SCIENTIFIC RESEARCH METHODOLOGIES AND TECHNIQUES

Unit 9: ASSESSMENT OF RESEARCH RESULTS

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PhD PROGRAM IN ELECTRICAL AND COMPUTER ENGINEERING

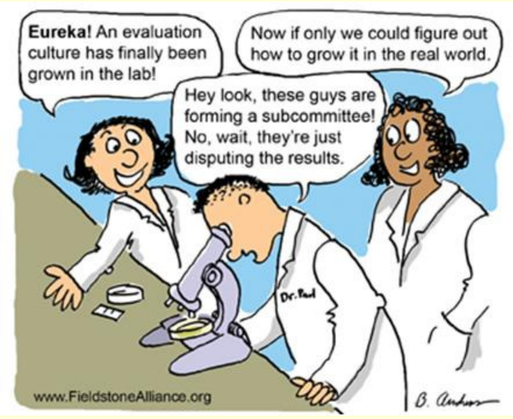
1. THE NEED

Why

- Research is the driving force of modern society.
- To a great extent the quality of research determines the future.
- A society that aims to play a leading role needs not only to invest on research programs but to also carefully monitor progress and assess the impacts of the various research initiatives.

- Evaluating research is a difficult subject for which there are no clear effective methods.
- Impact of research may not occur until years later.
- Created impact also depends on a number of external factors not under control of the research community.

Therefore, to evaluate an R&D initiative we should mainly measure the creation of capabilities and the capacity produced or induced by research,
i.e. the potential for creating impact.



Which approach

Assessment is not only a way to ensure accountability, but also an instrument to help projects keep on track.

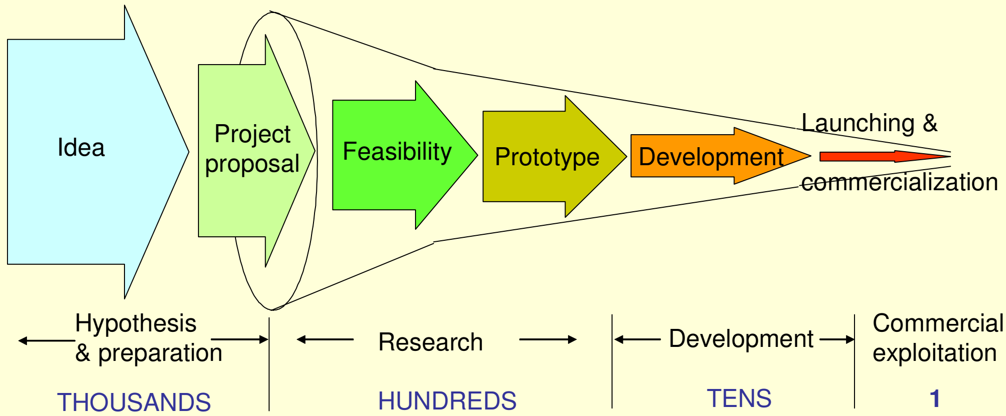
- Important to devise evaluation methods that *<u>are constructive rather than punitive</u>*
- A way to <u>identify additional added value</u>

"In the USA everyone understands that when someone takes a risk, there is the possibility of failure, while in Europe if we take a risk and fail we are almost criminalized".

Mr. Brinkhorst
Dutch Minister of Economic Affairs, in the informal Competitiveness Council in Maastricht , 2004

We need to change the mindsets in Europe towards more innovative approaches, being <u>able to accept and also learn from failures</u> that are inherent to risk taking.

On the nature of research results



A traditional view: it requires hundreds of research projects in order to end up with one successful development which results in effective commercial exploitation.

But there are other results and impacts e.g.:

- **the increased level of knowledge and experience**
- **training of higher quality human resources**
- **new ideas for other developments**
- **creation of links among organizations**
- **etc.**

which are also indirect impacts of research and drivers for economic development.

Outputs from science and technology

A proper assessent method should take into account all outcomes of S&T ...

- Science and technical ideas
- Scientific and technical publications, reports, and citations
- Intellectual challenges
- Technical assistance
- Presentations to learned societies
- Training of scientific and technical people
- New and improved products, materials, and processes
- Patents
- Transfer of technology
- Development of new testing methodologies
- Development of R&D/S&T management practices and techniques
- Start-up of new ventures, new companies, establishment of partnership
- Development of strategic technology alliances
- Development of scientific and technical benchmarks and standards
- Cost-savings in production, product design, and redesign
- Increased productivity and utilization of resources
- Improved product/process/service quality
- Reduced dependence on outside sources
- Facilitator in ability to outsource
- Savings in materials
- Contribution to maintenance/protection of lead or position in the discipline/industry/market
- Facilitation of use by client
- Contribution to adequate response to environmental and other regulatory pressures
- Contributions to potential adaptability of manufacturing to new processes and methods
- Contributions to the competitive features of a product or product line
- Contributions to creation of new market, market segments, and new customers
- Contributions to technology and business planning, and to the strategic management of the organization
- Development, manipulation, and exchange of new knowledge in S&T
- Provision of scientific and technical information to assist managers in areas such as licensing, mergers and acquisitions, and other activities imbued with content of S&T
- Contributions to institutional memory
- Contributions to the identification of opportunities and needs for S&T
- Contributions to improved project selection and resources allocation for S&T and for the innovation process
- Contributions to sales, profits, and other economic criteria of performance
- Contributions to the perception of S&T by the sponsors of this activity and by the public at large
- Increased ability to anticipate and to effectively deal with barriers to application and implementation of results from S&T
- Contribution to expending the state of the art in S&T
- Contribution to the prestige of S&T organizations and their impactees

