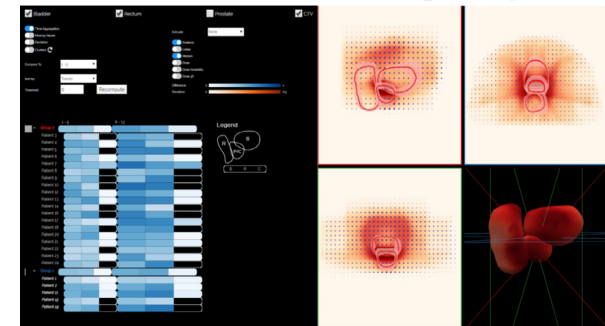


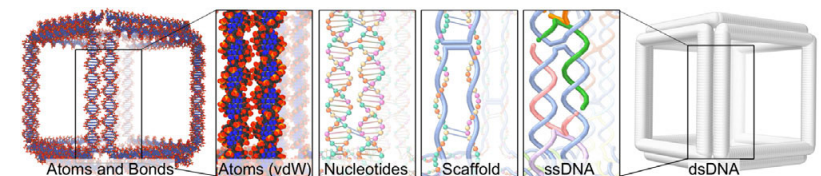
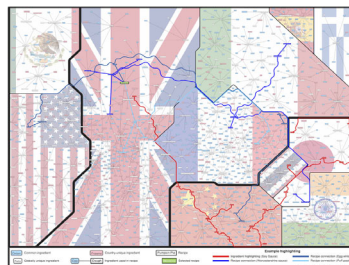
Research and How it Works



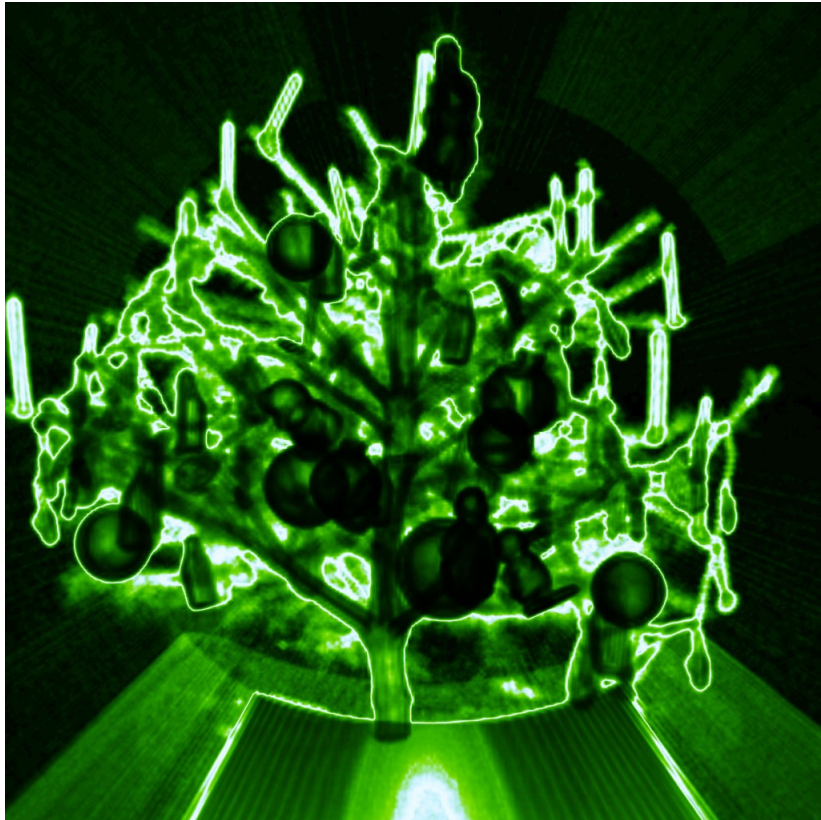
Eduard Gröller



Institute of Visual Computing & Human-Centered Technology,
TU Wien, Austria



What is Research?



