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Like a camera obscura …
or
Let the facts speak about the Journal of Integrated Design & Process Science

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Abstract This paper presents the findings of a bibliometric survey over the past 25 years of the Journal of Integrated Design & Process Science (JIDPS), which is the flagship publication forum of the Society of Design and Process Science (SDPS). The discussion is of a retrospective, statistical, and narrative nature. The goal of the survey was not only to expose the facts concerning publication statistics, but also to get an insight in the nature of the scientific contribution of the journal as a whole and to identify the target applications domains of the published papers. The paper lets the facts speak for themselves and offers the findings for further evaluation and road-mapping by the concerned stakeholders.

Keywords: JIDPS, bibliometric analysis, camera obscura, publication statistics, scientific contributions, target application domains

1. Why Is This Article?

The Journal of Integrated Design & Process Science (JIDPS), ISSN Print 1092-0617 and eISSN Digital 1875-8959, was brought to existence some 25 years ago and is proudly serving science even in these days. This is a quite remarkable achievement if we consider the turbulences caused by the disruptive scientific developments, the shifts in the societal gravity centres, and the unceasing digital revolution in this human generation-long period. The mentioned developments had a strong collective influence on the establishment of a well-based forum for scholarly publication and science communication. Also scientific publication and science communication went through a diversification process, which was fuelled by both the move from paper-based publication to screen-based publication and the emergence of open access-based publication as a complement of subscription-based publication. Time has come for JIDPS to celebrate the twenty-five years of establishment and its achievements, but also for an informed strategizing and a careful road-mapping. However, as Heraclitus said: *panta rhei*… We are witnessing a intensifying fierce competition between publishers and editors for contents, authors, peers, readers and, eventually, for market share and money. Like the overwhelming majority of other journals, JIDPS has to face these new challenges, while keeping its objectives, identity, liveliness, and usefulness.

An anniversary typically lends itself to two kinds of overviews. First, it allows making retrospective analyses with the goal of learning from the past happenings, successes, failures, and experiences. Second, it offers the opportunity to envisage a new opening, which may include (i) conceptualization of scenarios

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for the next 25 years considering the lasting trends and interests, as well as (ii) development of alternative strategies for achieving novel, scientifically and societally significant goals. It is preferable to base retrospective assessments and forward-looking strategies on facts and evidences, rather than on fallacious assumptions, personal impressions, or subjective opinions only. Therefore, this article intends to provide an objective view on the past 25 years and, indirectly, to contribute to planning the future by the stakeholders of JIDPS. The work presented in this paper is an unprejudiced bibliometric study that used statistical methods in the analysis. This explains why the subtitle is "Let the facts speak about the Journal of Integrated Design & Process Science". However, the study deviates from the standard bibliometric and scientometric approaches in that it includes not an only citation, connectedness, and impact analyses, but also a comprehensive content analysis. This latter concentrated on (i) identification of the domains of scientific contributions, (ii) classification of the published papers, and (iii) exploration of the target application fields.

2. Why Is This Main Title?

Like a camera obscura ... This part of the title is to cast light on the setup and approach of the scientometric analysis and my position with regard to the analysed content of the journal. Let me further elaborate on it. Having similar relationship with the subject, perhaps a camera obscura (pinhole camera) is the best analogy. It is a simple but ingenious construction that is able to make a snapshot, to create straight or upside-down, underexposed or overexposed image, and to let it see from inside and outside. As everybody knows, a camera obscura is a historical invention that consists of a dark box or chamber with a small hole in one of the four walls, or in the ceiling. A camera obscura maps only those parts of the surrounding worlds that are illuminating or illuminated. The light passing through the small hole will project an image of the scene or the subject outside the box onto the surface opposite to the hole. A convex lens can be placed in the hole to focus the image before it is projected onto a screen. The brighter an external object or the environment outside the camera box, the better image generated and the easier to see the image. Because the light moves in a straight line through the hole, the projected image will appear to be flipped upside-down. A tilted mirror inside the camera may make the image straight (flip the right-side-up on the side walls). If the wall of the box opposite to the hole is transparent, the projected image can be seen not only from inside, but also from outside, inverted or not. Naturally, in an ideal case, the image seen from inside coincides with the image observed from outside.

What the analogy of camera obscura means in the context of operation of the journal is as follows. In its broadest meaning, the journal itself is a camera obscura. When a new manuscript is submitted through the journal's subscription management system (the pinhole), the external world is projected into the journal in the form of a piece of scientific research. The pinhole represents not only an entry, but also a filter calibrated by the editors. A larger pinhole means a journal with a wider scope, whereas a smaller pinhole indicates a journal with a narrower scope. If a proper lens (a rigorous peer review mechanism) is added, the journal can take care of the image quality. Should high quality manuscripts be submitted (the external light), the journal can generate a brighter and more contrasted scientific image (as a really good camera). The reverted image means that, while exercising their scientific commitment and applying academic rigour, the editors see every submission with scepticism (upside-down): "Does this work indeed warrant consideration for publication?' "Does it worth releasing the results for a public debate considering the state of the art?' The editors, like the authors, see the projected image (i.e., the papers released for a public debate and/or utilization) from inside. Nevertheless, the image perceived by the editors may be opposite to that of the authors. The scholarly readers see the projected image only from outside and from a somewhat different perspective. For the readers, the access to scientific and methodological novelties through purchasing or downloading the papers is the major issue. The form of presentation of the papers and the academic standing of the journal are only commensurable relative to this.

Regarding this paper, my view is both internal and external. Being a member of the editorial board, I am aware of the internal views and share the intensions of the board of the journal. Notwithstanding, for

the sake of this paper, I looked at the outputs (the overall image) generated by JIDPS as an outsider, and this is how I compiled the rest of this paper. The scientometric analysis proved to be an appropriate means for taking a snapshot on the 25 years long history of the journal. The fact-based empirical approach was not only necessary, but also useful. The analysis is concluded in this paper, but the findings have nothing to do with philosophical, theoretical, and methodological issues of transdisciplinary convergence and scientific knowledge integration that are major concerns for the journal. The findings have intentionally not been taken further towards any future plan. This remains a stake, but waits for other studies and publications.

3. If You Would Not Know …

The Journal of Integrated Design & Process Science was established as the official journal of the Society of Design & Process Science (SDPS) in 1997. To establish collaborative environments that strengthen the relationships between research and practice, between science and engineering, and between cultural and social knowledge, the SDPS was formed as a non-profit organization in the USA in 1995. As an archival peer-reviewed technical journal, JIDPS serves this interest-driven society as well as the overall academic society and the creative industry. It publishes tested research findings concerning transdisciplinary notions of 'design' and 'process' with a focus on issues such as (i) comprehensive understanding of design and process crossing boundaries of natural, human, and built environments, (ii) investigating the principles, methodologies, processes, and tools of integrated designing and planning, and (iii) applications of design and process science to engineering, informatics, healthcare, and other social problems. It intends to create a structured and consistent repository of scholarly knowledge covering transdisciplinary notions of design and process in a rigorous fashion. Specific aim of the journal is to publish theories, methodologies, and tools of design and process development that cut across multiple disciplines and represent epistemological and methodological convergence. These are believed to be fundamental constituents and essential enablers of engineering problem solving at the beginning of the 21st century and beyond.