[Geisler,2000]

2. METHODS AND THEIR LIMITS

Methods

A. QUANTITATIVE OUTPUTS
- Count of publications
- Count of citations
- Count of new products and processes
- Count of improvements in products/processes
- Count of patents
- Economic/financial outputs (e.g., cost savings, ROI)
- Performance outputs (e.g., on time and on budget)

B. QUALITATIVE OUTPUTS
- Judgment evaluation
- Goal achievement
- Compliance with regulations
- Impacts on customer satisfaction
- Contributions to capabilities and skills of S&T staff
- Contributions to the pool of innovations
- Contributions to the prestige of S&T organizations

[Geisler,2000]

A panoply of methods

- quantitative & qualitative –

are used ....

... But none of them is perfect !

... And yet managers would like to have one single indicator!!!

Effectiveness of metrics

	EFFECTIVENESS CHARACTERISTICS OF INSTRUMENTS*						
CATEGORY OF METRICS**	Accuracy	Precision	Repeatability	Tolerance	Bias	Sensitivity	Level
BIBLIOMETRIC COUNTS OF PUBLICATIONS & CITATIONS	High	High	High	High	High	High	Quantitative
COUNT OF PATENTS	High	High	High	High	High	High	Quantitative
CO-WORD ANALYSIS	Low	High	Low	Low	High	Low	Mostly Qualitative
ECONOMIC IMPACTS	Low	High	Low	High	High	Low	Mostly Quantitative
PEER REVIEW	High	High	Low	Low	High	Low	Qualitative
DOWNSTREAM STAGE ANALYSIS OF IMPACTS	High	High	High	Low	High	High	Qualitative and Quantitative

[Geisler,2000]

Accuracy – degree to which the instrument measures the phenomenon correctly
Precision – when applied a large number of times to the same phenomenon, yields very similar values
Repeatability – ability to yield very similar values when applied repeatedly to measure one phenomenon
Tolerance – degree to which the instrument's readings will be different from the mean or expected standard
Bias – systemic error inherent in the instrument
Sensitivity – differences in measurement that occur for a given change in the values of the phenomenon
Level of measurement – refers to the use of qualitative or quantitative measures

Peer reviewing

One of the most traditional assessment methods in scientific research.

Assumption: the people best qualified to evaluate research are those with knowledge and experience to understand the quality and level of innovation of research projects (peers)

- Can provide assessment by qualified experts
- Provides opinions, comments, suggestions from peers
- Allows for checks and balances among diverse opinions and "schools of thought"
- The process is understood by all participants
- Although qualitative, it can provide adequate data for decisions on allocation of resources

[Geisler,2000]

Peer reviewing criteria

Peer-review criteria used by NSF (USA)

1981-1997
- Research Performance—competence.
- Intrinsic merit of proposed research.
- Utility or relevance of proposed research.
- Effect of proposed research on the infrastructure of science and engineering.

◊ Rank: "poor" to "excellent."

As of October 1, 1997

♦ **Intellectual Merit of Proposed Research**
- Importance to advancing knowledge within own field and across fields.
- Qualifications of the proposer.
- Creativity and originality of proposed work.
- Access to sufficient resources.

♦ **Broader Impacts of Proposed Research**
- Advancing discovery while promoting teaching, training, and learning.
- Broadening the participation of underrepresented groups (e.g., gender, ethnicity).
- Enhancing the infrastructure of research and education (e.g., facilities, networks, and partnerships).
- Broad dissemination of results.

◊ Rank: "poor" to "excellent."

Peer-review criteria used by Industry (USA)

ILLUSTRATIVE REVIEW CRITERIA

Potential returns and payoff within a foreseeable time line.
Probability of technical success within a project time-cost estimate.
Probability of commercial success within a given time frame.
Relevancy to corporate strategic plan.
Relevancy to product lines and businesses.
Amount and sufficiency of resources available.
Prior experience with the project team and with similar research.
Level of senior management's support for such research.
Relation to the overall corporate R&D portfolio.
Relation to an established need from marketing or another unit in the corporation, such as clients, users, regulators, or vendors.

[Geisler,2000]

Peer reviewing criteria ...

