Chapter 3
Art and Artistic Research in Quadruple and Quintuple Helix Innovation Systems

Elias G. Carayannis and David F.J. Campbell

Abstract The traditional understanding of arts emphasizes the aesthetic dimension of arts. Art and arts can also be understood (and re-invented) as a manifestation of knowledge, knowledge production and knowledge creation. Furthermore, knowledge production and knowledge creation extend to knowledge application and knowledge use. The here presented approach to arts introduces knowledge as an additional dimension for defining and understanding arts. This additional dimension does not replace, but extends the aesthetic dimension of arts, by this making the arts clearly multi-dimensional. Through knowledge creation, knowledge production, knowledge application, and knowledge use, research in the arts and arts-based innovation are being interconnected with research in the sciences and sciences-based innovation. Arts and artistic research add to the interdisciplinary and transdisciplinary spectrum of research organizations and of research networks, and can assist the sciences in building interdisciplinary arrangements. Arts and artistic research are now being regarded as drivers for forming and pluralizing interdisciplinary and transdisciplinary configurations and networks with research in the sciences and the application and use of knowledge and innovation in context of society, democracy, but also the economy.

The concepts of the *Quadruple Helix and Quintuple Helix innovation systems* are explicitly sensitive for the roles of arts and of artistic research for innovation. Within context of that line of thinking, arts, artistic research and arts-based innovation are essential for the further evolution and progress of innovation systems. Universities of the arts and other higher education institutions of the arts represent crucial organizations for innovation systems (national and multi-level innovation

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systems). Innovation may not be narrowed down to economic concerns and economic activities. Innovation is more than only economics. "Arts, research, innovation, and society" (ARIS) contribute to creating the basis for new models of economic growth, where "growth in quality" challenges the traditional focus on "quantitative growth" of selected economic benchmarks. "Arts, research, innovation, and society" (ARIS) furthermore interrelates and cross-links with Quality of Democracy. ARIS indicates opportunities for a creative design or creative-design-processes in the further co-evolution of knowledge economy, knowledge society and knowledge democracy.

Keywords AAA (art and artistic research) • AAA (arts, artistic research and arts-based innovation) • ARIS (arts, research, innovation, and society) • Art in the arts • Artistic research • Arts-based innovation • Arts-based research • Society-nature interactions • Socio-ecological transition • Multi-level innovation systems • Innovation ecosystem • Twenty-first century Fractal Research and Education and Innovation Ecosystem (FREIE) • Networks and network governance • Public-private partnerships for research and technological development (PPP RTD) • Democracy of knowledge • Republic of science • Co-evolution • Linear and non-linear innovation • Cross-employment and multi-employment

3.1   Introduction: Artistic Research and the Research Question of Our Analysis

This contribution does not focus on the *arts as such*. The focus is on "artistic research" and how artistic research relates to research, knowledge production (knowledge creation), innovation, and innovation systems. Artistic research may also have the potential to help us to better understand the arts themselves. By this, artistic research qualifies as an epistemic approach ("epistemic tool") that navigates to core meanings of arts and of "art in the arts". *Artistic research, however, also bridges, cross-connects and links the arts with knowledge production (research) and knowledge application (innovation) in the sciences or research and innovation that are based on the sciences.*[1] *Therefore, at least potentially, artistic research is also interdisciplinary in character*. Artistic research adds to the development and formation of designs and architectures of interdisciplinary research platforms and research as well as innovation networks, where different disciplines in the sciences are interconnected with the disciplines in the arts through research and innovation activities. In fact, interdisciplinary ambitions in the sciences are reinforced and

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[1] Within context of our analysis, the plural term "sciences" always includes the natural sciences, life sciences, but also the social sciences and humanities (human sciences). For us, the *sciences* address the whole and complete disciplinary spectrum. Therefore, "sciences" is not equivalent to science. When we use the shorter expression "scientific research", we actually always mean the research in all of the sciences.

excelled by bringing artistic research into play. Artistic research, but also the arts in more general, help in creatively strengthening and unfolding the interdisciplinary drive in the sciences. In one understanding, interdisciplinarity does not happen "automatically" in the organizational context of the sciences, but requires an involvement of structures and processes that encourage a further development of interdisciplinarity (within the institutional framework of universities or of other higher education institutions). For example, academic careers often follow a disciplinary logic: therefore, inserting and introducing interdisciplinarity to organizations and networks, requires to innovate and to re-invent the academic career logic. The organizational framing of transdisciplinarity creates even further challenges (on interdisciplinarity and transdisciplinarity, see for example Arnold 2013a, b). *There exists and is the opportunity of configuring and re-configuring scientific research (research in the sciences) and artistic research, interwoven in arrangements of interdisciplinarity and transdisciplinarity. In fact, artistic research has all the potential to increase interdisciplinarity and transdisciplinarity also in research in the sciences, when scientific research and artistic research are being interlinked.*

Our analysis is being driven by the following core research question: *How does artistic research relate to research in the sciences and how does artistic research relate to innovation and innovation systems?* Our inclination is to engage further in formulating, developing and designing propositions in reference to our research question. These propositions are more tentative in character, additional "research about research" is necessary and may impact future research agendas. The analysis of our research question will be based on Carayannis and Campbell (2013) and will departure in iterations conceptually from there. We are motivated to inquire connections of artistic research to innovation and innovation systems by relying on and by applying consequently the concepts of the Quadruple and Quintuple Helix innovation systems. In fact, we believe that the Quadruple and Quintuple Helixes are designed (and driven) in a way and are carried by an understanding that emphasizes the importance of arts, arts universities and artistic research for creativity, knowledge production and innovation. Triple Helix represents a basic model of the innovation core (see Fig. 3.4) and was developed by Etzkowitz and Leydesdorff (Etzkowitz and Leydesdorff 2000; Leydesdorff 2012). Quadruple Helix (Carayannis and Campbell 2009) and Quintuple Helix (Carayannis and Campbell 2010) bring in additional perspectives and by this already "contextualize the context". When we develop the importance and meaning of artistic research for research and innovation, we will follow in particular the conceptual logic of the models of the Quadruple and Quintuple Helix innovation systems. These models will serve as reference for artistic research. The Quadruple Helix and the Quintuple Helix express and emphasize why arts and artistic research are important for knowledge production and innovation.

Our following analysis is structured in the following sections. In Section Two, we explore further the cross-connections and inter-connection between arts and artistic research. This is based on an understanding of arts as a manifestation of knowledge. Section Three embeds artistic research in context of the concepts of Quadruple and Quintuple Helix innovation systems. We demonstrate, how concepts

of innovation and innovation systems have evolved, and how knowledge production, innovation and structures of organizations are intertwined in co-evolution. Finally, in Section Four, the conclusion to our analysis, we speculate on possible future scenarios of co-development of *arts, research, innovation, and society* (ARIS). ARIS has all the potentials of becoming crucial for the further progress of innovation and innovation systems that drives knowledge economy, knowledge society and knowledge democracy.