Registered in the profile category of Multidisciplinary Engineering, the Journal of Integrated Design & Process Science is published through IOS Press (commercial publisher) since 1999. The aims and scope of the journal have been defined at the time of its inauguration. The former specifies what the journal wants to achieve in the light of its publication policy/strategy, and the latter identifies the domains of interest and the targeted fields of applications. Based on the mission statement of JIDPS, five major attention fields have been identified as relevant. These are shown in **Figure 1**. The journal promotes

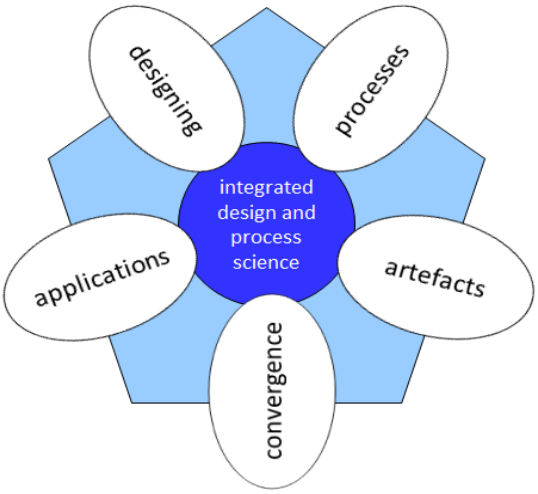

Fig. 1. The Domains of Interest Identified by the Mission Statement.

transdisciplinary design and process research in various disciplines such as mathematics, computer science, economics, engineering, management science, natural sciences, social sciences, and health science. The journal has both regular and special issues (called Numbers). It processes the following types of quality papers for publication: (i) philosophical and theoretical studies of critical and strategic issues, (ii) experimental research papers, (iii) reports on case studies, (iv) surveys on major design and process projects, (v) design and process standards and proposals, (vi) state-of-the-art and retrospective literature reviews, and (vii) position and discussion papers.

JIDPS is registered at many publication administration and review websites such as (i) Web of Science (Clarivate Analytics) (https://mjl.clarivate.com/), (ii) Academic Accelerator (https://academic-accelerator.com/), Resurchify (https://www.resurchify.com/), and SCImago (https://www.scimagojr.com/). The journal is abstracted and/or indexed in (i) Academic Search Premier, (ii) ACM Digital Library, (iii) Compendex, (iv) Elton Bryson Stephens Company's Databases, Engineering Collection, and Science & Technology Collection, (v) SciVerse Scopus, (vi) Ulrich's Periodicals Directory, and (vii) Web of Science: Emerging Sources Citation Index. JIDPS is ranked #124 over 299 journals related to the multidisciplinary engineering research field. The ranking percentile is around 58% in the mentioned field. In the period from 1999 until 2021, the journal published altogether 539 papers. This included 6 republished conference papers, 45 editorials, 487 peer-reviewed papers (including research, survey, and application papers), and one specific communication. The Publication Immediacy Index (PII) of the journal is not publicly available. As an index, PII is the average number of times an article is cited in the year it is published. It is a way of determining the "hot topics" in a discipline. The journal does not explicitly endorse Publons on peer review information.

Concerning JIDPS, the Resurchify website displays a current impact score of JIS = 0.67 (equivalent to the average number of times documents published in a journal/conference in the past two years have been cited in the current year). The variation of the Journal Impact Scores over the last years is as follows: JIS = 0.37 in 2014, JIS = 0.29 in 2015, JIS = 0.42 in 2016, JIS = 0.60 in 2017 and 2018, JIS = 1.00 in 2019, and JIS = 0.67 in 2020. This year's data are not yet available on the Resurchify website. The scientific influence is also expressed by the two-year Journal Impact Factor (JIF), which is calculated based on a two-year period by dividing the number of citations in the Journal Citation Reports (JCR) year by the total number of articles published in the two previous years. An impact factor of JIF = 2 means that, on average, the articles published one or two years ago have been cited two times. The trends are better captured by the 5-year JIF that is the average number of times the articles published in the past five years have been cited in the chosen JCR year. It is calculated by dividing the number of citations in the JCR year by the total number of articles published in the five previous years.

The specific impact factors of the journal in 2019-2020 are shown in **Table 1.** The Journal Citation Indicator (JCI) measures of the so-called Category Normalized Citation Impact (CNCI) of citable items (articles & reviews) published by the journal over a recent three-year period. It was JCI = 0.23 in 2019, it was JCI = 0.13 in 2020, considering all journals in the Web of Science Core Collection. It shows a falling trend. The diagram of self-citation ratio over the years is shown in **Figure 2.a**. In 2019-2020, the self-citation ratio of the journal was 25.68 %. The distribution of the five-year journal impact factor (JIF) of

Table 1. The Various Impact Factors (IF) of the Journal in 2019-2020 (According to Academic Accelerator).

IF in 2019-2020			
time span	IF	change	comment
five years	1.134	50.2%	
four years	1.121	90.6%	
three years	1.196	72.8%	
two years	1.042	22.6%	
one year			not available

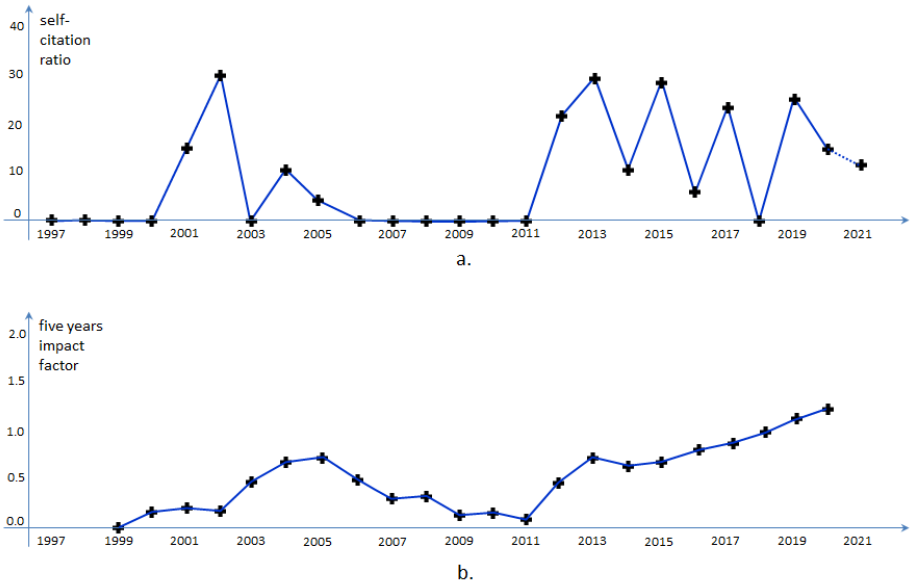

Fig. 2. The Self-Citation Ratio Per Year and the Five Years Impact Factor of the Journal (Part of the Data are from the Academic Accelerator).

JIDPS over the years is shown in **Figure 2.b**. The five-year JIF is the average number of times articles published by the journal in the past five years have been cited in the JCR year.

The H-index is a way of measuring the productivity and citation impact of the publications. It is defined as the maximum value of H such that the given journal/author has published H papers that have each been cited at least H number of times. The current H-index of the journal is H = 18 (meaning that 18 articles of this journal have more than 18 number of citations), while it was 17 and 16 over the preceding three years (according to Academic Accelerator) (https://academic-accelerator.com/5-Year-Impact-Factor/Journal-of-Integrated-Design-and-Process-Science).

According to the Scopus Source List, the number of papers published between 2017 and 2020 is 55, out of which 45% have been cited, and this resulted in 73 citations in the mentioned period and a CiteScore of 1.3. The total number (TN) of papers registered in Scopus in 2020 is 12, the TN of papers published in the last 3 years is 51, the TN of references in 2020 is 31, the TN of references in the last 3 years is 515, the TN of the citable papers in the last 3 years is 44, the average cites per paper in the last 2 years is 0.67, and the TN of references per documents in 2020 is 42.92. Based on these, the SCImago's Journal Rank indicator (that measures the scientific influence of journals considering the number of citations received by a journal and the importance of the journals from where these citations come) is SJR = 0.15. The fact that the journal is cited by a total of 31 papers during 2020 explains the journal's JIS, JIF and JCI indices.