1. Scientific and/or technological excellence (relevant to the topics addressed by the call) • Soundness of concept, and quality of objectives • Progress beyond the state-of-the-art • Quality and effectiveness of the S/T methodology and associated work plan	**Score:** *(Threshold 3/5; Weight 1)*
2. Quality and efficiency of the implementation and the management • Appropriateness of the management structure and procedures • Quality and relevant experience of the individual participants • Quality of the consortium as a whole (including complementarity, balance) • Appropriateness of the allocation and justification of the resources to be committed (budget, staff, equipment)	**Score:** *(Threshold 3/5; Weight 1)*
3. Potential impact through the development, dissemination and use of project results • Contribution, at the European and/or international level, to the expected impacts listed in the work programme under relevant topic/activity • Appropriateness of measures for the dissemination and/or exploitation of project results, and management of intellectual property.	**Score:** *(Threshold 3/5; Weight 1)*
Remarks	**Overall score:** *(Threshold 10/15)*

European Commission

Evaluation of project proposals ICT Program

Example from STREP proposals

Other types of projects have different thresholds

Peer reviewing criteria ...

European Commission
Periodic reviewing of running projects

1. OVERALL ASSESSMENT

❑ Excellent progress (the project has fully achieved its objectives and technical goals for the period and has even exceeded expectations).
❑ Good progress (the project has achieved most of its objectives and technical goals for the period with relatively minor deviations).
❑ Unsatisfactory progress (the project has failed to achieve critical objectives and/or is not at all on schedule).

Overall recommendations (e.g. on overall modifications, corrective actions at WP level, or re-tuning the objectives to optimise the impact or keep up with the State of the Art, or for other reasons, like best use of resources, re-focusing…).

2. OBJECTIVES and WORKPLAN

a. Have the objectives for the period been achieved? In particular, has the project as a whole been making satisfactory progress in relation to the Description of Work (Annex I to the grant agreement)?
b. Has each work package (WP) been making satisfactory progress in relation to the Description of Work ?
c. Have planned milestones and deliverables been achieved for the reporting period?
d. Are the objectives for the coming period(s) i) still relevant and ii) still achievable within the time and resources available to the project?

3. RESOURCES

a. To the best of your estimate, have resources used, i.e. personnel resources and other major cost items, been (i) utilised for achieving the progress, (ii) in a manner consistent with the principle of economy, efficiency and effectiveness. Note that both aspects (i) and (ii) have to be covered in the answer.
b. If applicable, please comment on large deviations with respect to the planned resources.

Peer reviewing criteria ...

European Commission
Periodic reviewing (cont.) ...

4. IMPLEMENTATION OF THE PROJECT

a. Has the project management been performed as required?
b. Has the collaboration between the beneficiaries been effective?
c. Do you identify evidence of underperforming beneficiaries, lack of commitment or change of interest of any beneficiaries?

5. USE AND DISSEMINATION OF FOREGROUND

a. Is there evidence that the project has/will produce significant scientific, technical, commercial, social, or environmental impacts (where applicable)?
b. Is the plan for the use of foreground, including any update, appropriate? Namely, please comment on the plan for the exploitation and use of foreground for the consortium as a whole, or for individual beneficiary or groups of beneficiaries and its progress to date.
c. Have the beneficiaries disseminated project results and information adequately (publications, conferences…)?
d. Are potential users and other stakeholders (outside the consortium) suitably involved (if applicable)?
e. Is the consortium interacting in a satisfactory manner with other related Framework Programme projects or other R&D national/international programmes, standardisation bodies (if relevant)?

6. OTHER ISSUES

a. Have policy-related and/or regulatory issues been properly handled (if applicable)?
b. Have ethical issues been appropriately handled (if applicable)?
c. Have safety issues been properly handled (if applicable)?
d. Has progress on Gender Equality Actions been satisfactory (if applicable for this reporting period)?

Peer reviewing criteria ...

Difficulties

- Difficult to find competent reviewers
- Some reviewers may show bias, jealousy, revenge, and intolerance toward other researchers
- Reviewers may protect their own area and subspecialty by promoting papers / *projects* in these areas
- Reviewers and editors tend to stick to existing paradigms in their disciplines and reject change
- Editors *(& project officers ?)* wield inordinate power and channel the discipline in their preferred direction, rather than in a "bottom up" approach from the bench scientists
- Secrecy of the process
- Tendency to prefer established, well-published scientists *(strong lobbyed project proposals?)*
- Problems with rating and raters, based on judgmental data
- ...

