

SUPPORTING INNOVATION AND ENTREPRENEURSHIP: University's Contribution to Sustainable Economic Development¹

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Summary

Sustainable development has an economic, ecological and a social component. Innovation and entrepreneurship play an important role in the sustainable development of an economy, a region or a country. We consider the ways in which universities can support innovation and entrepreneurship, and we outline some of the supporting structures and methods. The corresponding community aspects are covered by the author's paper on Civic Engagement and Project Learning. The following results are based on the author's experiences mainly in Germany as a researcher, lecturer, engineer, manager and consultant.

There are different ways for a university to support and encourage innovation and entrepreneurship. Although the aims and effects of innovation and entrepreneurship are quite different, universities have to support both in order to achieve a sustainable development of industry and society. Important aspects comprise motivation, modelling and management. The most important ways of support are given by the triad of education, research and direct support. Nevertheless, we must never forget, that people are the most important issue in innovation and entrepreneurship. Hence, motivation, information and networking play an important role.

1. EXCELLENCE AND SUSTAINABILITY

The success of a company lies in its ability to compete and to be better than other companies – not always in the direct competition but in the overall economic outcome. Excellence is seen to be the key to success, but sometimes the ability to survive is more important than to be the best. Hence, sustainability - the aim of a positive and stable future - applies not only to ecology and macro-economy but also to micro-economy: long-lasting cash-cows are more important than short-lived shooting stars.

Moreover, innovation and excellence must be measured according to these criteria of sustainability: a pure number of patents or start-ups is not an adequate indicator for a positive impact on the economy. Innovators and entrepreneurs must have the ability to succeed on the long run. The activities of German government towards fostering start-ups have been followed by an

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increase in bankruptcies a few years later. Although there may be a positive net effect left over, there will be also a waste of resources and talents.

1.1 Innovation and entrepreneurship

Innovation and entrepreneurship have a lot in common: they create something new, they have a positive impact on the economy, and they are considered to be positive values. To support them adequately, it is necessary to see also the differences, which mainly lie in the intention and in the corresponding activities.

Innovation mainly aims on creating new products or ideas from scientific results and development. Innovation is closely related to development and is most times more oriented toward technology. It should not be confused with invention, which merely creates a new idea or product without necessarily implementing this effectively. Innovation may also focus on processes – e.g. in production, organisation, or management. Processes that create values can be improved according to the economic principle in order to be more efficient. The innovator pushes forward the ideas in order to make them real.

Entrepreneurship is the attitude to start an enterprise and to take well-calculated economic risks. Entrepreneurship is based on the will to take decisions and to act. The entrepreneur is acting within an economy and investing his time and money to achieve an economic goal. Entrepreneurship must be differentiated from management; a manager is the executive and administrative leader of an enterprise, not necessarily the owner. The manager was neither involved in founding the company nor is he necessarily a shareholder whose risks his own money. In parallel to the manager, there are may be people with entrepreneurial thinking in any function or hierarchical level within the enterprise (in industry, business or administration); we call this intrapreneurship. These internal activities are also called “management” by Peter Drucker whose criterion of a manager is the contribution to the success of the enterprise.

There is entrepreneurship without an innovation (despite the innovation that lies in the new business itself) and also innovation without entrepreneurship (despite the fact that you need courage to bring out the innovation).

Innovation and Entrepreneurship:

	Not entrepreneurial	Entrepreneur
Not innovative	Leave everything as it is	Earn money on well-known tracks
Innovator	Implement research results	Start a business with an innovation

1.2 Knowledge, skills and state-of-mind

To act, a person needs 4 prerequisites:

- Knowledge – the facts and consequences “I see that it is”
- Ability – the necessary skills “I can”
- Attitude – the decision and will “I will”
- Freedom – the environment that does not prohibit the action “I’m allowed to”

Necessary prerequisites for a risk-taking attitude and for premium achievements in research and development are not only the basic knowledge but also a set of soft factors: skills, ethics and motivation. Besides this, there are a lot of external factors that influence the success of innovators and entrepreneurs. Among the most limiting factors are money (especially for entrepreneurs) and the access to information (especially for innovators).