4. Epistemological Domains of Scientific Contribution

Based on the type of the presented work and results, the 539 published papers were categorised. Three epistemological categories of scientific contributions have been considered in the paper: (i) domains (SCDs), (ii) themes (SCTs), and (iii) subjects (SCSs). My reasoning was that analogous and comparable subjects together form the themes of investigations or developments, and an aggregate of themes forms a domain of academic interest. Section 4 presents the identified SCDs, Section 5 deals with the themes of contributions in the various domains, and Sections 6 and 7 discuss the subjects (topics) of contributions.

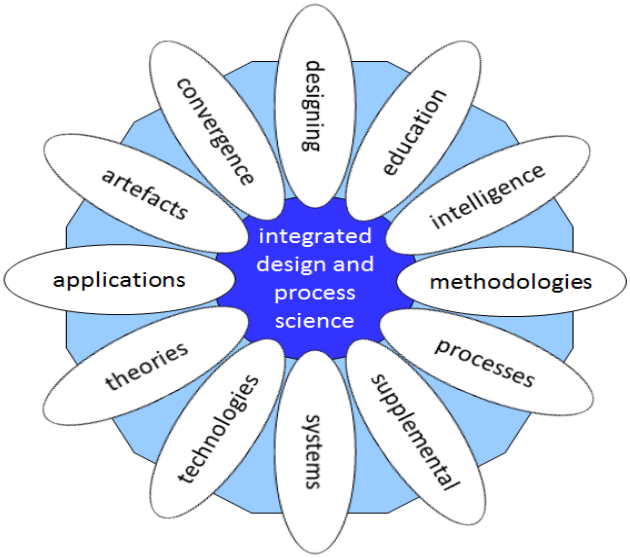

Fig. 3. Scientific Contribution Domains (SCDs).

Altogether 12 general scientific contribution domains were identified in the bibliometric analysis. A distinctive name was assigned to each of them. They are shown in **Figure 3**. As a complement of these, a so-called Supplemental domain has been defined for those published papers that could be placed into

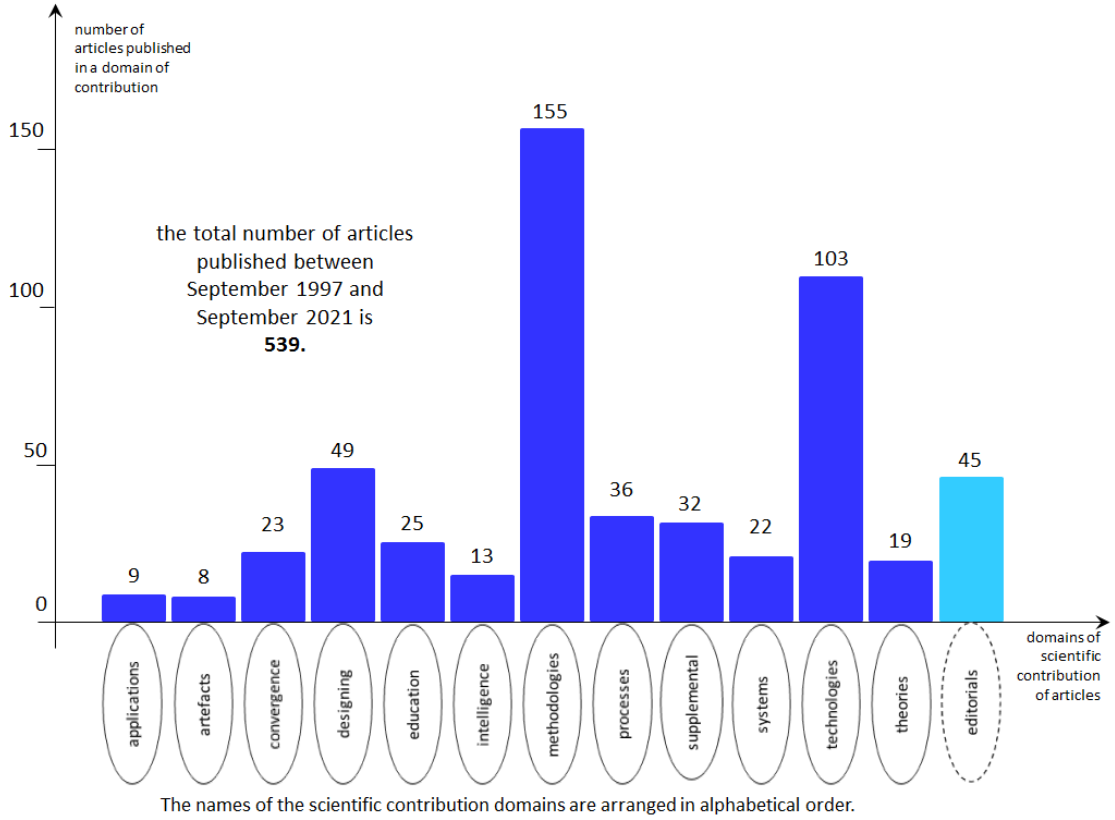

Fig. 4. The Number of Papers Published in the Various SCDs.

none of the other primary categories. With regards to the objective and scope of the journal, some of these contributions were borderline papers. Furthermore, another category was defined for the introductory papers of regular or thematic compilations. This category was dubbed as Editorials, and included both regular (less than 3 pages) and extended (more than 3 pages) editorials. The number of papers in the various categories is very different. This distribution is graphically visualized in **Figure 4**. The SCDs are arranged in alphabetical order to avoid indicating any priority. The two most populated SCDs were (i) methodologies (having 155 papers), and (ii) technologies (having 103 papers). The two least populated SCDS were (i) applications (having 9 papers), and (ii) artefacts (having 8 papers). The cardinality of the SCDs called design and process are in the middle range, including 49 and 36 papers, respectively.

The number of papers that belong to the SCD called convergence is 23. The appearance of this type of papers was more frequent at the first part of the almost 25-year period, while the papers of technical research became more frequent in its second part. As mentioned above, altogether 45 editorials could be counted. The distribution of the papers in the various SCDs shows a kind of randomness over time, with some local aggregations and patterns. The latter is due either to the thematic collection or to the special issue nature of certain Numbers.

5. Themes of Scientific Contribution

What scientific contribution JIDPS has made during its almost 25 years of existence? To answer this question, the rest of the paper provides an overview and insights in the themes of the papers in the various SCDs. To comply with the preferred practice of neutral presentation, the SCDs are considered in alphabetical order.