[Geisler,2000]
(adapted)

Quantification – Publications & citations

Bibliometrics

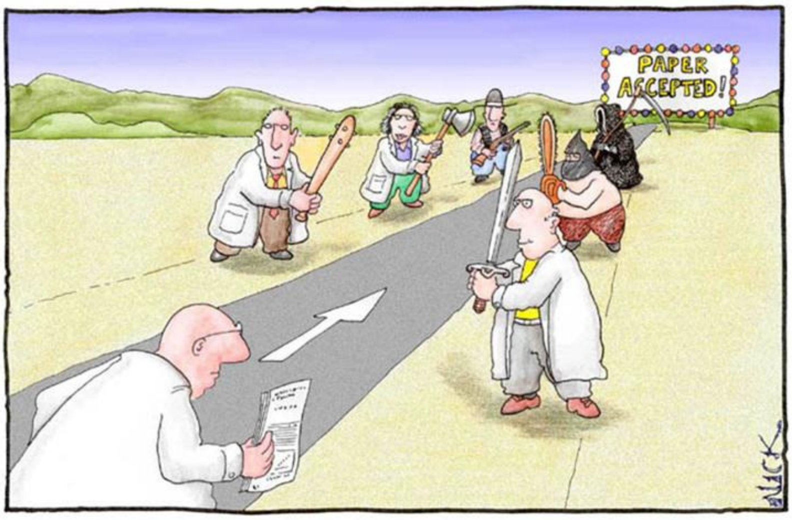
Counting the number of publications in peer-reviewed channels (journals, books chapters, and high-quality conferences) is a standard indicator of the innovative contribution of a research project.

- A manuscript is typically published in a good quality channel only when the peer reviewers and the editor consider it to have enough merit.
- Therefore, another form of peer reviewing.

The number of **citations** a publication receives is usually considered as a reflection of the importance of the contribution or its excellence.

- As citations are made by other researchers they can be regarded as recognition of merit and thus an extension of the peer reviewing.

Publications & peer reviewing ...



Most scientists regarded the new streamlined peer-review process as 'quite an improvement.'

Quantification – Publications & citations ...

Some difficulties

-Different practices in each scientific discipline.

- E.g., while in the computer science a journal paper typically has more than 15 pages, in micro-electronics it is usual to have journal publications with 2 to 3 pages.

-Patterns of publication. Unlike the traditional sciences, it is a common practice in ICT-related areas to publish in peer-reviewed conferences, which are not considered in ISI.

- Recently ISI introduced a new index for conferences. Will it be recognized by S&T evaluators?

-Timescale for citation. It is likely that the peak for citations of publications is between 1 to 4 years after the publication. On the other hand it usually takes longer than 1 year to have a paper published in a good journal. Therefore, the actual measuring of citations can only take place after the end of the project.

- Citations are not of equal value. A paper may be cited to recognize its excellence, but also sometimes to reject its arguments.

Quantification – Patents & Licences

Patents and licenses, as alternative to publications, represent another indicator of the innovative quality of project results.

- **Cannot be easily used in all branches of science and engineering**
  - Still controversy regarding the appropriateness and even possibility of registering patents on software
  - For some algorithms patenting can be considered as a suitable knowledge protection mechanism
- **European patenting system is still quite inadequate and geographically fragmented.**
- **There is a not-solved "conflict" between registering patents (knowledge protection) and publishing results (knowledge dissemination)**
  - patents are more recognized in industry (having an economic factor associated with them)
  - academic careers very much rely on publications and, in many cases, do not value much patents

- **Patents have a registration cost.**

Quantification – Invitations

External esteem: Invitations, committees, boards

- **Invitations to Program Committees of technical events**
- **Participation in technical / scientific boards**
- **Plenary addresses / keynotes**
- **Honors and awards**
- **Editorship**
- **Participation in advisory, review, funding, standards and planning bodies, etc.**

(directly or indirectly based on the work of the researcher in the project being assessed)

... to some extent, reflect the quality of the results and a kind of "footprint" that may help in tracking impacts of the research

Many of these invitations / participations also depend on the network of contacts (and prestige) of each researcher and his / her availability to participate in such activities.

Therefore, this measure needs to be taken just as a complementary indicator.

Quantification – Interactions

The number of interactions with other national and international projects, particularly those that involve some actual cooperation
&
The interactions with other bodies (e.g. scientific or technical organizations)

can give some qualitative indication of the potential of the project to cause impact.

But this indicator does not necessarily reflect the quality of the research ... It might rather reflect the "social networking" / lobbying capability !

Quantification – Other indicators

Economic indicators

Estimates of the economic benefits that organizations receive from the investments in R&D are an important element to help demonstrate the value of the R&D.

- Return on investment (ROI), the production function, customer surplus, and increased benefit to industry and society.
- Measurement of such indicators is hindered by the long time period between the R&D investment and the final realization of the economic benefit.

Customer and user evaluation

Measuring customer and user feedback is a way to determine performance.

- The customer of R&D is not always easy to identify as the outputs of new knowledge go into a general "pool of knowledge".
- Quantitative indicators can be obtained through web sites, surveys in meetings, etc.
- Although customer evaluations are typically quantitative, they are also subjective, what makes them prone to a number of sources of bias.

Human and social capital

Considering the value of human resources, in particular the "capacity", the ability of groups of scientists, engineers and other researchers to grow and sustain and to make the most of the available talent reservoir.