1.3 Modelling and Abstraction

Models and abstraction are essential prerequisites for anybody coping with a complex environment.

Innovative product development can be seen as a model transformation from the first (mental) model of a researcher to a physical realisation of the product (implementation). Moreover, the abstract view to a problem or of past solutions help a lot in inventing creative applications or implementing innovative problem solving approaches.

Entrepreneurship needs planning abilities and communicative skills. To plan means to model the future; and to communicate – especially then the contents is complex – needs common models.

A Model is a system that is used to describe another system. Model based problem solving is based on the idea that any solution process is based on a model of the real world.

To know the broad spectrum of models gives the innovator and entrepreneur a universal language to express his thoughts, to clarify and communicate ideas, and to formalise concepts in order to make them implementable.

1.4 Dealing with uncertainty

Dealing with uncertainty and decision making in uncertain (stochastic, fuzzy chaotic) situations plays an important role within entrepreneurship. Risk taking and selecting among alternatives as well as finding or selecting alternative solutions is essential for planning a new business.

In innovation decisions with respect to objects (the developed product or system) or processes (especially the decision to follow a given path or not, or to stop a project) are essential.

1.5 Project management and leadership

Management is an important aspect for entrepreneurship. But it is not the business administration approach to organise and control a company; it is the will and ability of “getting things done through other people”. Although starting an enterprise may be a one-man-show, a successful entrepreneur needs to involve other people – customers, employees, and partners. Innovators must involve their working groups as well as their peers.

Even much more important is the ability to manage projects. Managing a project involves:

- preparing, planning, evaluating, and organizing unique assignments,
- executing these tasks in goal-oriented team-work, communicating with everyone involved,
- monitoring task fulfilling and ensuring goal achievement and
- bringing the project to a successful conclusion.

A project manager’s task consists, in contrast to that of a line manager, of

- thinking in terms of results and phases, rather than time periods and sequences,
- being able to deal with uncertainties and handle planning time variables,
- being able to lead team members, even when (s)he is not their superior.

The success factors for any project manager lie in an overall combination of

- expertise: knowledge of the field, the matter at hand, and the facts,
- methodological competence: methods, applications, problem solving ability,
- social competence: dealing with people, responsibility, and assertiveness,
- personal competence: personality, motivation, and self-management.

1.6 Motivation and ethics

Intrinsic motivation is necessary for innovators as well as for entrepreneurs. External motivation systems – money or glory – may motivate some people to start such activities. But for a long-term standing, a clear foresight and the wish to succeed are necessary. The success factor lies also in the personality – the wish to achieve a positive result. Here, the term positive has two meanings: Of course, the result must be positive for the innovator or entrepreneur. But in order to be successful, the result must also be positive for society – in the sense of sustainability, in terms of economical, ecological, social, political and legal aspects.

To bring it to an exaggerated example: the innovative new way of producing false money or the entrepreneurship of founding a criminal gang both are not sustainable – neither for society nor – on the long run - for the initiator.

1.7 Competences

From the considerations made above, we can summarise the skills and competences needed for an entrepreneur and an innovator.

Levels of skills and competences for innovation and entrepreneurship:

	Focus for innovators	Focus for entrepreneurs
Ethical competence	Assess the consequences of the innovation	External (impact of actions) and internal (people)
Personal competence	Self-motivation	Assess and seize opportunities, risk awareness
Social competence	Communication	Dealing with people, communication, negotiating
Management competence	Within the workgroup	Within the enterprise
Problem solving competence	Core competence for innovators	Planning, overcoming difficulties
Knowledge	Basic requirement for innovations	About management and markets, systems behaviour
Facts	Important for problem solving	About markets and economy

2. UNIVERSITY SUPPORT

Within this paper, university has two meanings:

- The university as an institution that owes the resources and pays their staff. It takes action according to the decisions of its boards but is also a self-organising system.
- The members of the university: they have an impact that is independent from the formal role in the university and they also have a life outside this institution.

The most important ways of support are education, research and direct support.

2.1 Education

According to the overall effect for society, education seems to be the most important method of transferring knowledge from a university. Well-trained academics and an education that encourages innovation and entrepreneurship are the most valuable contribution of tertiary education towards economic sustainability and success.