3.2   Arts and Artistic Research

What is art or what are the arts? This creates a challenge in the quest for finding or identifying answers. However, for our analysis presented here, a possible definition of arts is not of primary concern, because we will focus with greater emphasis on artistic research and its ramifications for knowledge production and innovation. Therefore, we reflect more briefly on the issue of what art is or what arts may be considered to be. *There exists not only one definition, but a pluralism of different definitions of arts* (e.g., see Campbell 2013b). We must recognize and should acknowledge a variety of different definitions of arts, also with competing, sometimes even conflicting meanings. *There are contradictions between the available definitions of arts. Also, definitions of arts have changed over time, and continuously will do so, and are furthermore context-dependent.* Are the arts older than the sciences? Art (as a concept and practice) exists now for several hundred, better several thousand years (at least), so there was a sufficiently long time for a serious evolution of arts. Art (as a concept and practice) probably is even older than the sciences (modern sciences).[2] *A pragmatic simplification could suggest that art is what artists are doing (and artists do very different things). Consequently, "established art" is being represented by the established artists.* But there exists no universal criterion or general standard who may qualify (or not) being an artist. We know that several of the most influential (and innovative) artists only had an impact later in their life, if not even for later generations. In these cases, the not-established (non-established) artists were even more important.

   A "traditional" understanding of arts frequently associates the arts with an "aesthetic" dimension, which could be more abstract or more concrete. More concrete means to indicate a "perceived beauty", also an emotionally perceived beauty. Emotions imply that then beauty causes or is connected to emotions in the human "observer" (also producer) of arts, when art is being perceived (created). The emotional spectrum can be comprehensive and diversified, but also

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[2] Of course, depending on how the sciences or knowledge production in the sciences are defined or is being defined, we may arrive here at different conclusion. Perhaps, the sciences (or pre-forms of the sciences) are just as old as the arts (pre-forms of arts). *Reasoning and aesthetic sensitivity represent universal categories of humanity.*

controversial. Looking at art from a historical perspective, the aesthetic dimension of arts often was thought to express the beauty or perfect beauty (perfect order) of the world (the universe), of society, but also of individual people (for example, see the review and discussion in Öcal 2013, pp. 11–27).[3] This expression of beauty or perfection (*beautiful perfection*) could have religious connotations, but was not necessarily linked to religious connotations. In several contexts also cross-references were drawn between the beautiful, the perfect and the good. Was this the case (the construction of meaning), then the beautiful was furthermore the morally or ethically good. The "beautiful order" expressed the "morally good order". *By associating art closely to an aesthetic dimension, arts can also fulfill "aesthetic functions", or also those aesthetic functions, which society or specific communities want to assign to arts.* Acknowledging modern (post-modern) reactions against traditional (too traditional) aesthetical concepts and conceptions of beauty, the aesthetic dimension may also be sub-clustered into a complex world of very different sub-dimensions. Can the absence of beauty also be expressed in the aesthetical dimension? Is there the "beauty of the non-beauty" or the "beauty of the ugly", does the ugly also fulfill aesthetic functions? Does the aesthetic dimension capture equally the presence, but also the absence of beauty? Can beauty (aesthetics) be measured without referring to a specific context? In a terminology of *measurement of beauty,* beauty could be represented on a dimension (a scale or multi-dimensional scale) of aesthetics that expresses the presence (presence and/or absence) of beauty, allowing for gradual degrees of beauty or also the expression of "positive beauty" and "negative beauty".
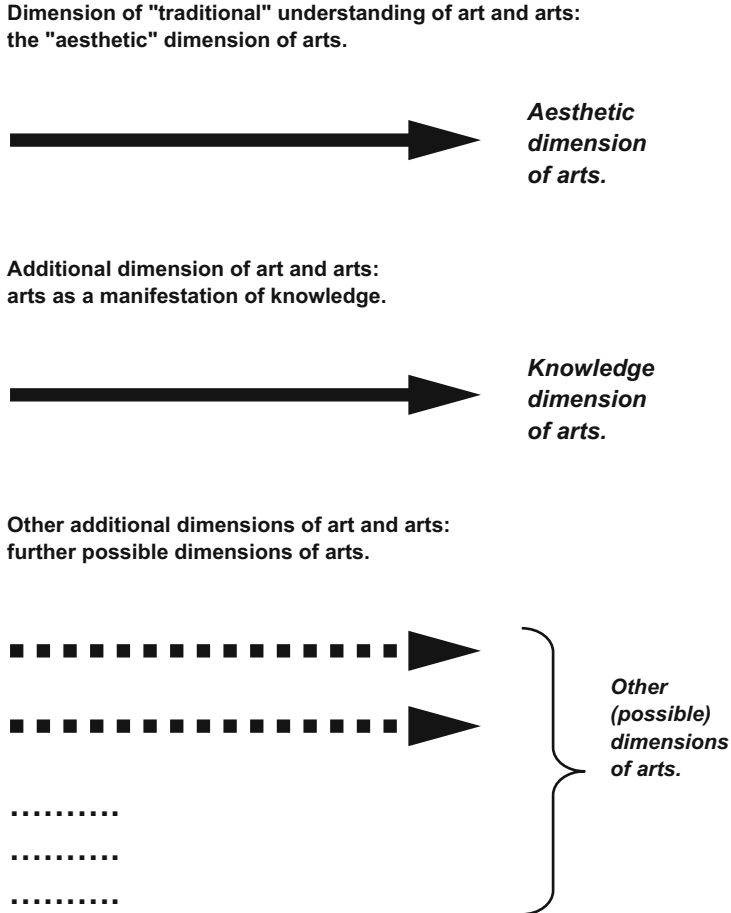
In addition to aesthetics, what are the possible alternative dimensions for conceptualizing and "measuring" the arts that complement and expand the aesthetic dimension of arts? *Beyond aesthetics, how can we conceptualize arts further?* In fact, we are interested in also promoting an understanding of arts which drives arts *further and beyond an only-aesthetic-understanding of arts,* which does not deny the aesthetic dimension (dimensions), but intends to complement the aesthetic dimension of arts. Therefore, we want to suggest as a new reference point for debate:

> Art and arts can also be understood (and re-invented) as a manifestation of knowledge, knowledge production and knowledge creation. Furthermore, knowledge production and knowledge creation extend to knowledge application and knowledge use.