- "capital of relationships" - the number and quality of the new connections an organizations establishes as a result of a research project is an important success indicator

Other indicators

Contributions to education and training, contribution to start new research, …

Multifaceted approach

“We become what we measure” ➔ **Need to choose metrics wisely !**

- The “publish or perish” dilemma has also caused several “deviating” behaviors in the academic community
- Some organizations that are extremely effective in their “social networking activities” (building social capital), which gives them better access to opportunities (e.g. invitations to consortia) but without actually contributing to the generation of any real innovation or research results

A multifaceted approach, combining as many indicators as possible, is recommended

Lessons learned

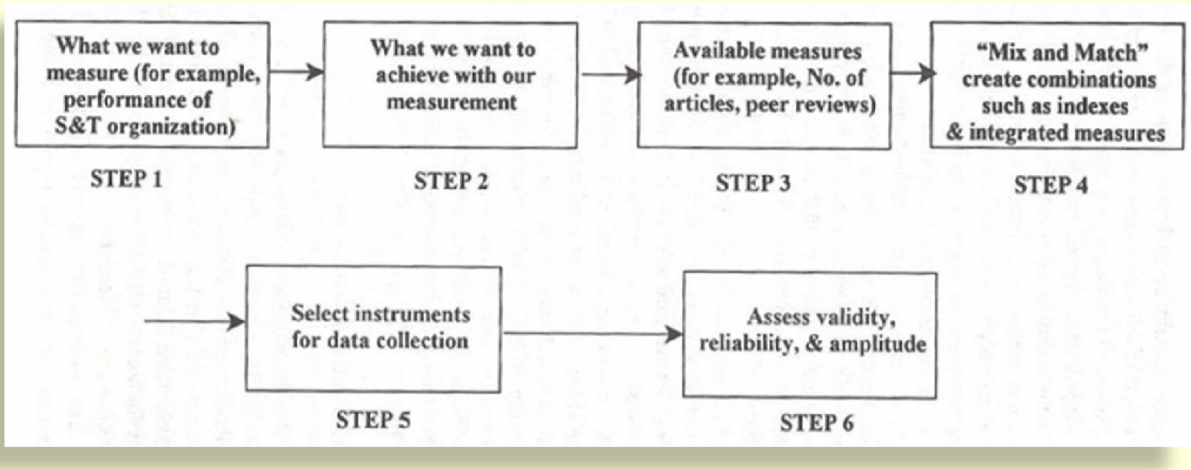
In a risk taking process, and when examining an innovative approach to solve a problem or trying to reach an ambitious aim, it is possible to discover that the approach is not appropriate or the aim is unreachable in the given time/criteria.

Nevertheless, such a result is not necessarily an indication of lack of performance or lack of progress !!!

In a R&D project the result of a task is negative <u>if and only if</u> no lessons are learned from it in order to improve and to benefit the next steps!

Being overly risk-averse is clearly unwise when the aim is to producing excellence, competitiveness, impact and leadership

A mix of metrics

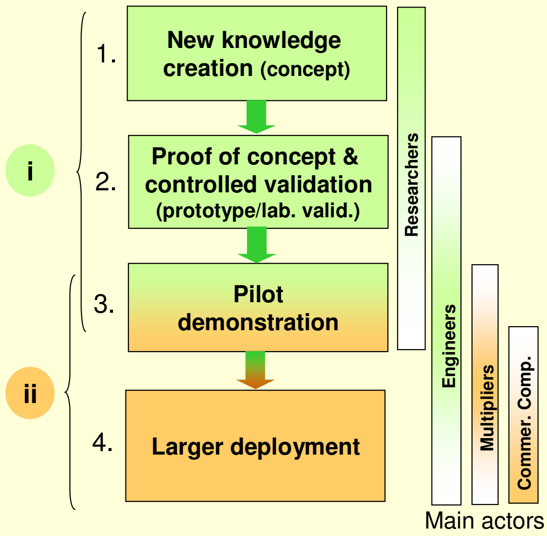


[Geisler,2000]

3. IMPACT CREATION

Impact creation process

Impact creation is typically a process that goes far beyond the time frame of a research project

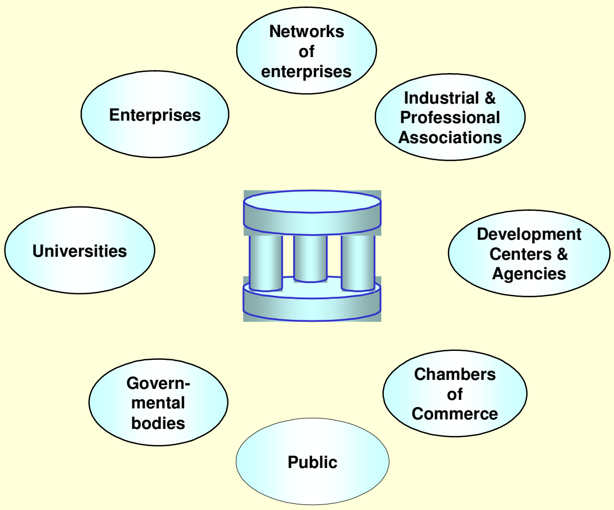


Creating impact out of research results is a multi-phase, long-term process

Two main phases:

1. **knowledge generation / innovation**
   (phases 1, 2, and part of 3)
   main actors: researchers and some engineers (for the prototyping and case studies)
2. **dissemination and deployment**
   (part of phase 3 and phases 4 and 5)
   main actors: "multipliers" and commercial companies (supported by engineers, in the case of technology development).

