its key strength is adaptability, but it can struggle with long-term planning and coordination in large-scale projects.

Stage-Gate® is better suited for industries requiring detailed planning and risk management, while Agile thrives in fast-paced, uncertain markets.

Examples (e.g. from the lecture): A car manufacturer such as Lotus used the Stage-Gate model to systematically develop a new vehicle (Elise) aligning with the market. An e-commerce platform such as Spotify employed Agile to release incremental updates, responding to customer needs and market trends.

Improved answers include more details about the two approaches and more importantly lift the quality of the answer by adding personal reflection (the question asks to discuss) on the appropriateness in different contexts of the two methods, which demonstrate personal research.

For example, this could be done by explaining that with Stage-Gate each stage of New Product Development (NPD) (e.g., concept development, testing, and launch) is carefully reviewed before advancing, this means risks reduction in innovation and aligns resources effectively. However, its linear structure designed upfront might be more appropriate for innovation that is more predictable (as we can understand the resources needed based on our prior experience). Instead, it can slow the innovation process and hinder responsiveness to

unexpected changes, which may limit its effectiveness in dynamic or unpredictable markets. This model also might create excessive bureaucracy and may slow progress in less regulated industries.

Agile methodologies instead enable rapid adaptation by breaking projects into smaller, iterative cycles (sprints) and it is hence appropriate where requirements evolve fast, such as in software or tech innovation, as it can increases flexibility and an ability to incorporate feedback. However, while Agile supports communication across all functions in a team, it may lack the discipline and documentation required for highly regulated industries. Challenges in coordinating across large teams or maintaining focus in long-term, complex projects might emerge.

These improved answers might demonstrate the understanding that these two methods are not mutually exclusive, and companies have the option of integrating them. Answers that include examples of how companies they have researched deploy these methods would be appreciated.

Question 2

(a) Discuss how a small or medium-sized enterprise (SME) in the food manufacturing sector could apply technology management tools and techniques to respond to the emergence of automation technologies. [50%]

This question is designed to stimulate reflection and application of learned theory in a practical scenario. The key issues here are that this a small-sized firm, in a sector with typically limited margins, therefore we may assume very limited capacity to devote time to exploring new technology opportunities.

Answer could reference the five technology management processes and focus on the ways in which these might be used in the context of process technology such as automation. This does not require the student to know much about the automation technology but does require them to think about how a technology at its early stage of adoption that is surrounded by lots of information ‘noise’ (e.g. hard to understand which competing standard to adopt, the real costs/benefits, lots of competing technologies and suppliers, etc) and with high levels of technological and market uncertainty might impact on a resource constrained manufacturing firm (e.g. Is this going to be a key source of competitive advantage in the future? How fast? What are the consequences of investing? (e.g. workforce training, adapting processes), Can they risk not investing in it? Where might investment come from? What sort of timescales? How might the technology be deployed?).

The **basic answer** should demonstrate an understanding of the typical technology management challenges facing a small sized manufacturing firm, and how technology management tools (such as tech. roadmapping, scenario planning, technology intelligence, MvB analysis etc) might be used to help them deal with these challenges.

Stronger answers might include some of the thinking below (even if other relevant points might be acceptable):

- reflect upon the practical challenges of implementing technology management tools and techniques (often designed and developed by large companies) in a small firm.
- connect the discussion of the implementation of the approaches to issues such as the nature of the company’s strategy and ambition, and the sector within which it is operating.
- explore possible different scenarios for the adoption of this technology, ranging from accessing it via a service provider, to transforming the company’s core operations (exploring the options in acquisition decisions)

(b) If a company is deciding between two projects—one involving the development of a new product for a growing but competitive market and another focused on incremental improvement of an existing product in a well-established market—how would the opportunity and feasibility method guide the decision-making process? [30%]

This question gives a scenario onto which to apply the opportunity-feasibility method. The basic answer will draw more on the description of the method, whilst the best answers will specifically address well the application scenario proposed.