To support this, academic education should comprise not only the teaching of knowledge and facts but also a variety of skills and attitudes. In order to encourage innovation and entrepreneurship, adequate methods of teaching and training are necessary. Among these, projects and planning games play an important role.

Student's projects must be driven by the skills and competences the students have to acquire. This means that a lot of didactical competence, project management experience and preparation labour is required to come up with a rewarding project. For a rewarding outcome, two aspects are necessary: a challenging project that gives the opportunity to learn and a successful project that provides a visible result and a positive feedback from the project partners in order to give students the feeling of not having wasted their time and efforts. This means, that projects have to be prepared carefully. The same is true for planning games where the training success depends on the preparation and the setting in scene of the planning game as an event.

As mentioned above, one of the most important prerequisites for innovation is abstraction - to see the problem in a wider field of view. Entrepreneurship needs planning abilities – to have a clear vision or model of the future. Hence, modelling skills are necessary for both aims. University training is highly model-oriented and should stay on this approach. Curricula should be based not only a short-termed training towards “what industry wants now” but also on a long-termed and basic education towards “what society needs in the future” and the ability to adapt to future ideas and paradigms. Basics such as mathematics give not only the abstraction and modelling competence but also the ability to acquire complex knowledge and structures.

2.2 Research and Development

Creating knowledge is the basis for innovation, research has to be done efficiently and effective, and the results have to be communicated in an effective way. This implies a structured and project-oriented approach. Project management is an important prerequisite to perform goal-oriented tasks in research and development.

Research and development is done within the university. It has a direct impact on innovation, since innovation is coming from these activities. It has also the function to enable university staff to support innovators. Development also encourages entrepreneurs from inside and may enable the university or staff to help companies outside the campus.

2.3 Direct support and consulting

Basic and applied research aims to generate (pre-competitive general) knowledge and not to support a dedicated company. Direct support of innovators and entrepreneurs from a university is the most direct and most

obvious measure. This support may be provided by giving access to basic research results in a transferable way or by creating and transferring immediately needed (competitive) know-how by doing research and development for a company or an entrepreneur. It may also comprise consultancy in any area. There are several successful methods and structures for this direct support or knowledge transfer from universities.

Types of support for innovators and entrepreneurs:

- training of specialised skills and knowledge within training institutions,
- projects with students (thesis, practical semesters, in-semester projects),
- institutes of applied research, competence centres and Transfer Centres,
- providing or sharing infrastructure (rooms, services) for research and business,
- privately run activities of professors, assistants and students e.g. own companies.

2.4 Networking and funding

The access to information, partners and resources is essential for the success of an enterprise. For an innovator, access to information and supporting partners may be more critical, for an entrepreneur, the contact to potential customers and investors may be of prime concern.

University can support this by several kinds of networks or platforms, these may be alumni networks or forums organised by the university. The cooperation of the university and of university staff in steering committees will help to access information and to give support to the most promising projects.

2.5 Measuring the Success

Of course, there is a need to measure the success of university efforts towards activation of students. The success of supporting measures is hard to measure: there are a lot of influences that make it attractive or unattractive for young people to go into research or self-employment. The effect on economy and welfare of a young academic successfully managing a critical project within a company may be bigger than that of a glorious inventor or booming businessman. Moreover, entrepreneurship is not only a question of adequate training. Well-trained top performers may be attracted by lucrative jobs in existing companies while some years later in a slack season, low performers are urged to stay in research or start their own business.

The level of entrepreneurship should not only be measured by the number of start-ups or patents. Continuous improvement is in most cases more effective and less risky than a spectacular big action.

3. SELECTED AREAS

Among the success factors for innovation and entrepreneurship, we consider the following “hard skills” for sake of their importance and their possible integration into the curricula. The “soft skills” like personality, leadership, communication, or networking may be more important for the individual success, but are less accessible to direct education. For these skills, methods like social or experiential learning, projects and planning games are more important. This will be discussed in a parallel paper on Civic Engagement and Project Learning.

Selected competence areas for innovation and entrepreneurship:

	Innovation	Entrepreneurship
Development	Development of new products, ideas or systems.	Development of a business plan.
Modelling	Models and abstraction as a basis for systems development.	Models as a basis for planning and communication.
Decision making	Select alternatives for the process and object.	Take risk and make economic decisions.
Project management	Manage a development team.	Plan the implementation of the enterprise.