Multipliers



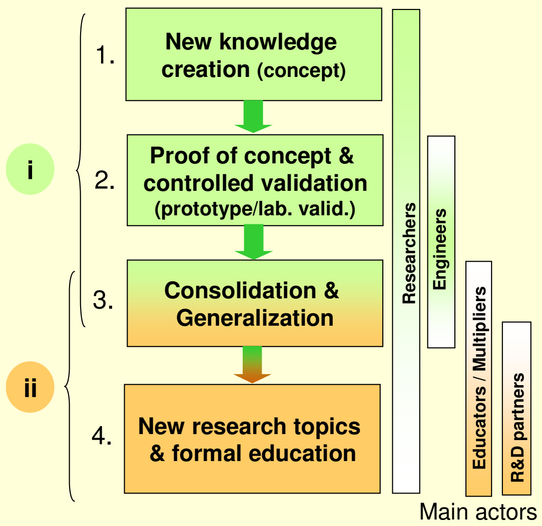
Example of multipliers from ECOLEAD project

Multiplier - an entity, external to the project, which thanks to its role and position in the society can help multiplying the impacts of the project.

- E.g. innovation promotion institutions, regional associations of SMEs, or professional associations.
- It is not realistic to expect that a research consortium can, by itself, cause a significant impact in the society.
- Even if good quality results are achieved and if the consortium is composed of organizations from a large number of countries, it is unlikely that such consortium has the resources to create impact at the European level (for instance).

Memorandum of Understanding (MoU) - specifies under which conditions the multiplier has access to the project's knowledge and what "multiplication" mechanisms will be applied (e.g. pilot implementations, demonstrations, training events).

Impact creation in academy



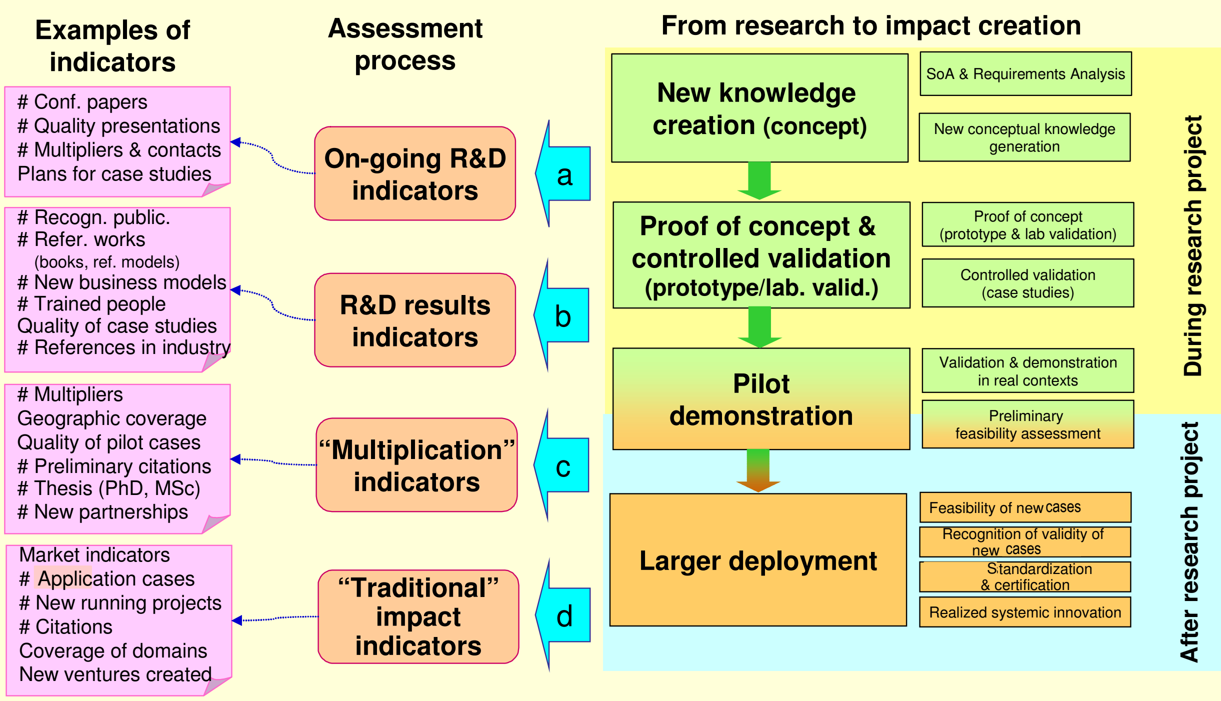
Creation of impact in the academia is a bit different.