5.1. Themes of contributions in the applications and artefacts domains

As shown in **Figure 5**, both the SCD of applications and the SCD of artefacts are populated by five unique themes, not appearing in different domains. When used in a general meaning, the term 'applications' refers to cases of placing something into a particular practical use. Hence the domain of applications includes papers that intend to use various artefacts, processes, concepts, etc. for a particular purpose and report on the mode, the results, and the experiences of doing it. In the applications domain,

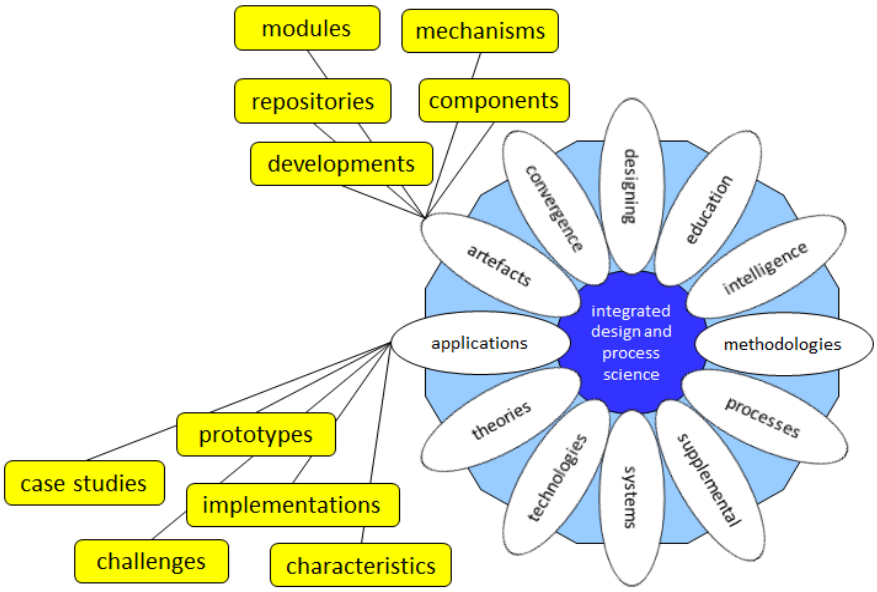

Fig. 5. Themes of Scientific Contribution in the Domains of Applications and Artefacts (Objects).

the numbers of papers belonging to the identified themes are as follows: (i) case studies with physical or virtual implementations: 04, (ii) testable implementations: 02, (iii) professional and computational challenges of use: 01, (iv) specific characteristics: 01, and (v) demonstrative prototypes: 01.

Primarily, papers that focus on making and/or studying mental, virtual, physical, and hybrid objects made by humans based on disciplinary, industrial, business, and social interests were considered in the domain of artefacts. In addition, papers discussing something observed in a scientific investigation or experiment but is not naturally present, or exist as a result of creative human procedures, were also included in this domain. The latter is represented by knowledge structures, data constructs, and media materials. The numbers of papers in the identified themes belonging to the artefacts domain are as follows: (i) computational mechanisms and applications: 02, (ii) software/hardware modules: 02, (iii) data/knowledge repositories: 02, (iv) artefact innovations and developments: 01, and functional components: 01. The cardinality figures do not indicate the dominance of any theme over the others.

5.2. Themes of contributions in the convergence and designing domains

Convergence is a social megatrend that manifests in rather different forms and ways (such as converging, confluence, integration, conjunction, merging, synthesis, blending, fusion, etc.). In the process of convergence many different things come together to form a new whole such as distinct disciplines, industries, technologies, knowledge, or instruments. Convergence has been considered from the time of establishing the journal a new trend that has significant philosophical, societal, industrial, technological, and personal influences and change effect. The themes belonging to this contribution domain are shown in **Figure 6**, together with the themes of Designing. The papers related to convergence discuss a variety of themes such as: (i) integration: 14, (ii) transdisciplinary: 05, (iii) converging: 01, (iv) internationalization: 01, (v) synthesis: 01, and (vi) unification: 01.

The theme of integration has the highest frequency of occurrence in the papers. Why technology integration (like in smartphones) is concrete and palpable, ontological, methodological and historical

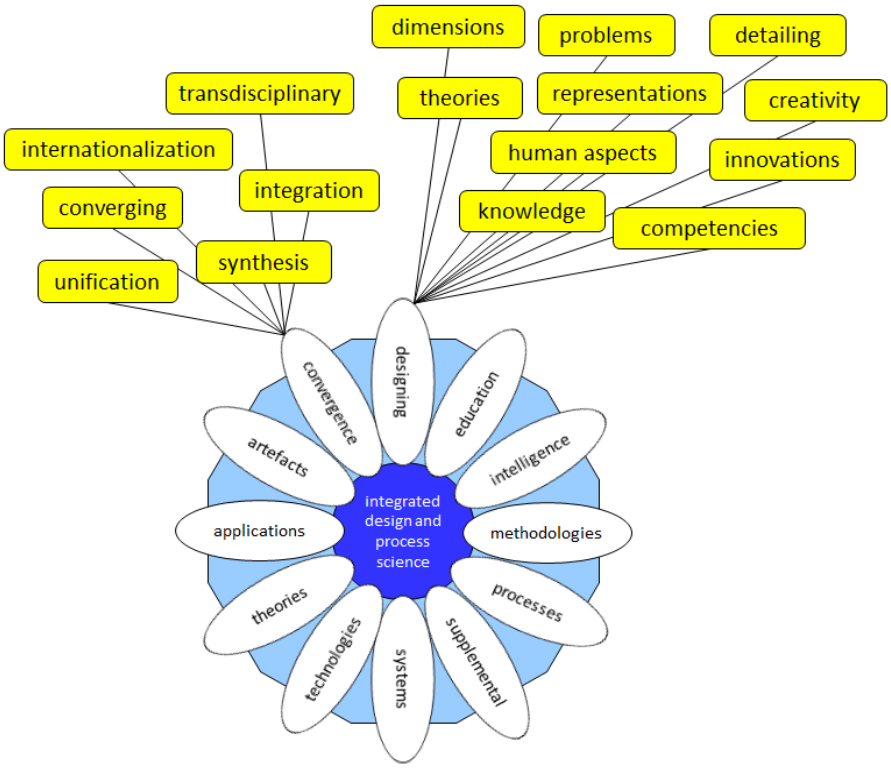

Fig. 6. Themes of Scientific Contribution in the Domains of Convergence and Designing.

converging of disciplines has remained more abstract and less graspable. Convergence is most frequently experienced in computer science, where combining different forms of electronic technology and information processing has become a daily routine. Many papers argued that the concerned things will necessarily not join together or evolve into one, but they stop being largely different and are becoming more similar. The most evidential examples of this act of moving toward higher-level union or uniformity are such as digital convergence, global product realization, hyper-converged infrastructure, and fixed mobile convergence.

Design science is one of the focus fields of the journal. The number of themes addressed in the domain of design happens to be 10 after sorting the related papers. The number of papers in these themes are as follows: (i) design problems: 14, (ii) design theories: 07, (iii) design dimensions: 06, (iv) human aspects: 06, (v) design representations: 06, (vi) design creativity: 03, (vii) design detailing: 03, (viii) design-based innovations: 02, (ix) design competencies: 01, and (x) design knowledge: 01. Apart from the number of studies concerning design problems, the research efforts are distributed over the other themes in a quite balanced manner. Design appears as a multi-faceted phenomenon in the papers and in various context ranging from philosophical considerations to best design practices.

5.3. Themes of contributions in the education and intelligence domains

The thematic decomposition of the education and intelligence domains is shown in **Figure 7**. Education has a fundamental role in facilitating transdisciplinary science, engineering, and design. The problematics of transdisciplinary engineering education appeared already in the last Number of Volume 4. Various educational research topics have been addressed in multiple regular Numbers and recently (in Volume 21 Number 2) a special issue was dedicated to this domain of academic interest. Education is themes varied number of papers: (i) learning enablers: 06, (ii) educational strategies: 05, (iii) methods and forms of teaching: 03, (iv) e-learning: 02, (v) learning objects: 02, (vi) educational programs: 02, (vii) performance and satisfaction analyses: 01, (viii) didactics and management: 01, (ix) life-long learning: (x)