Method Description: The opportunity and feasibility method evaluates projects based on two dimensions:

- the potential value or benefit a project could bring to the organization. Factors include: Market size and growth (e.g., size of the target market, potential for growth), Profitability (e.g., margin improvement, financial returns), Competitive differentiation (e.g., how the product stands out in the market) or Strategic alignment (e.g., alignment with organizational goals).
- the organization's ability to successfully execute the project. Factors include: Technical capability (e.g., availability of expertise and resources to develop the product), Market readiness (e.g., timing and readiness of the market to adopt the product), Organizational backing (e.g., alignment with internal processes, management support).

Projects are scored on these dimensions, often using a scale (e.g., 0–12 or H,M,L). The results are plotted on an Opportunity-Feasibility grid to visualize their potential and guide decision-making.

Application: Plotting the opportunity (i.e. the value or benefit the project could generate) and the feasibility (the organization's ability to execute the project) ensures decisions are aligned with strategic goals by systematically quantifying factors and integrating them into portfolio matrices (i.e. matrices where several projects are compared) for clearer prioritization (*portfolio management*).

For the example some assumptions could be made to explain how the question could be answered:

- the new product targeting a growing market might have high opportunity scores for factors like market growth and potential profitability but lower feasibility scores due to competitive intensity and the technical challenges of differentiation. Conversely, the incremental improvement project may score lower in opportunity, as the market is stable and the growth potential is limited, but higher in feasibility, given the organization's familiarity with the product and ease of integration into existing processes.

Using the Opportunity-Feasibility grid, managers can plot the best- and worst-case scenarios for both projects allowing different people in an organisation to express and compare their perception about the opportunity/feasibility. By visualizing these (and other) projects on the grid, the organization can make their investment decisions based on its strategic aims (i.e. how to invest in new technology and spread the risk) – with a portfolio management approach.

The best answers might include:

- a mock diagram.
- how the organization's overarching strategic goals (e.g., risk tolerance, resource allocation, innovation focus) would influence the decision. For instance, discuss how a risk-averse company might favour the incremental improvement project.
- Acknowledging how the scoring system accounts for uncertainty, such as by assigning ranges (best- and worst-case scenarios) and factoring in potential risk or confidence levels.

(c) Explain what scenario planning is and how it is used for strategic planning. [20%]

This question requires explaining the key characteristics of this technique and its role.

Basic Answers include

1. Its characteristics such as:

- Scenario planning is a strategic planning method that organizations use to envision and prepare for possible future environments or situations.
- Instead of predicting one specific future, scenario planning explores multiple plausible future scenarios (typically 4 – plotted on axes that represent the most

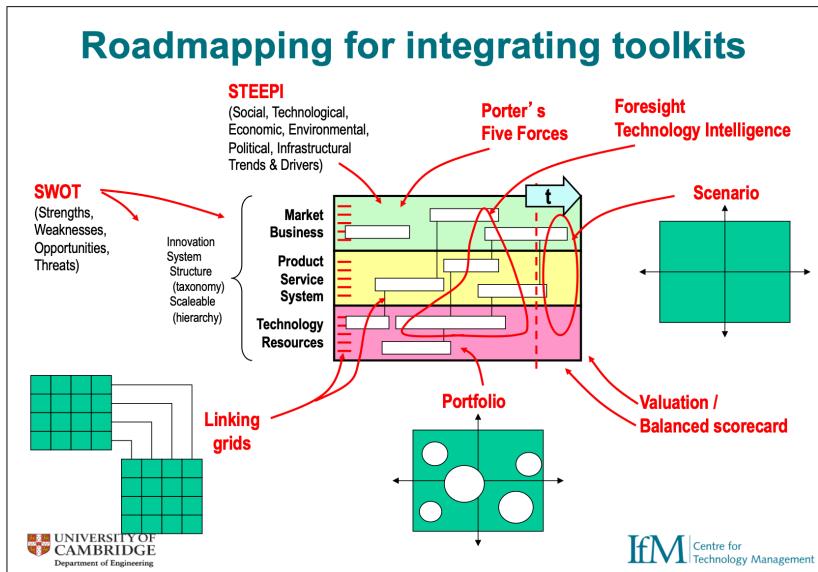
uncertain trends), allowing organizations to identify risks, opportunities, and strategies for adaptation.