"Multipliers" - mainly "educators" and, to some extent, the R&D planners as well as the decision makers on strategic research programs.

Researchers are involved in all phases of this process.

Impact assessment and indicators

Example



4. SUCCESS CRITERIA

Phases and indicators

Phase of project	Evaluated issue	Indicator
Project Running	Performance of the project according to plans	Project timeliness, quality of work, quality of deliverables, etc.
	Relevance of the work	Number of publications, early citations, promising foundation approaches, workshops, number of multipliers, demonstrations, etc.
	Chosen mechanisms	Trend in impact measures, size of interest in the project in other communities, results compared to expectations, etc
Project ended	R&D impact	Acceptance of foundation or reference models, curricula based on the foundation, etc
	Society impact	Amount of implementations and business, number of active multipliers, etc

Success indicators

Example from ECOLEAD project

Innovation process			Research (success) indicators			
Main phases	Detailed steps	Classes of indicators	Research & Academic entities	ICT developers & Business entities	Society and policy makers	
1. New knowledge creation	State of the Art and Requirements analysis	On-going R&D indicators	# Journal papers # Conference papers Plans for case studies Interactions with related initiatives	# New development ideas # Case studies / scenarios # New CNO-related contacts (customers & developers) Increase in collaboration & networking New organizational & management ideas # Trained people, increased competencies # Internal dissemination actions # Multipliers	# Trained people # People with new capacities # Proposals for new policies	During ECOLEAD
	New conceptual knowledge generation					
2. Proof of concept & controlled validation	Proof of concept (prototype & lab validation)	R&D Results indicators	# "Recognized" publications # Journal papers # Conference papers # Thesis (ongoing) # Training actions # Invited talks # "Prestigious" participations	Simulated (emulated) solutions Small scale realization of main functionality of prototypes Participation in training # Industry sectors addressed # Multipliers & prospective customers addressed # New business models Size of skilled teams Market size evaluation	# Trained people # People with new capacities # Proposals for new policies Level awareness for CNOs	

Success indicators ...

3. Pilot demonstration	Validation and demonstration in real context	Multi-plication indicators	# Prestige publications (journals, high quality conferences) # Books / chapters # Thesis (PhD, MSc) Inclusion in education programs # Preliminary citations Reference models # Trained people # Patents & technology transfer agreements	# Realized prototypes or solutions #Evaluated/demonstrated methods & organization models # New business relationships # Indirect business opportunities found # Trained people Increase in networking (# contacts, interactions) Lessons learned Cost / benefit indicators SWOT indicators ROI estimation # Business plans developed # VBE, VO, PVC addressed Attendance to project events # References in industry publications # Contributions to standards and best practices	# Trained people # References in general media # PhDs and MSc # People registered to the VLC # Multipliers actively involved # People with new capacities Prospects for new businesses # European regions contacted # Interactions with non-European entities and regions	
	Preliminary feasibility assessment					
4. Larger deployment	Feasibility of the new CNO forms	Traditional Impact indicators	# Citations # New projects CN established as a new discipline # Trained people # Patents, licenses & technology transfer agreements	# Implemented pilots # New ICT solutions # Engineered frameworks and methodologies Business volume (or its derivative) for solutions from ECOLEAD Increase in networking among ECOLEAD end user partners (# of contacts, interactions, etc) Increase of collaborative support in general # VBE, VO, PVC addressed / created / improved # New technology ventures created # New customers # Marketing leads # Companies and individuals reached	Networking is a natural part of the society Collaboration & networking is supported by the rules and legislation in the society Infrastructure support of connections and interoperability # New ventures created # New / improved CNO-related education programs Leadership in collaborative networks	After ECOLEAD

Example from ECOLEAD project (cont.)

Categories of outputs and metrics

Example from ECOLEAD project

Key categories of outputs	Metric: Quantitative	Metric: Qualitative
A. BIBLIOGRAPHIC OUTPUTS		
• (Base) concepts and principles	✓	✓
• Scientific & technical publications	✓	✓
• Presentations to CNO community	✓	✓
• Scientific & technical information (general)		✓
• Prestige		✓
• Research roadmaps	✓	✓
B. REFERENCE MODELS, PATENTS, FRAMEWORKS		
• Reference models	✓	✓
• Frameworks	✓	✓
• Patents	✓	✓
C. ICT TOOLS & INFRASTRUCTURES		
• e-Services	✓	✓
• ICT infrastructures & platforms	✓	✓
• Pilot demonstrators	✓	✓
D. PERFORMANCE OUTPUTS		
• Governance rules	(✓)	✓
• Business models and strategies	(✓)	✓
• IPR and value systems		✓
• Methodologies	(✓)	✓
• Contribution / response to regulations		✓
• Lessons learned		✓
• New collaboration relationships	✓	(✓)