- Nibble on the tree of knowledge
- Driving force: human curiosity



- Observations, measurements, trials
- Axioms, hypotheses, models
- Validation, verification, falsification
 - Proof (theoretical sciences)
 - Experiment (applied sciences), Empirical study, survey (social sciences)
 - Computational Sciences
 - Data Science

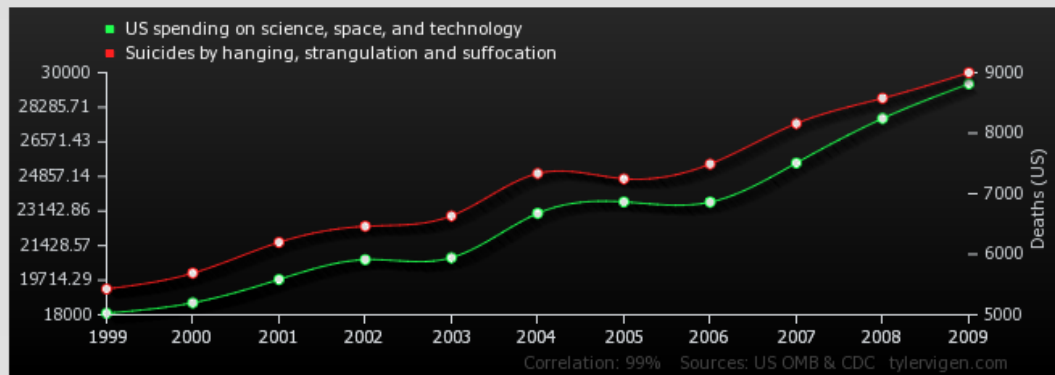


- Objectifiable, rational
- Reproducible, verifiable
- Principle of causality
- Reductionism - holism
- Paradigm shift



Spurious Correlations

US spending on science, space, and technology correlates with Suicides by hanging, strangulation and suffocation



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
US spending on science, space, and technology Millions of todays dollars (US OMB)	18,079	18,594	19,753	20,734	20,831	23,029	23,597	23,584	25,525	27,731	29,449
Suicides by hanging, strangulation and suffocation Deaths (US) (CDC)	5,427	5,688	6,198	6,462	6,635	7,336	7,248	7,491	8,161	8,578	9,000

Correlation:
0.992082

Permalink - Mark as interesting (5,147) - Not interesting (2,370)

