# Chapter 11
# Research and Development in Creativity


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**Abstract** The art and science of creativity and the creative process are examined. Analytic capabilities using information technology are supporting this work. Digital creativity is a focus for bringing together different disciplines, and also for providing support to the creative industries sector. The relationship between creativity and innovation is examined. National and international initiatives for research and development in creativity are presented. Many of these initiatives have funding programs which are seeking to investigate cognitive models of creativity using information technology, and also how creativity can be used to more effectively advance the research and development process. In addition, new tools are being developed to support creativity.

**Keywords** Creativity research · Cognitive models · Creative research · Digital industries · Cultural transformation · Innovation · Creative Europe · Knowledge transfer · Artistic analysis · Stages of creativity

## 11.1 Introduction

Many disciplines are seeking a greater understanding of creativity in order to be able to further research and development in their areas. Many national governments are investing in programs to improve the productivity of their work forces in order to overcome current problems and difficulties. Often this is perceived to be finding creative solutions to these problems leading to greater efficiency and effectiveness, and greater economic stability.

Four aspects to research and development in creativity are highlighted in this chapter. These may be summarized as follows:

1. The scientific and artistic analysis of creativity
2. Application of creativity to assist in research and development
3. Using creative approaches to advance interdisciplinary research and development
4. Creativity and innovation.



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**Scientific and Artistic Analysis of Creativity**

This may be considered as research into creativity. How may it be defined? What kind of cognitive models lead to a greater understanding of its operation and applicability? Can context and environmental factors aid in its development and effectiveness? In such modeling, simulation, and analysis, information technology is often used to gather data and perform computations and visualizations. This aspect may be described as the scientific and artistic analysis of creativity.

**Application of Creativity to Assist in Research and Development**

The second aspect is to more fully understand how creativity may be used in research to advance knowledge and understanding in academic disciplines. What approaches can make creativity more effective at uncovering unknown information and knowledge?

**Interdisciplinary Research and Development**

This considers the question of how creative approaches may be used to advance interdisciplinary research and development (R&D). Many academic disciplines exist in silos due to the budget allocation mechanisms within the academy and the traditions within disciplines. How can these barriers be overcome by using creative strategies? New knowledge often arises at the boundaries between existing disciplines and it is therefore important to be able to benefit from this.

**Creativity and Innovation**

Creativity may be regarded as producing new and novel ideas, and innovation as seeking out ways to implement them. However, the boundary can become fuzzy when all partners are working together on a project.

Each of these aspects will now be considered in more detail.

## 11.2 Research into Creativity

Psychologist Mihalyi Csikszentmihalyi studied more than 90 men and women who possessed the following characteristics:

(1) they produced works that were publicly recognized as creative, and
(2) they influenced or affected their culture in some important way.

This led to the psychological concept of ‘flow’ [1], a highly focused mental state conducive to productivity [2–4]. It may be characterized by complete absorption in a particular task, and ability to focus intensely on seeking to understand the task.

Dietrich identified four types of creativity with corresponding brain activities as follows [5, 6]:

- Deliberate and cognitive creativity
- Deliberate and emotional creativity

- Spontaneous and cognitive creativity
- Spontaneous and emotional creativity.

Dietrich also summarized these as a deliberate mode, a spontaneous mode, and a flow mode [7].

Other researchers have also proposed various stages of creativity as follows [8]:

- Intention. Your idea is born
- Incubation. This is the time you begin to put thoughts together
- Investigation. Here is where you do research
- Composition. This is the DO part where you begin to compose
- Compose—Get it out
- Clarification
- Changes
- Completion.

Hennessey [9, 10] describes the Consensual Assessment Technique which enables a panel of experts to assess the degree of creativity inherent in a particular product. Although creativity may be difficult to define and characterize, many people are able identify it and recognize it when they see it.

**Creativity and Intelligence**

Research in creativity views creativity and intelligence as different attributes which most studies appear to show can only be weakly correlated at best, though other studies seek to show a relationship between creativity test scores and IQ scores [11–14].

## 11.3 The Application of Creativity to Assist in Research and Development

Epstein recommends [15]:

- **Capture your new ideas**. Keep an idea notebook or voice recorder with you, type in new thoughts on your laptop or write ideas down on a napkin.
- **Seek out challenging tasks**. Take on projects that don't necessarily have a solution—such as trying to figure out how to make your dog fly or how to build a perfect model of the brain. This causes old ideas to compete, which helps generate new ones.
- **Broaden your knowledge**. Take a class outside psychology or read journals in unrelated fields, suggests Epstein. This makes more diverse knowledge available for interconnection, he says, which is the basis for all creative thought. "Ask for permission to sit in on lectures for a class on twelfth century architecture and take notes," he suggests. "You'll do better in psychology and life if you broaden your knowledge."