The here presented approach to arts introduces knowledge as an additional dimension for defining and understanding arts. This additional dimension does not replace, but extends the aesthetic dimension of arts, by this making the arts clearly multi-dimensional (see Fig. 3.1). Consequences of this are (when we follow the logic of that particular knowledge-definition of arts) that the arts cannot be understood comprehensively and sufficiently only on the basis of aesthetics alone. Of course we could speculate, whether the knowledge involvement of arts implies a

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[3] In her Master thesis, Derya Öcal also reflects on the question, *What is Art? Was ist Kunst?*

**Dimension of "traditional" understanding of art and arts:
the "aesthetic" dimension of arts.**

*Aesthetic
dimension
of arts.*

**Additional dimension of art and arts:
arts as a manifestation of knowledge.**

*Knowledge
dimension
of arts.*

**Other additional dimensions of art and arts:
further possible dimensions of arts.**

*Other
(possible)
dimensions
of arts.*

Fig. 3.1 Dimensions of conceptualization and measurement of art and arts (Source: Authors' own conceptualization)

knowledge for which aesthetic considerations play frequently an important role (forms of beauty or non-beauty). *Aesthetics may interact with different forms of reasoning or intelligence, such as intuition or emotional intelligence. Research and progress in the sciences clearly are also driven by and benefit obviously from intuition or emotional intelligence.* Clearly, there is furthermore more of a need to continuously reflect which dimensions (in addition to aesthetics and knowledge) may also be of further relevance for art and arts.

By introducing this additional-knowledge-dimension-of-arts, complementing the dimension of aesthetics, it is being acknowledged that also forms of arts-based research and arts-based innovation are existing and can emerge further. In fact,

"artistic research" represents one crucial expression of arts as a manifestation of knowledge. What are the differences between arts-based research and artistic research? Boundaries here are obviously fluid and depend on specific positions of perspective. Connotations of artistic research imply that the research is not only arts-based, but that research and arts are actually being intertwined and inter-linked with each other more directly (on "artistic research", see furthermore Damianisch 2013; Mateus-Berr 2013). Artistic research is more immediately and straightforwardly connected to the arts than arts-based research, at least being seen from a conceptual understanding. Of course, also artistic research and arts-based research overlap. *In fact, opportunities of interdisciplinary and transdisciplinary combinations of artistic research, arts-based research and academic research (in the sciences), extended by configurations of arts-based innovation and sciences-based innovation, are arising and can be utilized by institutions, organizations, communities and networks.* "In a short-cut, *transdisciplinarity may be defined as the application of interdisciplinarity* (transdisciplinarity = application of interdisciplinarity?)" (Campbell and Carayannis 2013a, p. 34). Of course, we have to admit that there also can be the transdisciplinarity of a "disciplinarity in application". Transdisciplinarity usually (always) refers to forms of application. Often (but not always) interdisciplinarity is more application-friendly than disciplinarity (see again Arnold 2013b).

The proposition (that knowledge, knowledge production and knowledge creation qualify as an-additional-dimension-for-art-and-arts) has the implication that the arts and our understanding of arts are being opened to knowledge and the "tree of ramifications" of knowledge. In fact, this bridges the arts with research and innovation. The arts are interconnected with research-and-innovation-in-the-arts and with research-and-innovation-in-the-sciences. *"Art as a manifestation of knowledge" draws interdisciplinary and transdisciplinary configurations in connectivity, where knowledge production and innovation in the arts are extended to knowledge production and innovation beyond the arts.* Furthermore, we can argue that in context of-a-knowledge-understanding-of-the-arts the "artistic research" actually is important for comprehending arts and also for developing the arts further. (There is no comprehensive understanding of the arts without artistic research?) Artistic research also touches on epistemic implications for the arts. Already in the introduction we asserted: "By this, artistic research qualifies as an epistemic approach ('epistemic tool') that navigates to core meanings of arts and of 'art in the arts'". *Is aesthetics more than only-beauty,* or what is the beauty of epistemology?

Having introduced knowledge, knowledge production and knowledge creation as a second dimension for art and arts, in addition to the dimension of aesthetics, we want to speculate on some of the implications and ramifications of this intellectual endeavor. The following propositions we want to suggest for further discussion:

1. *Art as a manifestation of knowledge:* Our proposition is that art and arts can also be understood as a manifestation of knowledge. This knowledge-based

definition refers to knowledge production and knowledge creation (research)[4] as well as to the application and use of knowledge (innovation). We introduced knowledge as a second (additional) dimension for defining arts that complements the first (and more traditional) dimension of arts, which is aesthetics. In our opinion, knowledge does not replace, but complements aesthetics for a broader understanding of arts. Dimensions in addition to aesthetics and knowledge appear also to be possible and valid for arts. (In context of our analysis here, however, we do not engage further in speculating on dimensions of arts beyond aesthetics and knowledge.)

2. *Arts, artistic research, interdisciplinary and transdisciplinary combinations of research in the arts and research in the sciences, innovation and innovation systems:* Artistic research represents one outflow in consequence of approaching arts as a manifestation of knowledge. In fact, it could be argued that artistic research helps in better understanding arts in all the possible ramifications. To turn the argument: without artistic research, our pictures of arts are incomplete, probably also too fragmented. Without artistic research, our visions of arts are insufficient. *Based on this paradigm of knowledge, arts-as-a-manifestation-of-knowledge and artistic-research clearly enable to cross-connect and interconnect the arts with knowledge.* Discourses in knowledge are being bridged with discourses in the arts. Research and innovation can spread from the domain of knowledge to the domain of arts. Arts and artistic research are now being regarded as drivers for forming and pluralizing interdisciplinary and transdisciplinary configurations and networks with research in the sciences and the application and use of knowledge and innovation in context of society, democracy, but also the economy. Arts and artistic research aid and add in widening our horizons of knowledge production and knowledge creation within the sciences. *With arts and artistic research, the domain (domains) of intelligence can be more fully leveraged for knowledge creation, which is also important for knowledge production in the sciences. What are forms or sources of knowledge production (intelligence) beyond language or the use of (written) texts?* Arts may also be utilized as an unconventional strategy for preparing grounds for *The New* "beyond horizon", for encouraging and experimenting with unconventional configurations of "interdisciplinarity in transdisciplinarity". *Arts-as-a-manifestation-of-knowledge and artistic research re-define the arts in a way, making it then obvious, why the arts are crucial (at least potentially) for innovation and whole innovation systems* (national systems of innovation or multi-level innovation systems; Carayannis and Campbell 2006, 2012, pp. 32–35). One radical proposition would be that without strong and continuously evolving cross-references to arts, every comprehensive innovation system (national or multi-

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[4] In context of our analysis here, we use knowledge production and knowledge creation as interchangeable concepts. We could speculate, whether "knowledge creation" fits better for purposes of describing processes (knowledge-based processes) in the arts and in artistic research than the term "knowledge production".

level architectured innovation system) is only premature, operating below possible capabilities. "The arts excel as innovation systems." Arts and artistic research also contribute to *Quality of Democracy* and innovation capabilities in democracies and in processes of further democratization (Campbell and Carayannis 2013a).