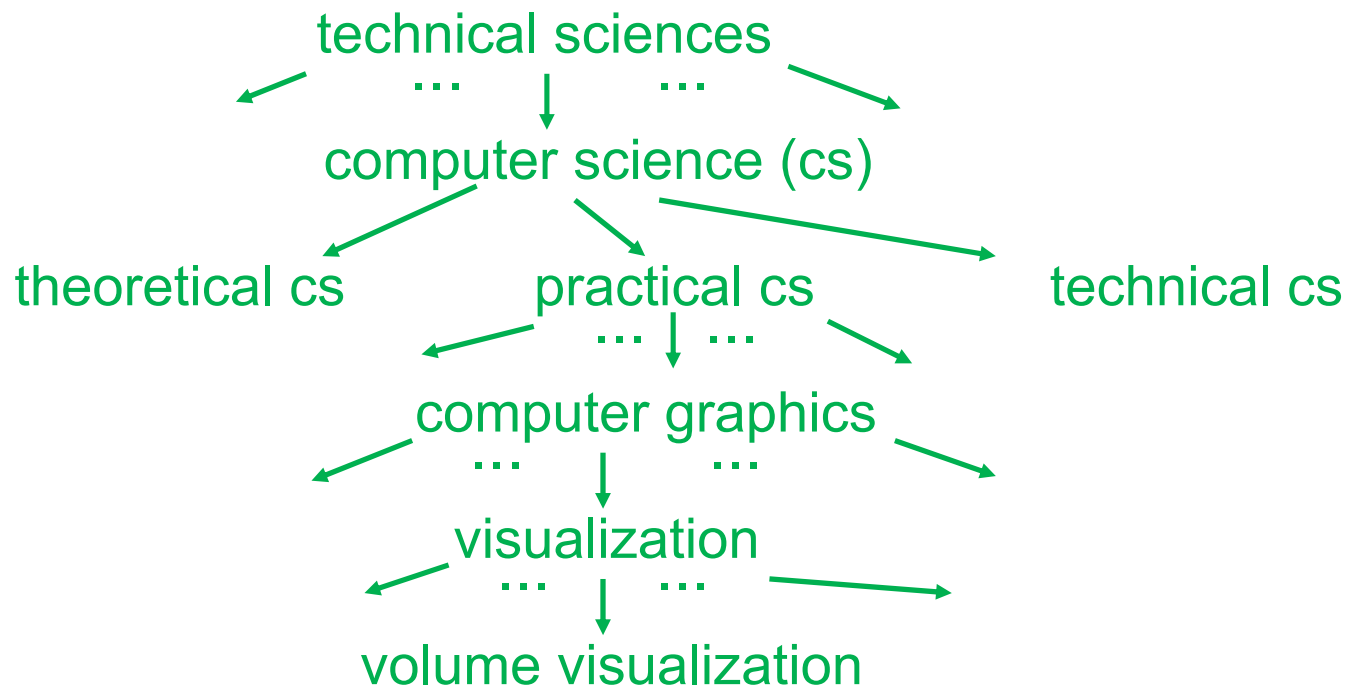
<http://www.tylervigen.com/>



- Epistemology
- Society and Science
 - Scientism
 - Anti-scientism
- Science – research - development
- Basic research – applied research
- Research is very costly (even more costly is not doing research)



■ Very strong differentiation



■ Exponential data growth



- Experimental sciences (observations, experiments)
- Theoretical sciences (modelling to describe and explain natural phenomena)
- Scientific computing (computer simulation of mathematical models)
- Data science (big data, smart data, machine learning)



Where does Research happen?

- Universities: “Unity of Teaching and Research” [<https://www.bmbwf.gv.at/>]
- Extra-mural research institutes
 - IST Austria, ALT, Joanneum Research, Oefai
- Academy of sciences
- Public – private research partnerships
 - K+ Centres (VRVis, <http://www.vrvis.at/>)
- Commercial companies
 - Typically in large companies
 - (Research and) development



- What is a university teacher doing?
 - He/she is teaching (4 - 12 weekly hours each term)
 - He/she is doing administrative work (study curriculum, ...)
- What is he/she doing during the breaks?
 - He/she is going on vacation



And then he/she is doing research



- Institute subdivided into several research groups
- Joint research interests
 - VC&HCT: Computer Vision (193-01), Computer Graphics (193-02), Virtual and Augmented Reality (193-03)
- Members of a research group
 - University teachers
 - Research associates, PhD students
 - Master students, Bachelor students, interested students
- Carrying out research projects



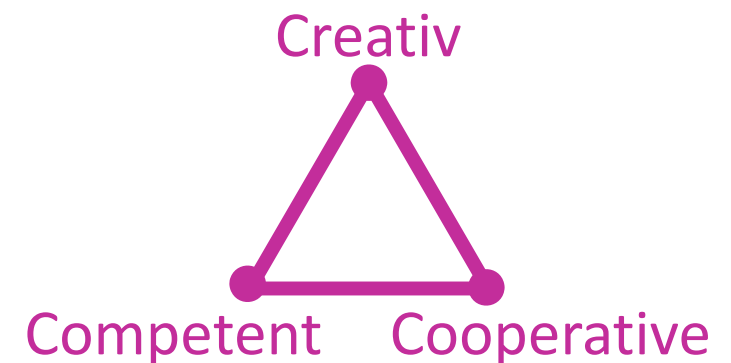
- Single projects – joint projects
- Problem, goal, approach, outcome, costs
- Processing in several phases (milestones)
- In each phase defined
 - Desired goals and results
 - Actions, implementation measures
 - Evaluation
 - Duration



Vis-Group: Funding and Projects



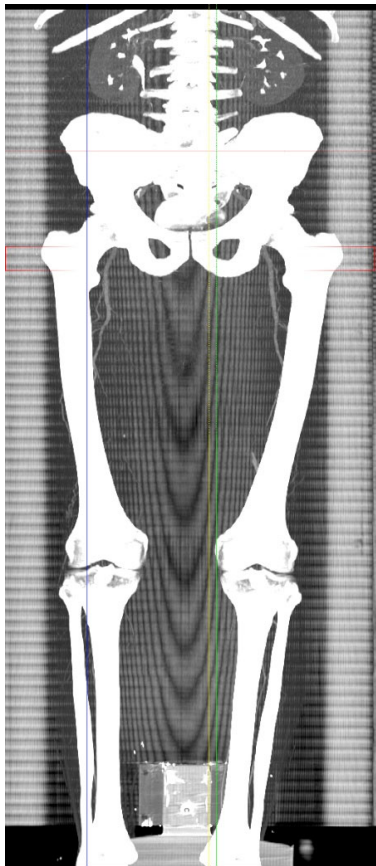
- Professional career in science
 - Tutor (teaching/research assistant)
 - Bachelor thesis, Masters thesis
 - Doctorate (university assistant, research assistant, ...)
 - PostDoc
 - Habilitation (tenured position), Professorship
- Qualities of a good scientist
 - Curiosity (why, why, why, ...)
 - Creativity
 - Excellent command of tools
 - Analytical thinking
 - Perseverance, tenacity, thoroughness, frustration tolerance