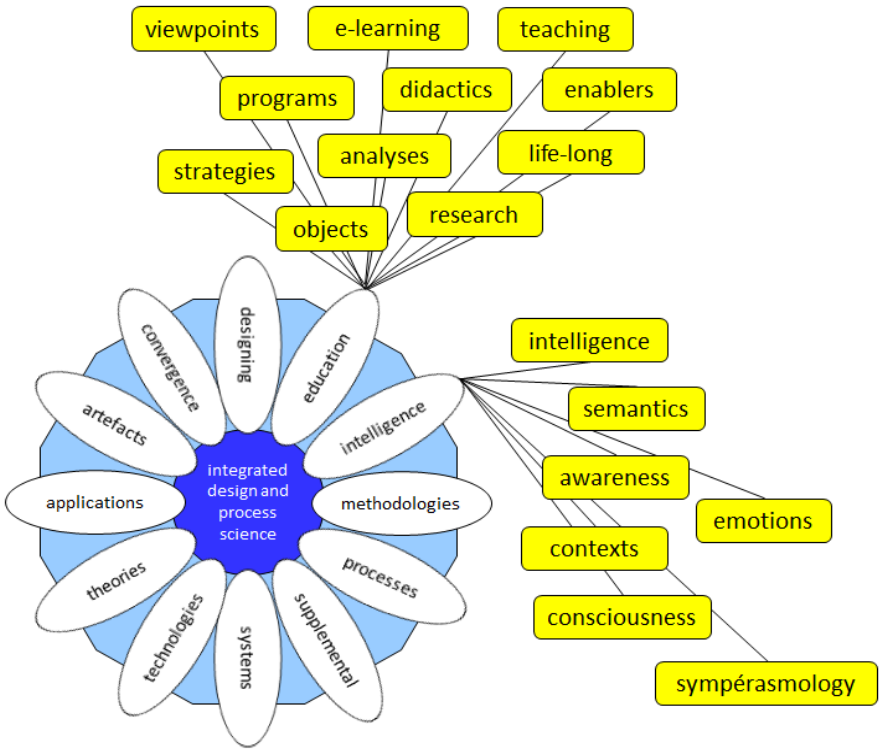

Fig. 7. Themes of Scientific Contribution in the Domains of Education and Intelligence.

01, educational research: 01, and (xi) stakeholder viewpoints: 01.

The front-runner papers in the domain of intelligence were published in Volume 9 Number 1, An intelligent design framework proposal. Contributions to this domain remain sporadic and evenly distributed in the journal. This is interesting observation because artificial intelligence research received significant attention in both enabling and automation of design and process planning after the so called AI winter. The themes in intelligence and the number of papers published in these teams are as follows: (i) roles and manifestations of (artificial) intelligence: 04, (ii) applied semantics: 03, (iii) contexts modelling and information processing: 02, (iv) awareness in design: 01, (v) consciousness: 01, (vi) reproducing emotions: 01, and (vii) theory of synthetic systems knowledge (sympérasmology): 01.

5.4. Themes of contributions in the methodologies and processes domains

Both the domain of methodologies and domain of processes are rather densely populated with research themes compared to other domains (**Figure 8**). The term 'methodologies' is used here as an umbrella phrase to identify the domain and to take care of the thematic variety, but ignoring it as the theory of methods. This domain is populated by systematic methodologies, but also by several other methodological concepts. My personal viewpoint is that, in general, methodology is a theoretically underpinned development, composition, and application of principles, methods, procedures, apparatus, and practices in a specific discipline. In order to differentiate itself from methodics (goal-driven selection/application of methods), approaches, and methods, a systematic methodology should (i) have at least one underpinning theory, (ii) propose one or more alternative procedural scenarios, (iii) have a pool of adaptable exploratory and confirmatory methods, (iv) identify a set of enabling instruments, and (v) define a set of applicability and performance criteria. Methodology also deals with how we can know something and the assumptions and methods of how things are studied.

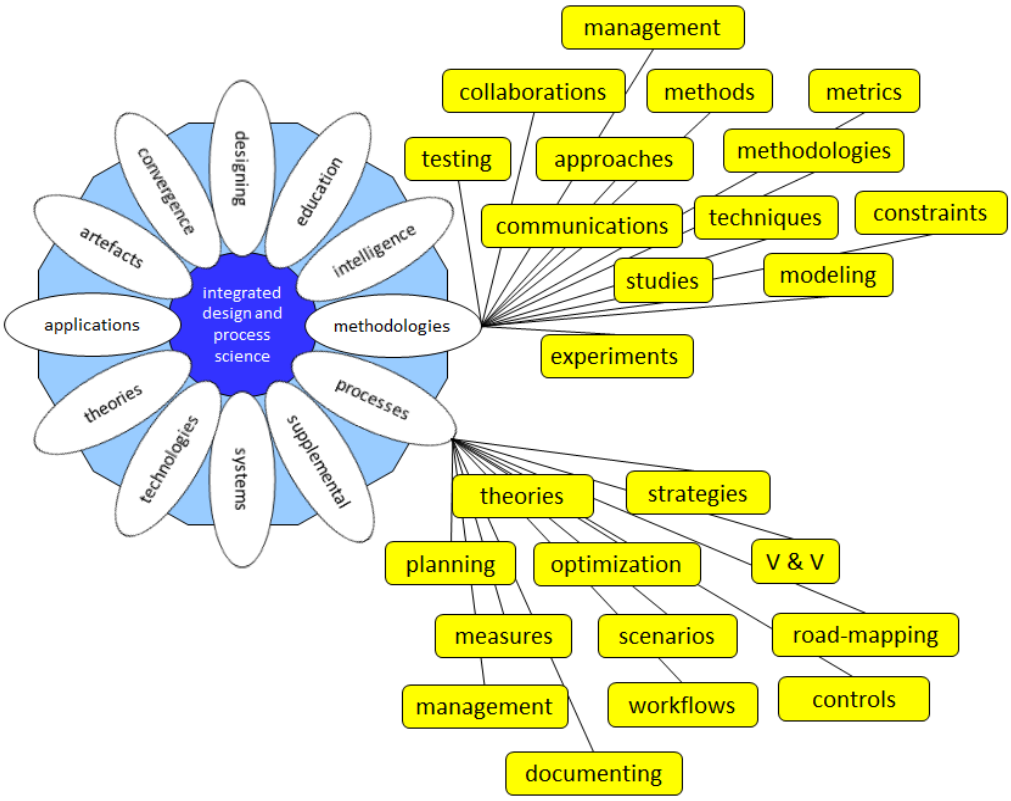

Fig. 8. Themes of Scientific Contribution in the Domains of Methodologies and Processes.

Methods represent focused actions within an overall methodology. They are used to ensure that the activities are carried out in a reliable and valid manner. Most of the papers belonging to this theme conceived methods as purpose-driven systematic procedures for collecting, creating, processing, and testing information and solving tasks. I regarded a methodological approach as a way of dealing with a research or development challenge, which features a particular way of doing the investigation or creating something. In my view, an approach means getting closer to something or becoming more sophisticated at addressing the challenge. A method may incorporate multiple skilful techniques, which are instrument-dependent (manual or computerized) ways of carrying out a particular inquiry or creative task.

Since the above addressed notions are often used interchangeably or as synonyms, the above explanations were included to differentiate and underpin the non-evidential themes mentioned as relevant to the domain of Methodologies. As shown in **Figure 4**, the largest number of papers has been published related to this particular domain. There are numerous themes addressed and large differences in terms of the number of papers in the themes. Arranging them in a descending order, we come to: (i) methods: 44, (ii) approaches: 41, (iii) modelling: 20, (iv) studies: 14, (v) methodologies: 10, (vi) techniques: 07, (vii) metrics: 07, (viii) testing: 05, (ix) constraints: 03, (x) collaborations: 01, (xi) communications: 01, (xii) experiments: 01, and (xiii) management: 01. The apparent dominance of methods and approaches does not reflect efforts for methodological convergence, integration, or fusion.