3. *Epistemic implications of arts and artistic research:* Arts-as-a-manifestation-of-knowledge and artistic-research also emphasize the epistemic implications of arts.[5] This is not being seen as being in conflict with the aesthetic dimension of arts, since beauty or non-beauty are per se neutral with regard to epistemic potentials. Epistemic ramifications of arts and artistic research are manifold, diverse and heterogeneous. For example, artistic research engages the arts in interdisciplinary and transdisciplinary networks of research in the sciences (or in networks of research in the sciences and the arts). Arts and artistic research help us thinking and imagining beyond the "written text". Imagination and science fiction are references for the powers of fantasy, and may inspire processes and scenarios of knowledge creation and knowledge production, long before a particular knowledge application or technology implementation is realistic ("thinking in possibilities before possible uses"). "Fiction or science fiction may serve as stimulators for creative ideas, with the potential of being later transformed, at least partially (and of course not always), into new knowledge creation and production. *We can also call this the creativity of knowledge creation*" (Carayannis and Campbell 2010, p. 48). *Arts and artistic research can be used for designing "virtual worlds" that could not exist "outside in the world" or that contradict the "outside world", leading to paradoxical phenomena and furthermore to questions of what reality is or "What really exists?".* One example is the Dutch graphic artist M.C. Escher (Maurits Cornelis Escher), who lived from 1898 until 1972.[6] Escher engaged in drawing "impossible constructions" [7] that actually represent "logical contradictions" (seen from a certain perspective of perception). Two famous drawings of his are "Ascending and Descending" (1960)[8] and "Waterfall" (1961).[9] We could speculate, whether the arts help us in seeing "impossible worlds". *Is there a contradiction between the picture (image) and a conventional logical explanation, which reality is truer (or is already this wording a contradiction in itself)?* These briefly discussed examples illustrate only tentatively and fragmentarily (in a partial

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[5] Epistemology or an "epistemic base" may apply as a concept to very different fields. For example, also policy and policies can be discussed under aspects of "epistemic governance" (Campbell and Carayannis 2013b, c). In fact, to utilize an epistemic base in unusual contexts has all the qualities of a potentially innovative approach or approaching.

[6] See: http://en.wikipedia.org/wiki/M._C._Escher

[7] For an overview see: http://www.mcescher.com/gallery/

[8] See: http://www.mcescher.com/gallery/impossible-constructions/ascending-and-descending/ and http://en.wikipedia.org/wiki/Ascending_and_Descending

[9] See: http://www.mcescher.com/gallery/impossible-constructions/waterfall/ and http://en.wikipedia.org/wiki/Waterfall_(M._C._Escher)

manner) the whole spectrum of epistemic implications of arts and artistic research that appear to be possible. Further research and further artistic work is necessary.

3.3 Innovation Systems in Conceptual Evolution: Mode 3 Knowledge Production in Quadruple and Quintuple Helix Innovation Systems

Universities, or higher education institutions (HEIs) in more general, have three main functions: teaching and education, research (research and experimental development, R&D) and the so-called "third mission" activities, for example innovation (Carayannis and Campbell 2013b, p. 5). In reference to "arts universities" now the question and challenge arises, whether, to which extent and in which way the arts universities differ from the (more traditional) universities in the sciences. Arts universities obviously place an emphasis on the arts, and the arts are not identical with the sciences. However, also arts universities frequently make references to the sciences, thus also arts universities can express competences in teaching and in carrying out research in the sciences. *The other major challenge of arts universities is to engage in "artistic research" and "arts-based innovation". By this, arts universities (and other higher education institutions in the arts) are also being linked to and are being inter-linked with national innovation systems and multi-level innovation systems.* This widens the whole interdisciplinary and transdisciplinary spectrum of higher education systems. *"Artistic research" furthermore complements the "teaching of arts" at arts universities* (see also the propositions formulated by Bast 2013). Hybrid and innovative combinations of universities of arts and universities of the sciences are possible and indicate organizational opportunities for promoting creativity.

University research, in a traditional understanding and in reference to universities in the sciences, focuses on basic research, often framed within a matrix of academic disciplines, and without a particular interest in the practical use of knowledge and innovation. This model of university-based knowledge production also is being called "Mode 1" of knowledge production (Gibbons et al. 1994). Mode 1 is also compatible with the linear model of innovation, which is often being referred to Vannevar Bush (1945). The linear model of innovation asserts that first there is basic research in university context: gradually, this university research will diffuse out into society and the economy. It is then the economy and the firms that pick up the lines of university research, and develop these further into knowledge application and innovation, for the purpose of creating economic and commercial success in the markets outside of the higher education system. Within the frame of linear innovation, there is a sequential "first-then" relationship between basic research (knowledge production) and innovation (knowledge application).

The Mode-1-based understanding of knowledge production has been challenged by the new concept of "Mode 2" of knowledge production, which was developed

and proposed by Michael Gibbons et al. (1994, pp. 3–8, 167). Mode 2 emphasizes a knowledge application and a knowledge-based problem-solving that involves and encourages the following principles: "knowledge produced in the context of application"; "transdisciplinarity"; "heterogeneity and organizational diversity"; "social accountability and reflexivity"; and "quality control" (see furthermore Nowotny et al. 2001, 2003, 2006). Key in this setting is the focus on a knowledge production in contexts of application. Mode 2 expresses and encourages clear references to innovation and innovation models. The linear model of innovation also has become challenged by non-linear models of innovation, which are interested in drawing more direct connections between knowledge production and knowledge application, where basic research and innovation are being coupled together not in a first-then, but in an "as well as" and "parallel" (parallelized) relationship (Campbell and Carayannis 2012). Mode 2 appears also to be compatible with non-linear innovation and its ramifications.