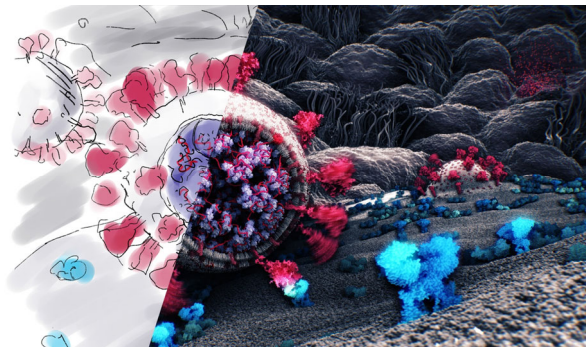
- Project start
- State-of-the-art survey
- Formulation of ideas and goals
- Implementation, realization
- Testing, evaluation
- Publishing (write a scientific paper)
- Project end with debriefing



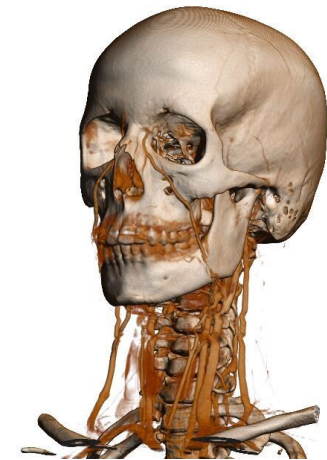
CT - Angiography



- Bachelor theses
- Master theses
- PhD theses
- Publications (<https://www.cg.tuwien.ac.at/research/publications/>)
 - At conferences
 - In scientific journals
- Software prototypes
- Patents, licenses
- Spin-off companies



nanographics



 **VISU APPS**
the visual application company



- Internal Communication
 - Individual meetings
 - Organisational meeting
 - Scientific meeting
 - Colloquy cycle
 - Yearly closed meetings
 - Social interaction



- External Communication
 - Colloquy cycle, guest lecturer
 - Guest researcher
 - External research stays
 - Conference attendance
 - Publications (papers, posters)
 - Scientific
 - Popular science
 - Trade fairs



- Organized by scientific associations
- Local organizers
- Conference chair, program committee
- Call-for-papers
- Submission of scientific papers (technical reports)
- Peer reviewing
- Conference attendance, giving a talk
- Article published in conference proceedings

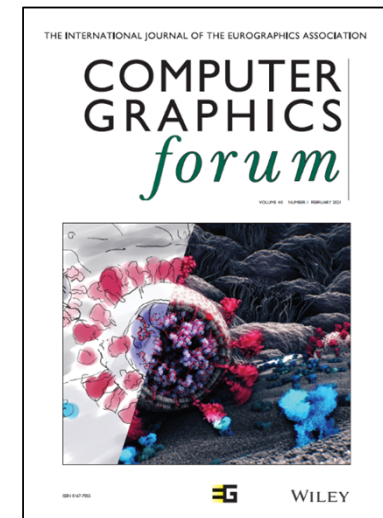
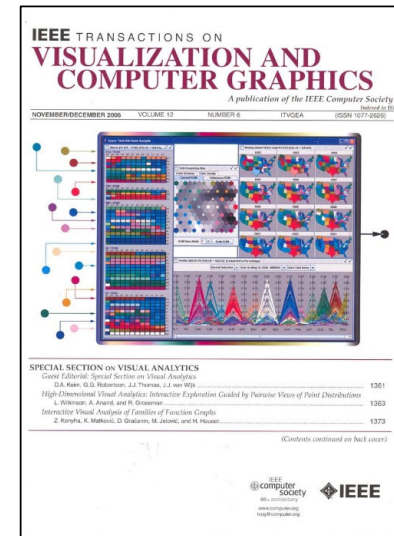