2. Description of its role in strategic planning:

- The method is particularly valuable in formulating possible futures addressing high uncertainty, complexity, or rapid change.
- It focuses on crafting narratives for "what could happen" rather than "what will happen."

The **best answers** will demonstrate more understanding of the technique by linking with other elements of the course, for instance:

- that scenario planning is only one of the techniques available to those who formulate strategic plans.
- As it helps to envision a possible set of futures, it can be integrated with other techniques (e.g. see diagram below). For example, to develop strategic plans one could develop a roadmapping to plan for each of the 4 scenarios developed.



Question 3

(a) Discuss, providing examples, the different business models for bringing a technology to market. [20%]

This question requires the responses not only to list and describe the different business models available but also to include their pros and cons, and considerations about their appropriateness in different circumstances and basically the link between the business model, the resources needed and those available:

The basic models to be described are:

- selling a product,
- selling a service,
- selling a product with the service,
- selling a product and consumables,
- selling an idea,
- licensing an idea,
- partner or do everything by themselves.

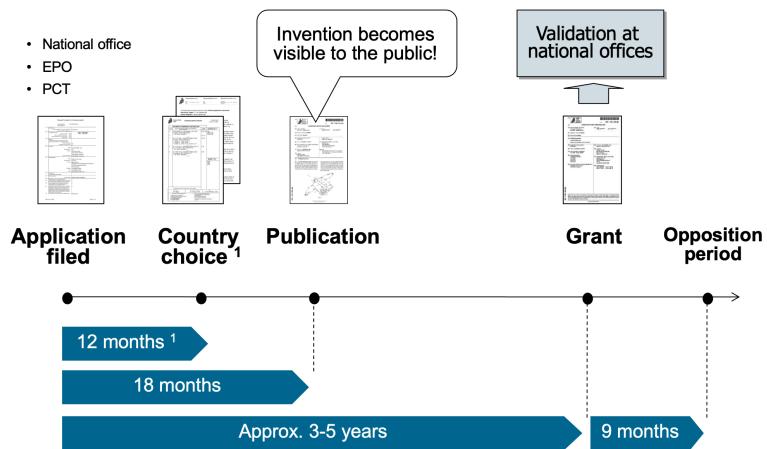
Considerations for appropriateness include, for example:

- the nature of the technology (soft vs hard),
- the stage of development,
- the needs in the market,
- the availability of partners/competitors

(b) i. Explain how patents work. [10%]

The most clear, complete and concise answer would obtain best marks. The answer may include elements such as:

- What are patents:
 - patents are IP rights that protect technical inventions.
 - patents are exclusive rights, i.e. they can be used by the owner to prevent others from using the invention protected by the patent, respectively its claims (claims can be narrow or broad or something in between).
 - patents are national rights, so need to be applied in countries separately (with some exceptions, e.g. the EPO member states) and the inventions can be freely used in countries where no patents exist.
- Patent Enforcement:
 - after being granted, it is up to the owners to take action to enforce its patents.
- Obtaining a patent:
 - It takes time to be issued a patent (see generic process from lecture below).
 - Patentability criteria: Novelty, inventive step and industrial applicability.
 - Renewal fees typically have to be paid to keep patents “alive” for a maximum duration of 20 years (with renewal fees typically increasing over time).
- Exploiting Patents: they can be licensed in all kinds of ways, such as exclusively to selected licensees or non-exclusively charging the licensees royalties.



ii. For each of the five (ISAEF) technology management processes, provide one example that explains the importance of patents or patent data for the related technology management decisions. [30%]

By knowing what patents are, students are required to extrapolate how they can be used to support each of the Technology Management activities. This requires an understanding and reflection about the concepts learnt (i.e. connecting the dots across lectures). **Basic answers** will provide general examples. **Excellent answers** will be more specific in their examples. For instance, they may provide concrete company cases or explain in more detail how the data can be used in each example and exceptions (e.g. for identification tapping into patent data might not work for identifying information about new process technologies as they are often covered by trade secret).