The Triple Helix model of knowledge, innovation, and university-industry-government relations, which was introduced and developed by Henry Etzkowitz and Loet Leydesdorff (2000, pp. 111–112), asserts a basic core model for knowledge production and innovation, where three "helices" intertwine, by this creating a national innovation system. The three helices are identified by the following systems or sectors: academia (universities), industry (business) and state (government). Etzkowitz and Leydesdorff refer to "university-industry-government relations" and networks, putting a particular emphasis on "tri-lateral networks and hybrid organizations", where those helices overlap in a hybrid fashion. Etzkowitz and Leydesdorff (2000, p. 118) also explain, how, in their view, the Triple Helix model relates to Mode 2: the "Triple Helix overlay provides a model at the level of social structure for the explanation of Mode 2 as an historically emerging structure for the production of scientific knowledge, and its relation to Mode 1". More recently, Leydesdorff (2012) also introduced the notion of "N-Tuple of Helices".
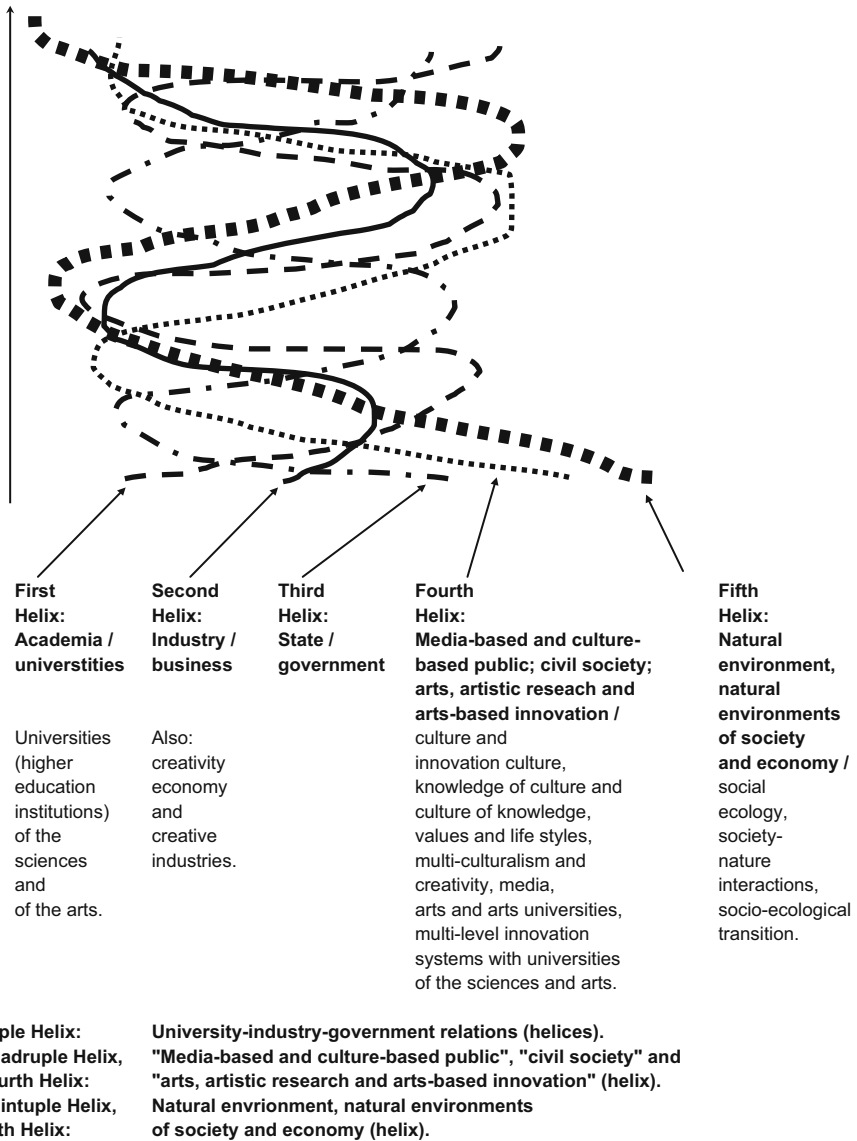
Mode 1 and Mode 2 may be characterized as "knowledge paradigms" that underlie the knowledge production (to a certain extent also the knowledge application) of higher education institutions and university systems. Success or quality, in accordance with Mode 1, may be defined as: "*academic excellence, which is a comprehensive explanation of the world (and of society) on the basis of 'basic principles' or 'first principles', as is being judged by knowledge producer communities (academic communities structured according to a disciplinarily framed peer review system)*". Consequently, success and quality, in accordance with Mode 2, can be defined as: "*problem-solving, which is a useful (efficient, effective) problem-solving for the world (and for society), as is being judged by knowledge producer and knowledge user communities*" (Campbell and Carayannis 2013b, p. 32). A "Mode 3" university, higher education institution or higher education system would represent a type of organization or system that seeks creative ways of combining and integrating different principles of knowledge production and knowledge application (for example, Mode 1 and Mode 2), by this encouraging diversity and heterogeneity, by this also creating creative and innovative organizational contexts for research and innovation. Mode 3 encourages the formation of "creative knowledge environments" (Hemlin et al. 2004). "Mode 3 universities", Mode