As it can be seen in **Figure 8**, the domain of Processes has more than ten themes. For the reason that the practical processes include logically and temporally arranged patterns of activities/operations to achieve, change, or maintain a given goal, the main concerns are organization, optimization, planning, and documenting process elements and flows. The distribution of the published papers over the identified themes in the domain of Processes is rather balanced. The themes has the following number of papers: (i) structured workflows: 07, (ii) process optimization: 05, (iii) process planning: 05, (iv) process documenting: 04, (v) process theories: 03, (vi) process management: 03, (vii) process measures: 02, (viii) process scenarios: 02, (ix) process strategies: 02, (x) process controls: 01, (xi) road-mapping: 01, and (xii) process verification and validation: 01. Putting together everything, the number of publications in the contribution domain Processes is moderate (36).

5.5. Themes of contributions in the supplemental and systems domains

I used the phrase 'supplemental themes' to refer to those that, according to my subjective personal judgment, are perhaps not in the main stream of integrated design and process science. Though address research topic like other mainstream papers, but either with an objective not relevant for the journal, or in a different application context seen as peripheral for it. The total number of these papers is 32, and this number is comparable to one of the mainstream (or key) domains, such as processes (36), or even designing (49). The themes of the Supplemental papers spread over a wide range, whilst the number of papers in the themes is not showing large differences: (i) analyses: 05, (ii) methods: 03, (iii) modelling: 03, (iv) case studies: 02, (v) management: 02, (vi) optimizations: 02, (vii) studies: 02, (viii) techniques: 02, (ix) ANN: 01, (x) approaches: 01, (xi) creative spaces: 01, (xii) detection: 01, (xiii) enablers: 01, (xiv) estimations: 01, (xv) impacts: 01, (xvi) implementations: 01, (xvii) obituary: 01, (xviii) thinking: 01, and (xix) transdisciplinary: 01. It is important to mention that supplemental papers are not of less quality of value, but could have been published in other (i.e. more relevant) journals.

If we look at the titles of the published papers, the word ‘system’ appears 124 times, in an almost even distribution over the years, and very different contexts. These facts (~ one fifth of the papers published so far) allow a thinking of an (explicit or implicit) system orientation of the journal. On the other hand, the themes and number of papers with direct contribution to systems science, engineering, or development are somewhat low. In the language of statistics, it means the following: (i) system theoretical insights: 07, (ii) cognitive systems: 05, (iii) system analyses: 04, (iv) system operations: 02, (v) sociotechnical systems: 02, (vi) cyber-physical systems: 01, and (vii) engineered systems: 01. These are shown in **Figure 9**. Most frequently addressed issues are related to software systems and information systems. Two special Numbers addressed the practical issues of and the emerging perspectives on system-of-systems, and the

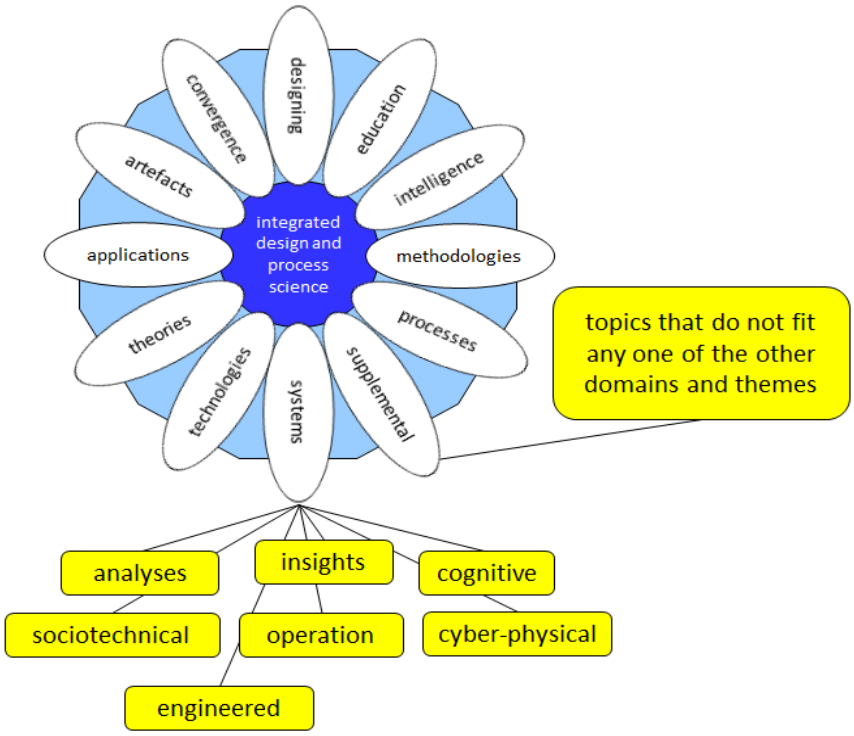

Fig. 9. Themes of Scientific Contribution in the Domains of Supplemental and Systems.

theories and realization of behaviourally adaptive engineered systems, respectively. The application orientation of the systems has shifted to service provisioning, cyber-physical computation-based computation, and system intellectualization. However, the issues of convergence are only tangentially addressed in a sub-set of the papers.

5.6. Themes of contributions in the technologies and theories domains

The thematic decomposition of these two domains is shown in **Figure 10**. Like the considerations related to methodologies, the themes introduced in the contribution domain called Technologies also deserve further clarification. For the purpose of classification, the term ‘technologies’ was used to refer to the practical utilization of ‘to know’, ‘to do’, and ‘to make’ types of knowledge in development of enablers and in production of durable and consumable products. Obviously, this involves material, energy, and information transformation technologies, as well as human, environment, organization, construction, processing, digital, and cognitive technologies. This broad interpretation was needed because the published papers practically touched upon each of these, with a dominance of information, computing, and software technologies.

To capture the various themes of the domain Technologies, some abstract notions, such as enablers, frameworks, and platforms, were needed in addition to the more obvious ones. Since these are used variously in the literature, let me clarify my interpretation of the abovementioned ones. A (technology) framework is a simple or a layered, conceptual or real structure that orientates and supports the building of something that expands the structure into something useful. A framework is a reusable construction or design for a system or a part of it, which is often underpinned by standards and normative specifications. A (technology) platform is a restricted environment for building and running applications, systems and processes. Technology platforms include such manifestations as (i) AI platforms, (ii) analysis/simulation platforms, (iii) API platforms, (iv) application development platforms, (v) computing platforms, (vi)

database platforms, (vii) game platforms, (viii) media content platforms, (ix) mobile platforms, (x) operating systems, (xi) robotics platforms, (xii) storage platforms, (xiii) web platforms, and so forth.

The common definition for a (technology) enabler identifies organizational enablers (such as policies, strategies, funding, investment, and projects of governments, regulatory bodies, and other organizations) and technical enablers (such as guidelines, standards, specifications, catalogues, instrument repositories, and professional forums). Papers contributing to these were considered in this theme together with those that could eventually be not sorted in any of the other themes. Anyway, the domain of technologies was the second most fed domain of scientific contributions. The following themes were identified in the domain of technologies: (i) enablers: 21, (ii) frameworks: 20, (iii) software/system agents: 10, (iv) human/system interfaces: 08, (v) platforms: 06, (vi) hardware/software tools: 06, (vii) software/system architectures: 05, (viii) software/system packages: 05, (ix) operative (practice-based) research: 05, (x) computational algorithms: 04, (xi) synthetic languages: 04, (xii) meta-models: 04, (xiii) middleware: 02, (xiv) knowledge ontologies: 02, (xv) deep learning: 01, (xvi) information/knowledge sharing: 01. The relatively large number of papers contributing knowledge about specific enablers and technological frameworks is worth noting.