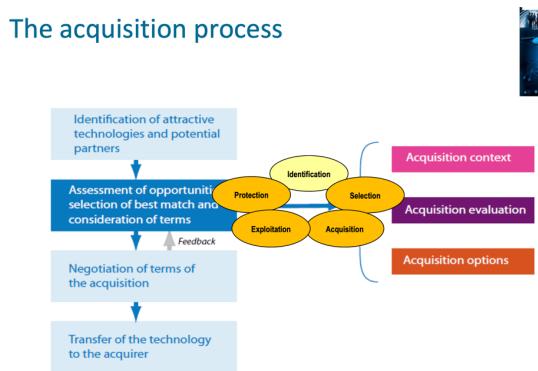
- Identification: Patent data can be extracted from different databases to identify actors that develop new technologies with possible relevance to a company. For instance, a company may operate a technology scouting process as part of their foresight activities to pick up early signals from universities, start-ups, etc. on emerging technologies, which could potentially disrupt the company's business.
- Selection: Information contained in patent data can be used to evaluate internal or external technologies or technology portfolios to support strategic decisions making. For instance, firms can derive patent data from different databases and calculate multi-dimensional indicators (e.g. patent quality) that can be used as proxies for deciding among different strategic options.
- Acquisition: Patent data can be used to identify and evaluate potential acquisition targets. For instance, patent landscapes may be used to visualize patent portfolios of companies that have been identified as acquisition options.
- Exploitation: Having selected technologies to be exploited externally, patent data can be helpful to find non-competing companies in other markets and countries in which the own company does not operate and has limited knowledge about. For instance, patent forward citation networks can be used to identify potential licensees.
- Protection: Patents can be filed in different countries, respectively jurisdictions in order to protect outcomes of R&D investments (technical inventions) and prevent copying by competitors and thereby build or maintain a competitive advantage through innovativeness.

(c) You are the CTO of a company that wants to upgrade its operations to reduce its carbon footprint. As a result of a technology intelligence exercise you have

identified a group of suitable software technologies available from different providers that might help monitor and optimise resources. Using the technology acquisition process, discuss what needs to be considered to prepare for the acquisition of the software technology from different technology providers. [40%]

Whilst the technology acquisition framework should be the basis for the answer, the application of the framework to the circumstances described would complete answer (in particular which part of the framework is relevant and how it is specifically useful).

Basic answers will provide a description of the four stages of the technology acquisition process, (extracted from the illustration below).



Good answers would then recognise that the preparation focuses on the second step of the process (Assessment of opportunities), providing more details on this stage (Context, Evaluation, Options). The motivations for the acquisition have been already stated in the scenario and the company is clearly looking to acquire software externally rather than having to decide whether to develop internally. Hence, the preparation would particularly focus on the Acquisition Evaluation and Acquisition Options.

Best answers will concentrate on these two steps more deeply:

- Acquisition evaluation step: the company needs to assess the match between (1) technological capabilities and (2) the characteristics of the providers as well as the (3) internal capability of the firm to absorb and make good use of the technologies that other firms are developing (See fig. below). Students could provide further details, reflection and discussion on for example by discussing: the evaluation issues, adding examples of questions to be included in the checklist to evaluate each aspect.
- Acquisition options steps: this includes considerations regarding how the technology will be developed (if this is needed for example to adapt it to the company needs), how will the firm collaborate with the providers (Outsourcing? Licensing? Acquiring the software firm?...), what will be given in return for the acquisition, how will the software be exploited commercially etc..