3 higher education institutions and systems, are prepared to perform "basic research in the context of application" (Campbell and Carayannis 2013b, p. 34). This has furthermore qualities of non-linear innovation. Governance of higher education and governance in higher education must also be sensitive, whether a higher education institution operates on the basis of Mode 1, Mode 2, or a combination of these in Mode 3. The concept of "epistemic governance" emphasizes that the underlying knowledge paradigms of knowledge production and knowledge application are being addressed by quality assurance and quality enhancement strategies, policies and measures (Campbell and Carayannis 2013b, c).
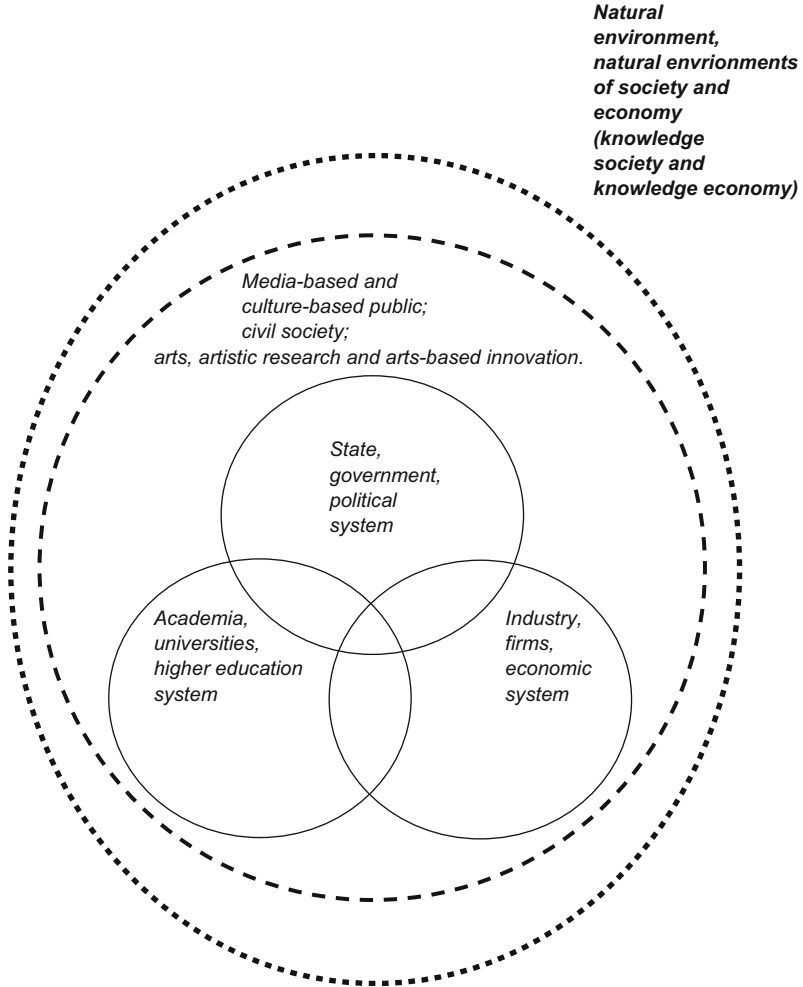
Emphasizing again a more systemic perspective for the Mode 3 knowledge production, a focused conceptual definition may be as follows (Carayannis and Campbell 2012, p. 49): Mode 3 "... allows and emphasizes the co-existence and co-evolution of different knowledge and innovation paradigms. In fact, a key hypothesis is: *The competitiveness and superiority of a knowledge system or the degree of advanced development of a knowledge system are highly determined by their adaptive capacity to combine and integrate different knowledge and innovation modes via co-evolution, co-specialization and co-opetition knowledge stock and flow dynamics*" (see Carayannis and Campbell 2009; on "Co-Opetition", see Brandenburger and Nalebuff 1997). Analogies are being drawn and a co-evolution is being suggested between diversity and heterogeneity in advanced knowledge society and knowledge economy, and political pluralism in democracy (knowledge democracy), and the quality of a democracy. The "Democracy of Knowledge" refers to this overlapping relationship. As is being asserted: "The *Democracy of Knowledge*, as a concept and metaphor, highlights and underscores parallel processes between political pluralism in advanced democracy, and knowledge and innovation heterogeneity and diversity in advanced economy and society. Here, we may observe a hybrid overlapping between the *knowledge economy, knowledge society and knowledge democracy*" (Carayannis and Campbell 2012, p. 55). The "Democracy of Knowledge", therefore, is further-reaching then the earlier idea of the "Republic of Science" (Michael Polanyi 1962).

The main focus of the Triple Helix innovation model concentrates on university-industry-government relations (Etzkowitz and Leydesdorff 2000). In that respect, Triple Helix represents a basic model or a core model for knowledge production and innovation application. The models of the Quadruple Helix and Quintuple Helix innovation systems are designed to comprehend already and to refer to an extended complexity in knowledge production and knowledge application (innovation), thus, the analytical architecture of these models is broader conceptualized. To use metaphoric terms, the Quadruple Helix embeds and contextualizes the Triple Helix, while the Quintuple Helix embeds and contextualizes the Quadruple Helix (and Triple Helix). The Quadruple Helix adds as a fourth helix the "media-based and culture-based public", the "civil society" and "arts, artistic research and arts-based innovation" (Carayannis and Campbell 2009, 2012, p. 14; see also Danilda et al. 2009). The Quintuple Helix innovation model even is more comprehensive in its analytical and explanatory stretch and approach, adding furthermore the fifth helix (and perspective) of the "natural environments of society" (Carayannis and Campbell 2010, p. 62) (see Figs. 3.2 and 3.3).

*Direction of
flow of time*

First
Helix:
Academia /
universtities

Universities
(higher
education
institutions)
of the
sciences
and
of the arts.

Second
Helix:
Industry /
business

Also:
creativity
economy
and
creative
industries.

Third
Helix:
State /
government

Fourth
Helix:
**Media-based and culture-
based public; civil society;
arts, artistic reseach and
arts-based innovation /**
culture and
innovation culture,
knowledge of culture and
culture of knowledge,
values and life styles,
multi-culturalism and
creativity, media,
arts and arts universities,
multi-level innovation
systems with universities
of the sciences and arts.

Fifth
Helix:
**Natural
environment,
natural
environments
of society
and economy /**
social
ecology,
society-
nature
interactions,
socio-ecological
transition.

Triple Helix: University-industry-government relations (helices).
Quadruple Helix,   "Media-based and culture-based public", "civil society" and
Fourth Helix: "arts, artistic research and arts-based innovation" (helix).
Quintuple Helix,   Natural envrionment, natural environments
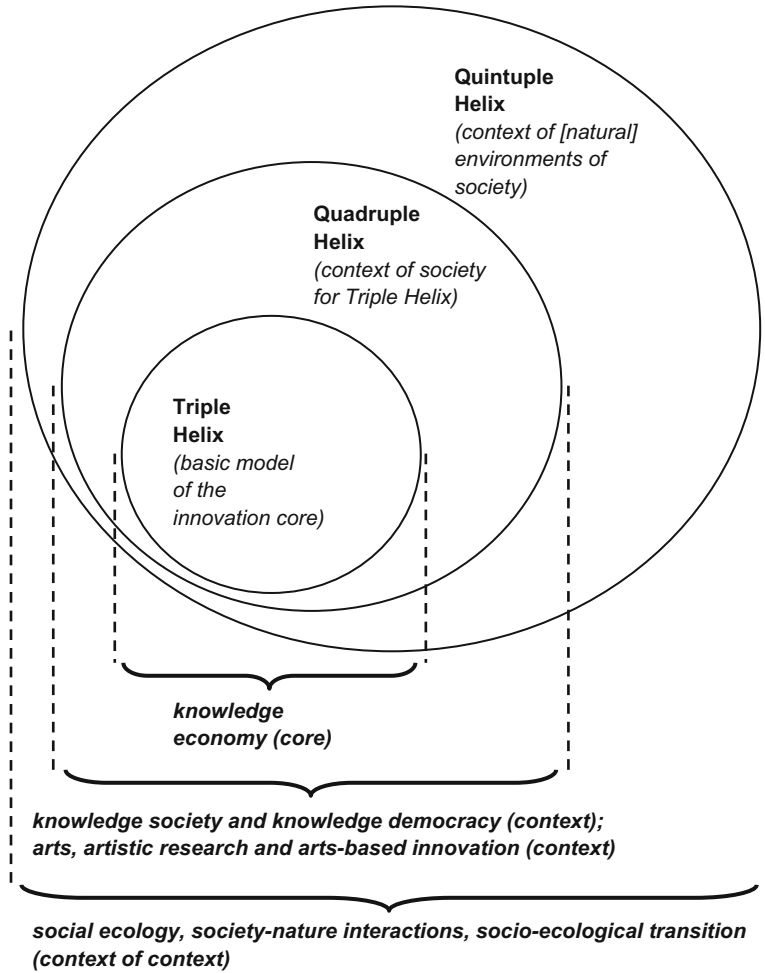**Fifth Helix:**   of society and economy (helix).