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Publications - Journals

- Published by commercial publisher or scientific association
- Editor-in-chief, editorial board
- Submission of scientific papers (technical reports)
- Peer reviewing
- Major revision with second review cycle
- Article published in journal
- Duration: half a year and longer

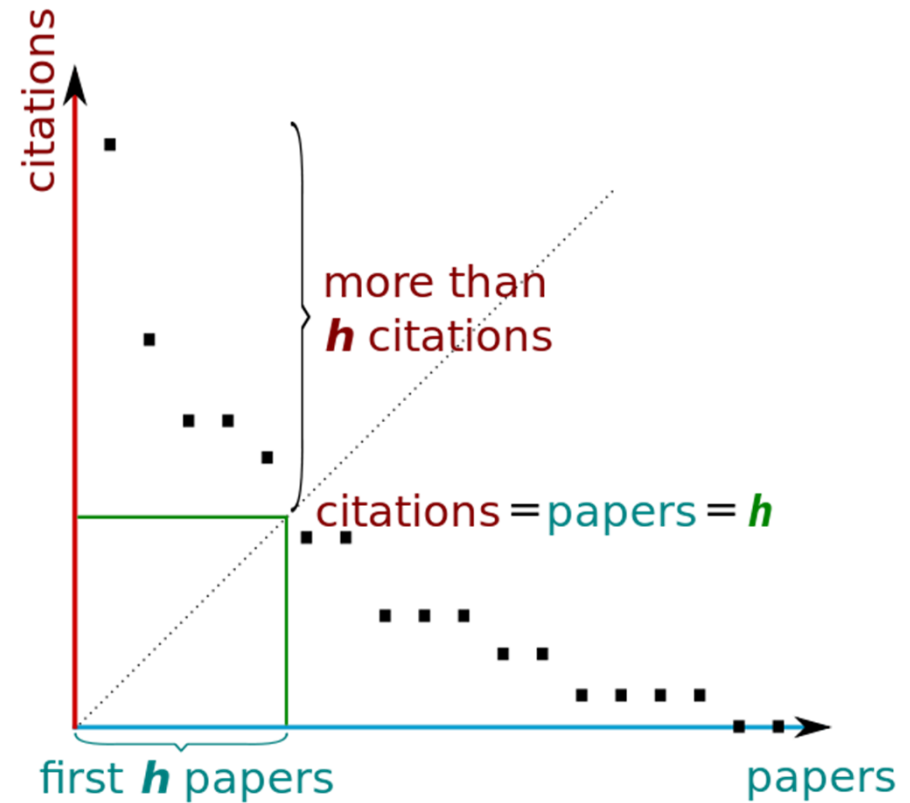


Scientific Associations

- Advancement of scientific area, members
- Ethical guidelines
- Publishing of journals
- Organization of scientific events
- Examples of scientific associations
 - OCG (<http://www.ocg.at/>)
 - GI (<http://www.gi-ev.de/>),
 - Eurographics (<http://www.eg.org/>)
 - IEEE (<http://www.ieee.org/>)
 - ACM (<http://www.acm.org/>)



- #Publications
- #Patents
- #Talks
- Acquired research fundings
- #PhD, #Master, #Bachelor students
- Member in scientific associations
- Member in program committees
- Member in editorial boards
- #citations
 - Science Citation Index
 - <http://scholar.google.com/>
 - <http://citeseer.ist.psu.edu/>
 - <https://www.scopus.com/home.uri>
 - <http://www.vs.inf.ethz.ch/publ/slides/Citation-Index-Unsinn.pdf>



[<https://en.wikipedia.org/wiki/H-index>]



- University, science funds, company funding
- Science funds
 - FWF – basic research fund (<http://www.fwf.ac.at/>)
 - FFG – applied research fund (<http://www.ffg.at/>)
 - EU – funding programs
 - Horizon Europe (2021-2027)
 - ERC grants