Outputs & "users"

Example from ECOLEAD project

Generic outputs from Science & Technology	Covered in ECOLEAD	Potential "users": Research & Academic	Potential "users": ICT & Business entities	Potential "users": Society & Policy makers
Science and technical ideas		✓		
Scientific and technical publications, reports, and citations		✓		
Intellectual challenges		✓		(✓)
Technical assistance		✓	✓	
Presentations to learned societies		✓		
Training of scientific and technical people		✓	✓	
New and improved products, materials, and processes		✓	✓	
Patents	?		✓	✓
Transfer of technology		✓	✓	
Development of new testing methodologies				
Development of R&D/S&T management practices and techniques		✓	✓	✓
Start-up of new ventures, new companies, establishment of partnership	?		✓	
Development of strategic technology alliances	?		✓	
Development of scientific and technical benchmarks and standards	(reference models)	✓	✓	
Cost-savings in production, product design, and redesign	?		✓	
Increased productivity and utilization of resources			✓	✓
Improved product / process / service quality			✓	✓
Reduced dependence on outside sources				
Facilitator in ability to outsource			✓	
Savings in materials				
Contribution to maintenance / protection of lead or position in the discipline / industry / market		✓	✓	✓
Facilitation of use by client				
Contribution to adequate response to environmental and other regulatory pressures				
Contributions to potential adaptability of manufacturing to new processes and methods		✓	✓	
Contributions to the competitive features of a product or product line			✓	
Contributions to creation of new market, market segments, and new customers			✓	
Contributions to technology and business planning, and to the strategic management of the organization		✓	✓	(✓)
Development, manipulation, and exchange of new knowledge in S&T		✓	✓	
Provision of scientific and technical information to assist managers in areas such as licensing, mergers and acquisitions, and other activities imbued with content of S&T		✓	✓	
Contributions to institutional memory	(value systems)	✓	✓	(✓)
Contributions to the identification of opportunities and needs for S&T	(roadmap)	✓	✓	✓
Contributions to improved project selection and resources allocation for S&T and for the innovation process	(roadmap)	✓	✓	✓
Contributions to sales, profits, and other economic criteria of performance			✓	
Contribution to the perception of S&T by the sponsors of this activity and by the public at large		✓	✓	✓
Increased ability to anticipate and to effectively deal with barriers to application and implementation of results from S&T		✓	✓	✓
Contribution to expanding the state of the art in S&T		✓		
Contribution to the prestige of S&T organizations and their impactees		✓	✓	(✓)

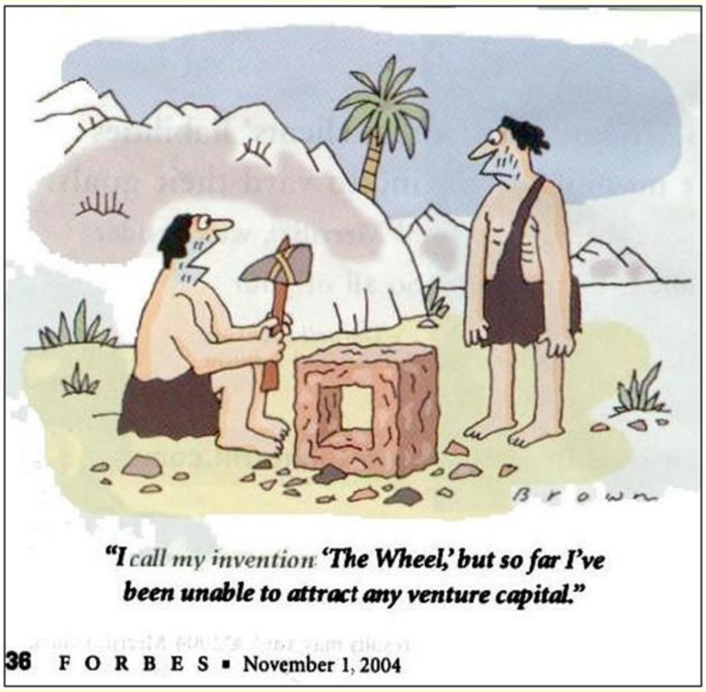
Directly covered
? Not known yet
Partially or indirectly covered
Limited or not covered

General remarks

Besides the quality of the research results, impact creation very much depends on:

- **Investing on "foundational work", i.e. producing results that can be re-used by others.**
- **Using proper communication channels, focused on the target communities.**
- **In terms of dissemination it is important to clearly distinguish two main directions:**
  - **"business-related dissemination" (for companies, industrial associations, other social bodies), and**
  - **"scientific dissemination" (for the research community).**

  These two dissemination directions address different audiences, requiring completely different channels and approaches.
- **Establishment of cooperation agreements with external entities that have the capability to act as impact multipliers.**
- **... and Lobbying .... !!!!!**



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