Among these, modelling is the basic competence, since it implies or supports the other core competences:

- Development is based on models and model transformation.
- Decision-making is based on models of future outcomes and of uncertainty.
- Project planning and controlling is based on planning models.

On the other side, project management is the most effective instrument. It is needed in development and in the modelling process. Efficient project management can take away a lot of risk and uncertainty and make decisions easier.

3.1 Development

Product development is the core of innovation. Development creates the exact and unambiguous description of a product or plan – also that of an enterprise.

Within development we subsume all the phases that comprise the way from ideas and requirements to the decided product description, leading to an implementation phase that may comprise production activities for physical products. Also systems (organisation, logistics, production, servicing) should be considered as products as long as their development is systematically planned.

One of the most helpful tools in development management is the introduction of phase concepts that allow to correlate activities with decisions and documents over the course of the development process. Any phase has its documents (models) that are created or transformed according to the decisions made within that phase. Phase concepts and the milestones derived thereof also allow to establish gateways: the milestones require explicit decisions whether to stop or to continue a project. Such an explicit set of breakpoints is essential for innovative projects such as starting a new business.

3.2 Modelling

Innovation may be seen as the transformation of abstract scientific findings and vague customer ideas into implemented systems. Product development is a model transformation from the first (mental) model of a researcher or a potential user (vision) to a physical realisation of the products (implementation) or a concise description (plan).

A model is a system that is used to describe another system. In engineering as well as in economics, we need a huge bundle of potential models in order to find the right one. Model classes (classification) include:

- static, stationary and dynamic models according to the explicit consideration of time,
- deterministic or stochastic models according to the influence of chance,
- graphs with a lot of different semantics to model complex systems, relations and behaviour,
- logical and mathematical models as a basis for formal or computerized problem solving,
- informal models, e.g. drawings or structured text.

The model building process usually goes from informal models to more formal and abstract models that can be handled via formal methods. Models need some syntax (relation among the model's symbols, formal criteria) and semantics (relation between model and reality).

3.3 Decision Making

Decision-making plays an important role within entrepreneurship.

There are several metaphors to describe the complexity of the real world involving non-linear, stochastic or chaotic behaviour, dynamics in several time scales and structure in a huge scale of dimensions in space or number.

Model based decision-making and the classical methods such as scoring or decision tree methods can be used for basic decisions. They make clear, that any decision must be based on an a-priori analysis of the goals (target function, priorities), the restrictions and the set of alternatives (which can be

enriched via creativity methods). Modelling helps to formalize a decision situation and to integrate aspects of dynamics and uncertainty.

In an uncertain situation, the analysis and assessment of the risk is important to have a sound basis for the decisions. Alternative outcomes must be analysed via scenario analysis and the measures must be planned according to a risk management process.

In a dynamic context such as entrepreneurship and innovation it is important, to use the methods (or at least the models) of dynamic programming. The most important effect is to make clear, that decisions must only be taken based on the information given at that point of time that requires a decision. Decisions should also take into consideration the future development and decisions and the possible future outcomes as well as the possible reactions. Planning games allow to integrate this temporal aspect of decision-making into the university training-

3.4 Project management and teamwork

Project management means to plan and control a project over its whole lifecycle. One of the most important items to keep in mind is the so-called "Magic Triangle" of project management:

- Q for the quality of the results. Good quality means not only parameters of the result but also the right (kind of) results. The result involves the vision and scope of the project as well as deliverable items and customer's or sponsor's satisfaction.
- R for the resources needed within the projects. The resources needed (reserved or consumed) comprise people, money, information and infrastructure. Motivated and skilled people play the most important role within innovation or entrepreneurial projects while money may be a bottleneck.
- T for time. The time taken to fulfil the plan is measured absolutely and with respects to timeliness and reliability.

Above all, one should not forget that project management means to work with people. Motivation, vision and leadership are more important than tools and numbers.