- **Surround yourself with interesting things and people**. Regular dinners with diverse and interesting friends and a work space festooned with out-of-the-ordinary objects will help you develop more original ideas, Epstein says. You can also keep your thoughts lively by taking a trip to an art museum or attending an opera—anything that stimulates new thinking.

  The American Psychological Association states [16]:

  > A study last year in the *Creativity Research Journal* (Vol. 20, No. 1), found that working on these four areas enhances creativity. Seventy-four city employees from Orange County, Calif., participated in creativity training seminars consisting of games and exercises developed by Epstein to strengthen their proficiency in these four skill sets. Eight months later, the employees had increased their rate of new idea generation by 55 percent—a feat that led to more than $600,000 in new revenue and a savings of about $3.5 million through innovative cost reductions.

A number of funded research programs are seeking to identify how creativity can assist in various research areas.

Kelly provides guidance on developing creativity for research and those mentoring research [17]. This is based on a curriculum developed at the Hasso Plattner Institute of Design at Stanford University.

> By focusing attention on how research happens as well as its outputs, you can increase your ability to address research challenges and produce the outputs you care about. Simultaneously, you may also transform your emotional relationship with your work, replacing stress and a harsh inner critic with a more open and emotionally empowered attitude. Whatever your background, discipline, or career stage, this book can give you concrete tools to gain clarity, be innovative, and make progress in your research journey [17]
>
> In our work at the Stanford d.school, we've found that creative processes are useful to practitioners across many disciplines—design, business, and education to name a few. Through compelling, straightforward prose and concrete examples, this book shows that creative thinking is equally useful for researchers of all kinds. It is exciting to imagine the possibilities that will surely come from the approaches presented inside [17].

## 11.4 Using Creative Approaches to Advance Interdisciplinary Research and Development

A particularly significant gulf may exist between the sciences on the one hand and the arts and humanities on the other. When funding in the academy becomes constrained or limited, questions begin to be asked about how effective various disciplines are, and their overall benefit to society. This can set faculties in the academy in opposition to each other at the very time when more effective solutions may be found by a greater interworking. Snow characterized this as the two cultures [18]. This has been analyzed further in [19].

> This appeared to be due to a variety of factors including tradition, vocabulary, ways of working, and contributions to society, all of which could be different in different disciplines and circumstances. Critchley [20] proposed that Snow had diagnosed the emergence of

two cultures because of the loss of a common framework of understanding. Scientists and engineers favoured advancement of society through technology and industry, whereas the arts and humanities preferred intellectual and literary endeavor. However, Gould took an opposing point of view and emphasized the commonalities between science and the humanities [21]. In 1963, Snow appeared to take a more optimistic view about the relationship between science and the arts [19, 22]

In the Foreword to [19] Journeaux states:

In an interview with Alfred Appel Jr., in 1966, Vladimir Nabokov reacted to C.P. Snow's assertion that the gap between the two supposedly separate cultures of science and the arts was unbridgeable. He argued that science has an artistic and creative side and that the arts require scientific truths, saying: "*I certainly welcome the free exchange of terminology between any branch of science and any raceme of art. There is no science without fancy, and no art without facts*" [23].

Journeaux also wrote:

However, if we consider the processes and ambitions associated with creativity supposed differences between artists and scientists may become less distinct. Creativity theorist Mihaly Csikszentmihalyi reminds us that: "*creativity does not happen inside people's heads, but in the interaction between a person's thoughts and a sociocultural context. It is systemic rather than an individual phenomena*" [2]. In his book *Creativity* Csikszentmihalyi argues that levels of creativity do not just depend upon creative individuals but are also affected by the willingness of domains and fields to recognise novel ideas and artefacts [2].

## 11.5 Creativity and Innovation

Creativity and innovation may be related but the former is primarily concerned with the generation of ideas (which may also be innovative) and the latter is more concerned with the applicability of the ideas and their expression in practical situations. This may involve changing the existing processes within a particular organization or system. For example, as products and services evolve through innovation, companies have to decide the optimum time to migrate to a new system or a new set of products while maintaining existing market share, and also being able to attract new customers as demands shift in the market-place [24].

## 11.6 Research Funding Which Includes Creativity

This section summarizes funding programs related to creativity in research and development in the European Union, Fraunhofer in Germany, the National Science Foundation in the USA, and the UK.

**European Union—Creative Europe**

A database of the all the projects is online and contains details of the projects and the results of those projects that have completed their work [25, 26].

### Horizon Europe—Cluster 2: "Culture, Creativity and Inclusive Society"

Under Horizon Europe, the European Commission funds research and innovation projects for social, economic, technological and cultural transformations toward healthier democracies where cultural values are protected.