Fig. 3.2 The Quadruple and Quintuple Helix innovation systems (Source: Authors' own concep-
tualization based on Etzkowitz and Leydesdorff (2000, p. 112), Carayannis and Campbell (2009,
p. 207; 2012, p. 14; 2013) and Danilda et al. (2009))

Natural
environment,
natural envrionments
of society and
economy
(knowledge
society and
knowledge economy)

Media-based and
culture-based public;
civil society;
arts, artistic research and arts-based innovation.

State,
government,
political
system

Academia,
universities,
higher education
system

Industry,
firms,
economic
system

Fig. 3.3 The Quintuple Helix (five-helix model) innovation system (Source: Authors' own conceptualization based on Carayannis and Campbell (2010, p. 62; 2013))

The Triple Helix is explicit in acknowledging the importance of higher education for innovation. However, it could be argued that the Triple Helix sees knowledge production and innovation in relation to economy, thus the Triple Helix models the economy and economic activity. In that sense, the Triple Helix frames the knowledge economy. The Quadruple Helix brings in the additional perspective of society and of knowledge society. The Quadruple-Helix-innovation-system understanding emphasizes that sustainable development of and in economy

(knowledge economy) requires that there is a co-evolution of knowledge economy and knowledge society. The Quadruple Helix even encourages *the perspectives of the knowledge society and of the knowledge democracy* for supporting, promoting and advancing knowledge production (research) and knowledge application (innovation). Furthermore, the Quadruple Helix is also explicit that not only universities (higher education institutions) of the sciences, but also universities (higher education institutions) of the arts should be regarded as decisive and determining institutions for advancing next-stage innovation systems: the inter-disciplinary and trans-disciplinary connecting of sciences and arts creates crucial and creative combinations for promoting and supporting innovation. Here, in fact, lies one of the keys for future success. The concept and term of "social ecology" refers to "society-nature interactions" between "human society" and the "material world" (see, for example, Fischer-Kowalski and Haberl 2007). The European Commission (2009) identified the necessary socio-ecological transition of economy and society as one of the great next-phase challenges, but also as an opportunity, for the further progress and advancement of knowledge economy and knowledge society. The Quintuple Helix refers to this socio-ecological transition of society, economy and democracy, the Quintuple Helix innovation system is therefore ecologically sensitive. Quintuple Helix bases its understanding of knowledge production (research) and knowledge application (innovation) on social ecology (see Fig. 3.4). Environmental issues (such as global warming) represent issues of concern and of survival for humanity and human civilization. But the Quintuple Helix translates environmental and ecological issues of concern also in potential opportunities, by identifying them as possible drivers for future knowledge production and innovation (Carayannis et al. 2012). This, finally, defines also opportunities for the knowledge economy. "*The Quintuple Helix supports here the formation of a win-win situation between ecology, knowledge and innovation, creating synergies between economy, society and democracy*" (Carayannis et al. 2012, p. 1).

**Quintuple
Helix**
*(context of [natural]
environments of
society)*

**Quadruple
Helix**
*(context of society
for Triple Helix)*

**Triple
Helix**
*(basic model
of the
innovation core)*

*knowledge
economy (core)*

*knowledge society and knowledge democracy (context);
arts, artistic research and arts-based innovation (context)*

*social ecology, society-nature interactions, socio-ecological transition
(context of context)*

Fig. 3.4 The Quadruple and Quintuple Helix innovation systems in relation to society, economy, democracy, and social ecology (Source: Authors' own conceptualization based on Carayannis, Barth and Campbell (2012, p. 4) and Carayannis and Campbell (2013))

Conclusion: The Program of Arts, Research, Innovation, and Society (ARIS)

The terms and concepts of Mode 3 knowledge production and Quadruple Helix innovation systems were first introduced to international academic debate by Carayannis and Campbell (2006 and 2009), and were later developed further (Carayannis and Campbell 2012). The same applies to the Quintuple Helix (Carayannis and Campbell 2010). From the beginning, the "media-based and culture-based public" as well as universities and other higher education institutions of the arts were being regarded as crucial attributes and components of the Quadruple and Quintuple Helix innovation systems, *implying that arts are essential for the progress and evolution of innovation systems* (see again Figs. 3.2 and 3.3). *In our analysis here, we developed more specifically the Quadruple and Quintuple Helix innovation systems in terms and in favor of arts, artistic research and arts-based innovation. We wanted to demonstrate the full momentum and flexibility of the Quadruple and Quintuple Helix for conceptually addressing and integrating art and arts.*

More generally speaking, further ramifications of Mode 3 knowledge production in Quadruple Helix and Quintuple Helix innovation systems are:

1. *Multi-level innovation systems, the global and the local (GloCal):* Lundvall was pivotal for introducing the concept of the "national innovation system". Lundvall (1992, pp. 1, 3) explicitly acknowledges that national innovation systems are challenged in permanence (but are also extended) by regional as well as global innovation systems. Here, Kuhlmann (2001, pp. 960–961) could be paraphrased and the assertion that as long as nation-states and nation state-based political systems exist, it is plausible to use the concept of the national innovation system. More comprehensive in its analytical architecture than the national innovation system, is the concept of the "multi-level innovation system" (Carayannis and Campbell 2012, pp. 32–35). In a spatial understanding, multi-level innovation systems compare the national with the sub-national (regional, local), but also with the trans-national and global levels (see, for example, Kaiser and Prange 2004; furthermore, see Pfeffer 2012). However, it is also important to extend multi-level-innovation-systems to the challenges and potential benefits and opportunities of a non-spatial meaning, understanding and "mapping": "Therefore, multi-level systems of knowledge as well as multi-level systems of innovation are based on spatial and non-spatial axes. A further advantage of this multi-level systems architecture is that it results in a more accurate and closer-to-reality description of processes of globalization and *gloCalization*" (Carayannis and Campbell 2012, p. 35).