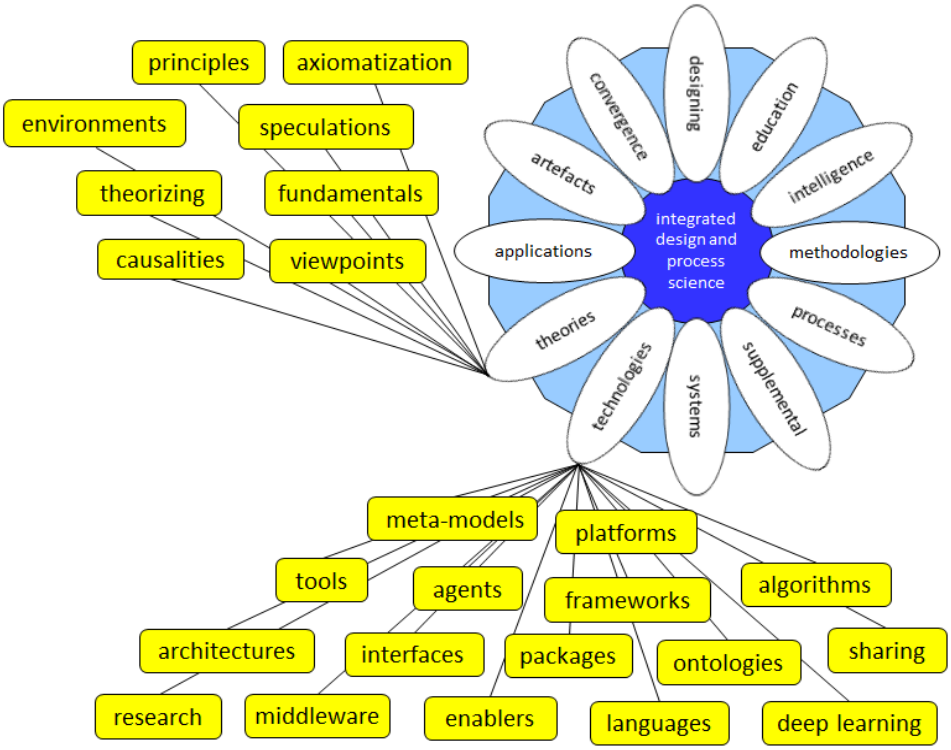

Fig. 20. Themes of Scientific Contribution in the Domains of Technologies and Theories

The domain of theories was found less densely populated with scientific contributions - 19 papers have been published related to this. I considered works as theoretical contributed if they offered descriptive, explanatory, predictive, or operational knowledge about the overall phenomenon of design, or any specific constituent or implied phenomena, with a large amount of evidence and testing behind it. However, not all contributions were concerned with development of formal theories or conceptual fundamentals, but offered personal or contextualized viewpoints, identified basic principles, or scholarly speculations. The addressed theoretical themes were: (i) theorizing: 05, (ii) viewpoints: 03, (iii) fundamentals: 03, (iv) speculations: 03, (v) principles: 02, (vi) axiomatization: 01, (vii) causalities: 01, and (viii) environments: 01. The balanced distribution of the papers shows a modest interest in design and

process theories, and offered restricted contribution to the theoretical understanding of the convergence of design and process science and technologies.

For the sake of completeness, I mention that I could not identify any systematic shift in the topics addressed over the years, apart from the slow shift caused by the progression of software engineering and the digital revolution, proliferation of system thinking and artificial intelligence. On the other hand, many papers exemplified a kind of random 'reoccurrence' of topics in 'distant' epochs of the operation of the journal. In other words, certain research phenomena or development issues popped up in the past as well as recently.

6. A Historical View on the Topics of Scientific Contributions

The almost 25 years of existence of the journal can be decomposed into five epochs, each of which includes approximately five years. The epochs can be named as (i) inauguration, (ii) stabilization, (iii) destabilization, (iv) convalescing, and (v) unfolding.

6.1. Inauguration - The first five years

The very first Number was a compilation of 8 papers, which presented progressive scientific visions, discussed academic, industrial, and social missions, and circumscribed, among others, the phenomenon of scientific convergence. The basis of these papers were keynote talks, scientific position talks, opening address, and technical contributions presented at the Second World Conference on Integrated Design and Process Technology. The common element for them was the issue and challenge of building transdisciplinary science, which was regarded indispensable for progress. Many outstanding scientist and scholars contributed to this first issue. George Kozmetsky, the first Chairman of the Board of the Society for Design and Process Science, discussed general road-maps to commercialization of science and technology at the time of the millennium. He emphasized the importance of finding complex solutions for complex challenges. Nobel laurate Herbert A. Simon addressed the juxtaposing design (processing information to create new possibilities) and process (processing substances to realize these possibilities). He dealt not only with the role of technologies, but also with the role of humans in integration of design and process technology. Computer scientist Chittoor V. Ramamoorthy reported on a study of the evolutionary processed in digital electronic products and concluded that intelligence-based functions evolve faster than physically-based functions so as in the case of biological evolution.

Raymond T. Yeh, co-founder of the Syscorp International and other enterprises, elaborated on designing holistic enterprise evolution. His main finding was that enterprises need different approaches in concert with their maturity levels. Executive advisor of the NEC Corporation, Yukio Mizonu discussed some of the key impacts of information networks on global company operation and emphasized the importance of adjusting the network to companies' operational profile. Professor Thomas J. Kozik exposed process design as one of the new mandates of engineering. He argued that the nature of design is closer to art than to science, though the latter is necessary to establish criteria, bounds, and evaluation. Professor John N. Warfield proposed a platform for sociotechnical system design and identified its five dimensions as (i) human behaviour, (ii) science, (iii) communication, (iv) modelling, and (v) complexity. Professor Andrew D. Dimarogonas addressed several philosophical issues of engineering design such as usefulness, ethics, knowing of truths, intuitions, and uniqueness. Professors Murat M. Tanik and Attila Ertas discussed the overall concept of interdisciplinary design and process science. They compared the inquiry and teaching methods on a historical scale and identified demarcating differences in them and in the so-called social machinery. They exposed the challenge of combinatorial explosion and introduced the notion of 'meta-fusion' as the engine of converging science.

The papers published in Volume 2 contributed exemplifying and confirming theoretical investigations and experimental research results. As shown in **Figure 11**, the number of published papers was 9 in 1997, 26 in 1998, 20 in 1999, 21 in 2000, and 29 in 2001. Concerning the most cited publications in the first five years, the paper entitled "Modular product design: A life-cycle view", the work of Gershenson J.K.,

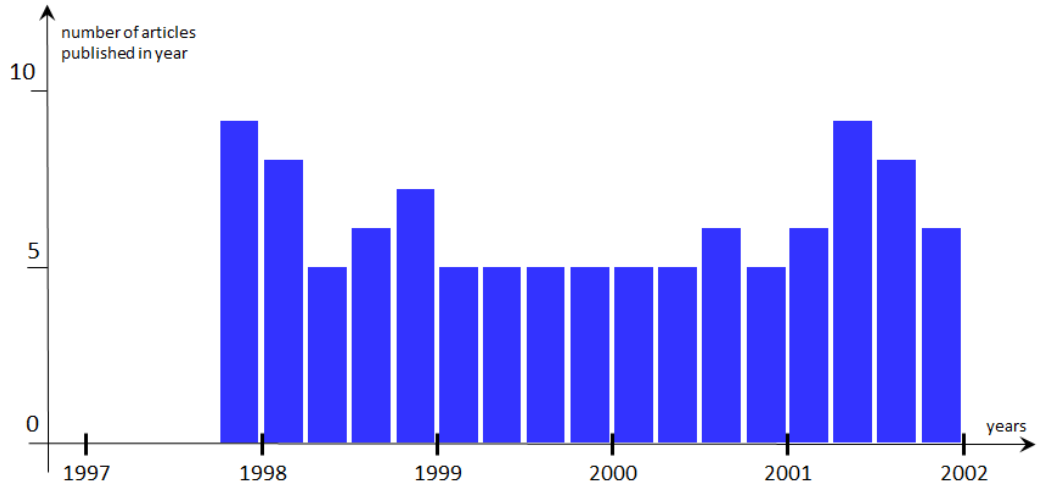

Fig. 11. Number of Papers Published in the Period 1997-2002.