FWF

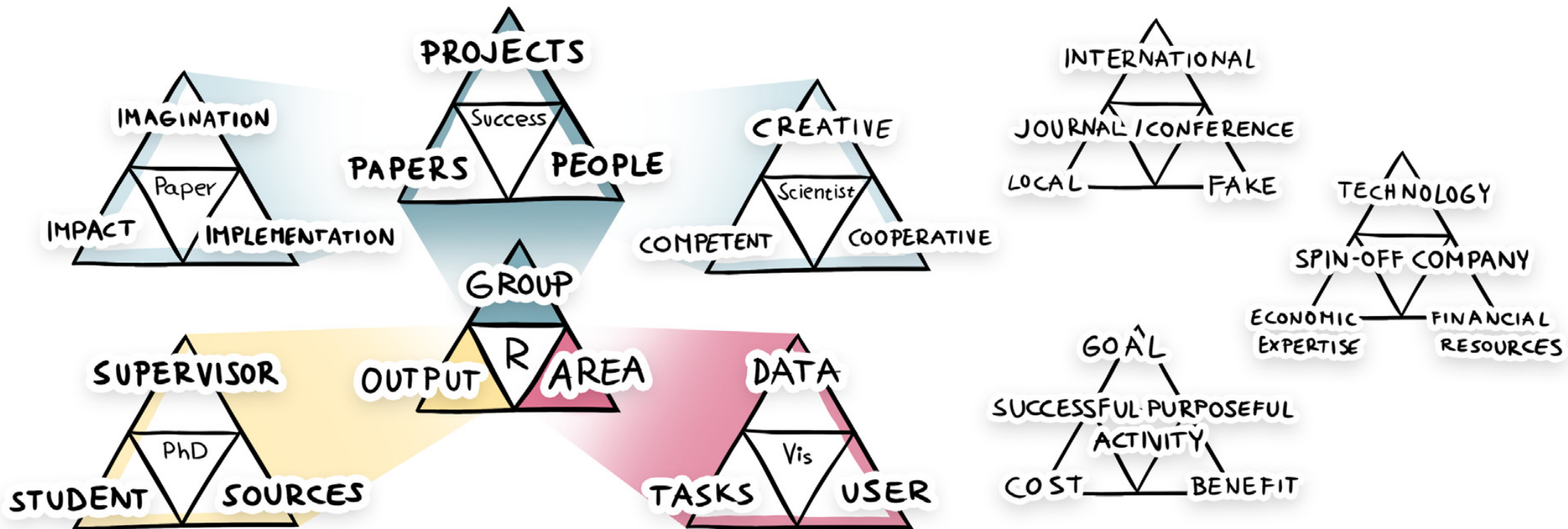
Der Wissenschaftsfonds.



European Research Council
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How to Run a Successful Research Group?

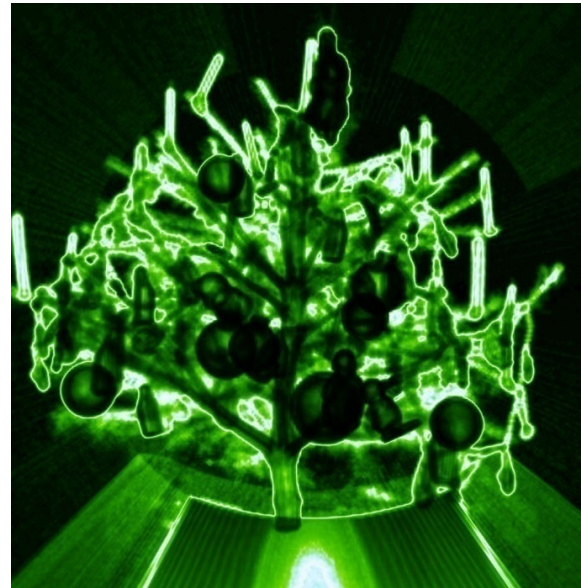


<https://www.cg.tuwien.ac.at/research/publications/2021/wu-2021-vi/>



- Unity of teaching and research
- Scientific topics dealt with in
 - Proseminars, Seminars
 - Programming assignments, computer science projects
 - Bachelor thesis
 - Master thesis
 - PhD thesis

Research is fascinating
Join in nibbling!



Further References

- https://www.cg.tuwien.ac.at/research/publications/2021/Groeller_2021_BVM/
- <https://www.cg.tuwien.ac.at/research/publications/2021/wu-2021-vi/>
- <http://www.cg.tuwien.ac.at/research/publications/2011/patel-2011-PEA/patel-2011-PEA-Paper.pdf>
- <http://research.microsoft.com/en-us/collaboration/fourthparadigm/>
- http://archive.wired.com/science/discoveries/magazine/16-07/pb_theory
- <http://er.educause.edu/articles/2012/6/scientific-research-how-many-paradigms>
- http://www.informatics-europe.org/images/documents/informatics-doctorate-europe_2013.pdf