2. *Linear and non-linear innovation:* Knowledge application and innovation are being challenged and driven out of an interest of combining and integrating linear and non-linear innovation. Key to here are a diversity, heterogeneity and pluralism of different knowledge and innovation modes, and their linking-together via an architecture of co-evolving networks. Firms, universities and other organizations can engage (at the same time) in varying and multiple technology life cycles at different levels of maturity. Another way, how to think non-linear innovation, is being suggested by the concept of cross-employment (Campbell 2011, 2013a). As a form and type of multi-employment, cross-employment emphasizes that the same individual person may be employed by two (or more) organizations at the same time, where one organization could be located closer to knowledge production, and the other to knowledge application (innovation): are those organizations also rooted in different sectors, then cross-employment acts also as a trans-sectoral networking (Campbell and Carayannis 2013b, pp. 65, 68). *Cross-employment can furthermore bridge different sectors and disciplines in the sciences with different disciplines in the arts*. What results is a "Mode 3 Innovation Ecosystem": "This parallel as well as sequentially time-lagged unfolding of technology life cycles also expresses characteristics of Mode 2 and of nonlinear innovation, because organizations (firms and universities) often must develop strategies of simultaneously cross-linking different technology life cycles. Universities and firms (commercial and academic firms) must balance the nontriviality of a fluid pluralism of technology life cycles" (Carayannis and Campbell 2012, p. 37; see furthermore Dubina et al. 2012). The relationship between networks, "cooperation and competition" ("Co-Opetition"), represents a challenge and sensitive issue, and allows for different creative answers in organizational representation and manifestation.

3. *Twenty-first century Fractal Research, Education and Innovation Ecosystem (FREIE):* Here, the understanding of FREIE is: "This is *a multilayered, multimodal, multinodal, and multilateral system*, encompassing mutually complementary and reinforcing innovation networks and knowledge clusters consisting of human and intellectual capital, shaped by social capital and underpinned by financial capital" (Carayannis and Campbell 2012, p. 3).

4. *Linear and non-linear innovation, and the causality of "if-then" and of "if-if" relations:* The hybrid overlapping of linear innovation and of non-linear innovation displays also possible ramifications and draws associations to models of causality and their re-modeling. "We can speculate, whether this parallel integration of linearity and nonlinearity not also encourages a new approach of paralleling in our theorizing and viewing of causality: *in epistemic (epistemological) terms, the so-called if-then*

(continued)

relationships could be complemented by (a thinking in) 'if-if' relations"
(Carayannis and Campbell 2012, p. 24; see also Campbell 2009, p. 123).

At the beginning of our analysis (in the introduction) we formulated the following research question: *How does artistic research relate to research in the sciences and how does artistic research relate to innovation and innovation systems?* We were inclined to develop the interrelation and inter-linkage between arts, research and innovation on basis of the concepts of the Quadruple and Quintuple Helix innovation systems. We wanted to address *art and artistic research* (AAA) in context of the Quadruple Helix and Quintuple Helix. "*Arts, research, innovation, and society*" (ARIS) *may be regarded as a program with implications for theory, policy and practice*. In the following, we develop further a few more propositions with regard to ARIS. These propositions should be regarded as input for discussion and discourse:

1. *"Arts as a manifestation of knowledge"*: By defining "arts as a manifestation of knowledge" (in complementary extension of a more "traditional" understanding of the aesthetic dimension of arts), the artistic research and arts-based innovation then inter-flow directly with art and arts. Artistic research helps explaining the arts. Artistic research also contributes to the epistemic potential of the arts and in arts. Universities and other higher education institutions of the arts are challenged to respond to artistic research and to implement strategies for developing artistic research, which also informs and drives university teaching. Through knowledge creation, knowledge production, knowledge application, and knowledge use, research in the arts and arts-based innovation are being interconnected with research in the sciences and sciences-based innovation. Arts and artistic research add to the interdisciplinary and transdisciplinary spectrum of research organizations and of research networks, and can assist the sciences (also science) in building interdisciplinary arrangements. Interdisciplinarity often qualifies as a good basis for transdisciplinarity. Arts and artistic research foster heterogeneous processes of diversification and pluralization within knowledge production and innovation. Arts and artistic research promote creativity, which is key for knowledge creation, knowledge production and innovation.

2. *Art and artistic research*[10] *in Quadruple and Quintuple Helix innovation systems:* The concepts of the Quadruple Helix and Quintuple Helix innovation systems are explicitly sensitive for the roles of arts and of artistic research for innovation. Within context of that line of thinking, *arts,*

(continued)

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[10] In context of our analysis here, *art and artistic research* (also *arts, artistic research and arts-based innovation*) refers to a conceptual "Triple A" of the qualities of arts-based knowledge production and arts-based innovation.

artistic research and arts-based innovation (AAA) are essential for the further evolution and progress of innovation systems. Universities and other higher education institutions of the arts represent crucial organizations for innovation systems (national and multi-level innovation systems). In multi-level innovation systems, the global, national and local innovation systems co-evolve in parallel and in being mutually intertwined.

3. *"Arts, research, innovation, and society"* (ARIS) *and the quality in economy and the quality of democracy:* Innovation may not be narrowed down to economic concerns and economic activities. Innovation is more than only economics. "Arts, research, innovation, and society" (ARIS) contribute to creating the basis for new models of economic growth, where "growth in quality" challenges the traditional focus on "quantitative growth" of selected economic benchmarks or indicators. Arts, artistic research and arts-based innovation are key for advanced economies as well as the emerging markets. "Arts, research, innovation, and society" (ARIS) furthermore interrelates and cross-links with Quality of Democracy. ARIS indicates opportunities for a creative design or processes of creatively designing the further co-evolution of knowledge economy, knowledge society and knowledge democracy.

4. *Arts, artistic research, arts-based innovation and "Creative Knowledge Environments":* "Creative Knowledge Environments" (Hemlin et al. 2004) are interested in contributing to capabilities of knowledge creation, knowledge production and innovation in organizations and in networks. Cross-employment (Campbell 2013a) defines one strategy for doing so (also for non-linear innovation). Arts, artistic research and arts-based innovation furthermore represent approaches that add to the formation of "Creative Knowledge Environments". Arts, artistic research and arts-based innovation and innovations are at least "potentially" relevant to all organizations and networks that are engaged in research (knowledge creation and knowledge production) and innovation (knowledge application and knowledge use). This clearly demonstrates the possibilities and opportunities of arts, artistic research and arts-based innovation for the sustainable development and the "innovative re-invention" of organizations and networks that are involved in and perform in knowledge production. *There is a need for more creative organizational design.* In aggregation, this is also of relevance for whole innovation systems.

In a free association with the work of M.C. Escher,[11] we finally want to close the analysis here with the following two words: *Ascending Waterfalls.* This is the beginning.

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[11] See again our analysis in section "Arts and Artistic Research".

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