Horizon Europe is adopting a creativity theme in its funding of Cluster 2. The European Commission mobilized €158 million for four calls under Horizon Europe—Cluster 2: Culture, Creativity and Inclusive Society. The Cluster 2 calls opened in June 2021 and closed on the 7th of October. The European Research Executive Agency (REA) received 378 applications across the four calls. 51 projects were selected for funding in June 2022.

Partnerships which have to deliver a product or service normally have partners with expertise in usability testing, user trials, human computer interaction, and art and design. In order for a product or service to be viable in the market-place it has to justify its existence and provide function, form, and value to the appropriate sector, as well as being able to appeal to potential users. This is where expertise in art and design can add value to the product. Such partners can add value in all areas of the EU's projects, not just in culture and creativity. This is where a consortium with interdisciplinary expertise is able to make significant contributions in Europe and also internationally.

The EU wishes to ensure that the program of work enables the research and innovation to be transformative across businesses and society as a whole within the European Research Area (ERA).

> In order to address today's multiple challenges, ERA needs to accelerate the transitions, strengthen resilience to future crises, while sustaining its competitiveness. High quality results require sufficient levels of investments in R&I, in particular from Member States and the private sector. Lagging innovation ecosystems can hardly improve without intense cooperation between academia and industry accompanied by better access to excellent facilities and infrastructures. While overall the EU is already leading in research and scientific excellence, it needs to step up its support to breakthrough market-driven innovations that will underpin green digital Europe and will boost growth, job creation and competitiveness. Only an excellent and impactful R&I system, will offer attractive career paths for researchers, mutually favourable circulation of talents within the EU and increase attractiveness of the EU abroad [27, 28].

The next section details how EU funding of projects operates.

### European Union (EU) Funding of Projects and Initiatives

The European funds various kinds of initiatives and projects, usually by evaluating proposals that respond to Calls at particular times that define the priorities of the Call, the areas it covers, and the funding available.

Research and development projects are intended to be collaborative and have been funded in the past through various Frameworks. Horizon 2020 and ran from 2014 to 2020 with a budget of approx. $80 billion [29].

Horizon Europe is the current EU research and innovation program. It has a budget of €95.5 billion and runs until 2027. More than 85% of the budget is to be allocated to collaborative projects.

> The programme facilitates collaboration and strengthens the impact of research and innovation in developing, supporting and implementing EU policies while tackling global challenges. It supports creating and better dispersing of excellent knowledge and technologies. It creates jobs, fully engages the EU's talent pool, boosts economic growth, promotes industrial competitiveness and optimises investment impact within a strengthened European Research Area. Legal entities from the EU and associated countries can participate [30]

Project proposals normally consist of 3 or more partners from different EU member states [31]. It is expected that the partners have the necessary expertise in order to carry out the R&D detailed in the proposal. In practice, most consortia are typically 10–20 partners, but some can have 30 or more. Duration of the project can be 3–5 years. The contribution that each partner makes to the delivery of the project is defined in the project proposal and partners usually have complementary expertise. For example, the research organization (e.g., universities or research institutes) can provide the state of the art knowledge at the cutting edge of research, industrial companies can provide development and manufacturing of prototypes and sales and marketing, and telecommunication providers can provide expertise on network delivery. SMEs, and-users, and marketing agencies can provide specific expertise that is required by the project. Associate partners and sub-contractors with specific functions can also be involved in the project but are not signatories of the EU grant agreement. Participants from non-EU countries can also be partners in the consortium. If the project proposal is approved, their funding component is paid for by their particular country and not the EU. Following the UK's departure from the European Union, organizations based in the UK can no longer be partners in proposals. However, the UK is intending to be an associate to Horizon Europe. If this is not approved, then an associate partnership in a proposal may be possible.

The objective is for the project to deliver a program of work for the development of new assets, and new products and services that meet the needs of European and international markets. Each partner in the consortium is expected to add value and expertise to the project as a whole, so that the overall project is able to deliver more than the sum of its parts. Proposals normally also a define a Consortium Agreement which defines how any intellectual, or other assets, which are developed during the project are to be shared across the partnership during and after the conclusion of the project. Such Intellectual Property Rights (IPR) can include patents, trademarks, copyrights, and any prototypes that may be developed in the project. The project is led by a Project Co-ordinator who is normally someone with appropriate management and commercial experience.

Normally a proposal as expected to have an appropriate balance between academic institutions, private sector research and innovation, and end-user organizations. The EU regards businesses as the 'engine of innovation'. Therefore, being able to involve them in wider partnerships with complementary expertise should be able to significantly drive this process forward with greater efficiency and effectiveness [32].