An approach to support project management skills is currently made at AAUAS within a project supported by a grant from the Baden-Württemberg ministry of science. With the PMBOX, we have in a physical box a collection of project management methods together with training methods and case studies. The PMBOX will allow self-learning as well as efficient and effective training for projects management.

Each entry is contained on a double sheet of cardboard allowing to add own remarks and materials and contains the following elements:

- title of the method/ training unit,
- purpose and prerequisites,
- contents description, keywords,
- methods and materials for direct use in projects, for training and for self-learning,
- reference/ literature, additional materials,
- exercises/ planning games/ case studies,
- personal remarks, additional information.

It is planned to have about 100 elements that are structured hierarchically and that cover project management methods for development, science and business.

The following list gives some of the keywords:

- Project, Projects, Project Management, Project Manager.
- Project Planning, Magic Triangle, Result, Vision, Quality, Deliverables, Stakeholders, Resources, Work Breakdown Structure, People and Skills, Training, Budgeting, Time, Schedule, Milestones, Phase models, Gateways, Network, Gantt Diagram, Organization, Controlling, Information Management, Reporting, Task Assignment, Gateways, Milestones, Cost Controlling, Earned Value Analysis.
- Projects, General, Modelling, Requirements Analysis, Acceptance Testing, Science, Research, Verification and Validation, Statistics, Descriptive Statistics, Inferential Statistics, Bayes´ Method, Estimation, Tests, Normal Distribution, Chi Square Test, Development, Model Transformation, Phase Concepts, Reviews, Configuration Management, Testing, Event Management.
- Management, Leadership, Ethics, Communication, Intercultural Competence, Quality Management, Change Management, Risk Management, Presentation and Communication.
- Techniques, Scoring, Portfolio, Morphologic Box and Matrix, Creativity Methods, Setting Targets.

4. BOLOGNA PROCESS – THE EUROPEAN VISION

Germany is facing the challenge of rebuilding its higher education system within the next year. According to the Bologna declaration, higher education system will be unified in the European Union. The most visible effect is, that

the German Diplom studies (e.g. Dipl.-Ing.) of usually 9+x semesters will be replaced by a Europe wide system of Bachelor and Master.

This means not only to rename the curricula but also to change the focus of higher education towards more self-organised learning and less classroom lectures. The basis of the new system is a system of credit points, which is based on a workload of 900 hours per student and semester. Hence, there will be more capacity for practical exercises, planning games and student's projects.

This will be a chance to promote innovative and entrepreneurial skills within the course of studies.

5. SUMMARY: STRATEGY FOR SUSTAINABILITY

The following items have been presented as a summary on the innovation summit.

- **Education: Skills**

Academic education should comprise not only the teaching of knowledge and facts but also a variety of skills and attitudes by adequate methods of teaching and training.

To foster personal initiative and motivation, university management and staff should see themselves as enablers and should be willing and flexible enough to support those activities and even to be positive examples of innovation and entrepreneurship.

- **Education: Projects and Resources**

Project management is the key to success in innovation and entrepreneurship. Students must learn to solve a problem or perform a task within a given framework of time, money, staffing and support. They must be able to attack a problem by planning a project.

Budgeting should be flexible enough to allow ad hoc decision according to the training situation.

- **Education: Internal**

Initiative and responsibility should be supported in academia. Innovators and entrepreneurs can only grow in an environment that challenges thought and is open to new ways of thinking and teaching.

Adequate curricula should not merely be based on "required knowledge" but also on the ability to cope with future challenges.

- **Research**

Researchers must be allowed to bridge the gap between pure and applied research, even if this means to be "stuck in the middle" and will neither lead to a publication nor to a patent.

Researchers should be urged to bring their results closer to practical application. They should be given a workgroup for knowledge transfer especially when there is no promising immediate product in sight.

- **Support**

Academic staff should be allowed to do transfer – as part of their job or outside their employment. Clear-cut rules must be laid down.

To provide networking and funding, Universities should build up networks for supporting staff, student and alumni.

- **Measuring and Control**

The level of entrepreneurship should not only be measured by the number of start-ups: To have a positive impact on the economy, a start-up must sustain.

Moreover, economy and welfare depend on innovations, but there is more need for successful implementations than for inventions and patents. Continuous improvement is more effective and less than a spectacular big action.

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