Project proposals are reviewed by a panel of experts in the subject area(s) of the proposal call and then ranked. Generally, many more proposals are received than can be funded. For example, for the Horizon Europe Cluster: Culture, Creativity

and Inclusive Society, the European Research Executive Agency 378 applications in 2021 across 4 calls, and 51 projects were funded starting in 2022. This gives a success rate of about 1 in 7 [33].

In FP7, partners included:

- research groups at universities or research institutes;
- companies intending to innovate;
- SMEs (small and medium-sized enterprises) or their groupings;
- public administration;
- researchers (from early-stage to experienced);
- research infrastructures;
- civil society organizations;
- organizations and researchers from third countries and international organizations.

It can be difficult for those new to the process to find appropriate partners that will be able to work together effectively on a proposal, and then on the project itself, if the proposal is successful. Joining a network can help in understanding the expertise sets available in European organizations and industry. Networks of Excellence were initiated during the EU's FP6 program. They can also provide contacts of potential partners in other EU states. Generally, they have a large number of partners with cognate interests who met from time to time to share ideas, and promote seminars and conferences. It also enabled those who wished to produce a program of work to join together and develop a project proposal.

National governments are concerned that their investment in the academies can be seen by their populations to deliver societal and economic benefits. Therefore, universities are increasingly including relationships with industry and business in their mission statements, alongside teaching and research. For example, the UK has the Higher Education Innovation Fund (HEIF) to support knowledge transfer to industry. Its objective is to benefit the economy and society [34].

This updated agenda for many of the academies in Europe enables them to synchronize more closely with the requirements of the EU research and development programs.

**Fraunhofer**

The Fraunhofer organization in Germany supports 76 institutes in Germany which focus on different aspects of applied science. Many have close relationships with academic institutions in their geographical areas [35, 36].

**European Research Council**

The EU also provides funding for frontier research in any field through the European Research Council (ERC). The average success rate for applications is around 12%. The sole criterion for acceptance is excellence. There are no thematic priorities or geographical quotas.

> In the ERC Work Programme, the ERC Scientific Council earmarked €628 million for an estimated 407 Starting Grants in 2023. The ERC is now beginning the evaluation of the proposals. The projects selected for funding are planned to be announced in summer 2023 [37, 38].

EU work programs are monitored to evaluate their impact and effectiveness [39].

### National Science Foundation

The objective of the CISE is to explore the synergies between creativity and information technology, science, engineering, and design research.

> Information technology is playing an increasing role in extending the capability of human creative thinking and problem solving. Design, as a reflective process, develops new products in the context of a perceived need or problem. In design, the reflection on problem finding becomes as important as problem solving, recognizing that designers often redefine the problem to be solved as they explore design solutions within a specific context. The combination of creativity and design thinking in information technology, science, and engineering has the potential to define new areas and lead to increased successful innovation. Considering the synergy of creativity with research in design can have outcomes such as new models of creative cognitive and computational processes [40].

One of the research areas seeks to understand creative cognition and computation:

> This area has two major thrusts: research and education. Research in this area leads to cognitive models that serve as inspiration for computational models of creativity, support for human creativity, and approaches for educating people to be more creative. This research is typically done by adopting or adapting a model of cognition and evaluating its creative performance in different contexts, or developing a new model of creativity based on empirical or ethnographic studies. The emphasis in this area is the development of new models of cognition and computation that explain or simulate creativity. These models may then become the basis for new tools and new educational environments [40].

Another area is to develop information technology to support creativity:

> This area both develops new software and user interfaces to support users in being more creative and evaluates their performance through user studies either in controlled environments with empirical studies or in the context of a complex problem or situation with ethnographic studies. The emphasis in this area is the development of new support tools where the tool itself may be a creative product, and the tool is intended to support people in their creative activities [40].

### UK Arts and Humanities Research Program

The Arts and Humanities Research Council (AHRC) launched the Creative Industries Clusters Programme in 2018. The £120 million investment continues to drive innovation and growth across the UK's creative industries, to encourage a new type of applied research. It lasts from 2018 to 2023 [41, 42].

The AHRC also supplies funding to enhance the international impact of research related to the creative economy and global sustainable development [43, 44].

A complementary review of art and design examines how research and development in these areas can be formulated and framed and then evaluated and measured, particularly in terms of the quality of their research outputs [45].

## 11.7 Conclusions

Creativity is a hot topic with many researchers and national governments. The latter are concerned to devise methods and strategies to support businesses and national economies, and make them more internationally-leading and more resilient to problems and crises. Researchers are seeking to understand what makes creativity effective and how it can be optimized and harnessed to a greater degree. Funding programs in the areas summarized in this chapter are all seeking to obtain answers to these important questions.

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