Prasad G.J., and Allamneni S. must be mentioned. Published in 1999 (Volume 3, Number 4), this papers was cited 131 times, which is the highest number of reference in the history of the journal. There were three papers in 2000 which were cited at least 15 or more times. The gold medallist in this year was the paper of Ertas A., Tanik, M.M., and Maxwell, T.T., entitled "Transdisciplinary engineering education and research model" (Volume 4, Number 40) with 29 references. The silver medallist was the paper of Kachroo P., and Krishen K., published in Volume 4, Number 1, under the title "System dynamics and feedback control design problem formulations for real time ramp metering", with 20 references. The bronze medallist with 18 references was the paper "Modelling engineering design processes with role activity diagrams", by Murdoch, J., McDermid, J.A., Astley, K., and Wilkinson, P., in Volume 4, Number 2. In 2001, two papers received more than 15 references, namely the paper of Saglam, H., and Unuvar A., entitled "Three-component, strain gage based milling dynamometer design and manufacturing", in Volume 5, Number 2 (19 references) and the paper of Schmidt, H., Poernomo, I., and Reussner, R., entitled "Trust-by-contract: Modelling, analysing and predicting behaviour of software architectures", in Volume 5, Number 3 (16 references).

6.2. Stabilization - The second five years

The second epoch of the history of the journal can be characterized by the word stabilization. The journal has managed to attract the attention of many authors and published several important scientific contributions. In terms of statistical figures it meant that 26 papers were published in 2002, 31 in 2003, 39 in 2004, 25 in 2005, and 27 in 2006 (**Figure 12**). There were five publications that received more than 15 citations in 2002. The largest number – 77 – was on the paper of Zeng Y. , which presented an "Axiomatic theory of design modelling" in Volume 6, Number 3. The second largest – 25 – was earned by the work of Quartel, D., Pires, L.F., and van Sinderen, M. concerning "On architectural support for behaviour refinement in distributed systems design", in Volume 6, Number 1. Altogether 24 citations were made to the work of Engels, G., Küster, J.M., and Groenwegen, L., entitled "Consistent interaction of software components" (Volume 6, Number 4). Submitted by Padberg, J., the paper "Petri net modules" (Volume 6, Number 4) was cited by 17 times, while the paper of Enders, B.E., Heverhagen, T., Goedicke, M., Tröpfner, P., and Tracht R., entitled "Towards an integration of different specification methods by using the viewpoint framework", published in Volume 6, Number 2, was cited 15 times.

Published in 2003, five papers received 15 or more citations so far. The most – 76 – was received by the work of van der Aalst, W.M., Weske, M., and Wirtz G., under the title "Advanced topics in workflow

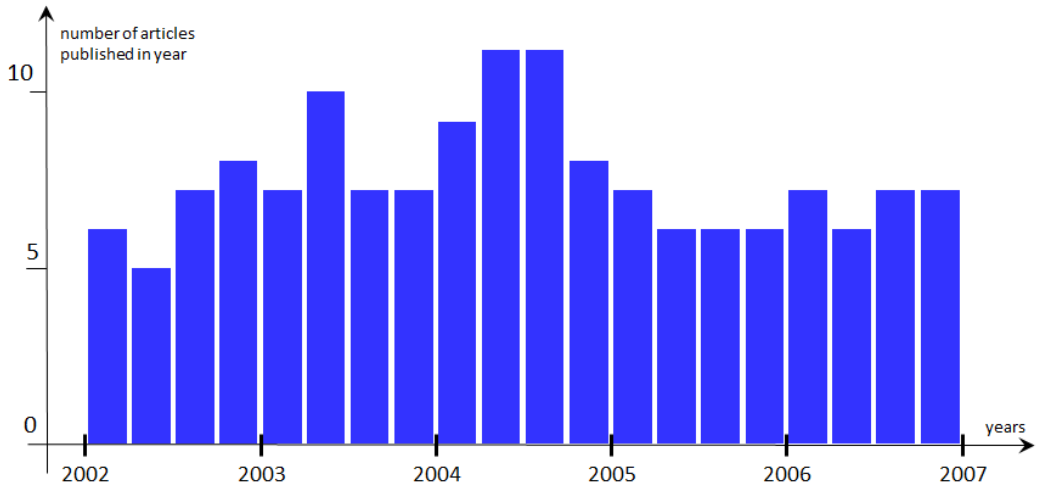

Fig. 12. Number of Papers Published in the Period 2002-2007.

management: Issues, requirements, and solutions" (Volume 7, Number 3). The other up-runners were the paper of Sun, J., Han, B., Ekwaro-Osire, S., and Zhang H.-C., "Design for environment: Methodologies, tools, and implementation" (Volume 7, Number 1) with 35 citations, of Kowalczyk, R., Braun, P., Mueller, I., *et alias*, "Deploying mobile and intelligent agents in interconnected E-marketplaces" (Volume 7, Number 3), with 19 citations, of Zha, X.F., Lim, S.Y., and Lu, W.F., "A knowledge intensive multi-agent system for cooperative/collaborative assembly modelling and process planning", (Volume 7, Number 1), with 19 citations. Finally, the work of Plasil, F., and Mencl V., entitled "Getting 'whole picture' behaviour in a use case model" (Volume 7, Number 4) earned 15 references since 2003.

From the set of papers published in 2004, two papers excelled: the submission of Zeng Y., entitled "Environment-based formulation of design problem" (Volume 8, Number 4) with 76 references, and the paper of Berardi, D., De Rosa, F., De Santis, L., and Mecella M., entitled "Finite state automata as conceptual model for e-Services" (Volume 8, Number 2) with 35 references. None of the papers published in 2005 was referenced more than 18 times. The highest number - 11 -was received by the work of Kubo, A., Washizaki, H., Takasu, A., and Fukazawa, Y., published under the title "Extracting relations among embedded software design patterns" (Volume 9, Number 3). One paper published in 2006 must be mentioned here: The paper of Lee, T., entitled "Optimal strategy for eliminating coupling terms from a design matrix" (Volume 10, Number 2), received 16 citations.

6.3. Destabilization - The third five years

This epoch of operation of the journal is characterized by varying figures (**Figure 13**). In the language of statistical figures it means that there were 25 papers published in 2007, 19 papers in 2008, and the yearly amount of published papers fell back to 12 in 2009. The second Number in this years included only one paper, and the third number only three. Though the statistical figures are usually talkative, the presented ones are not able to explain the reasons and it is not the task of the bibliometric study to further analyse it. It is positive, that the publication figures are more positive in the following two years, but still modest, in spite of the fact that an extra Number with eight papers was published in 2011. There were 17 papers published in 2011 and 27 in 2011.

In the year 2007, the most cited paper was that of Madni, A.M. entitled "Transdisciplinarity: Reaching beyond disciplines to find connections" (Volume 11, Number 1), which was cited 33 times. The work of Jackson S., under the title "A multidisciplinary framework for resilience to disasters and disruptions, (Volume 11, Number 2), was the best up-runner with 14 citations. In the following years, there was no paper referenced at least 15 times. The highest scores were 7, 11, and 4, respectively. In the year of 2011,

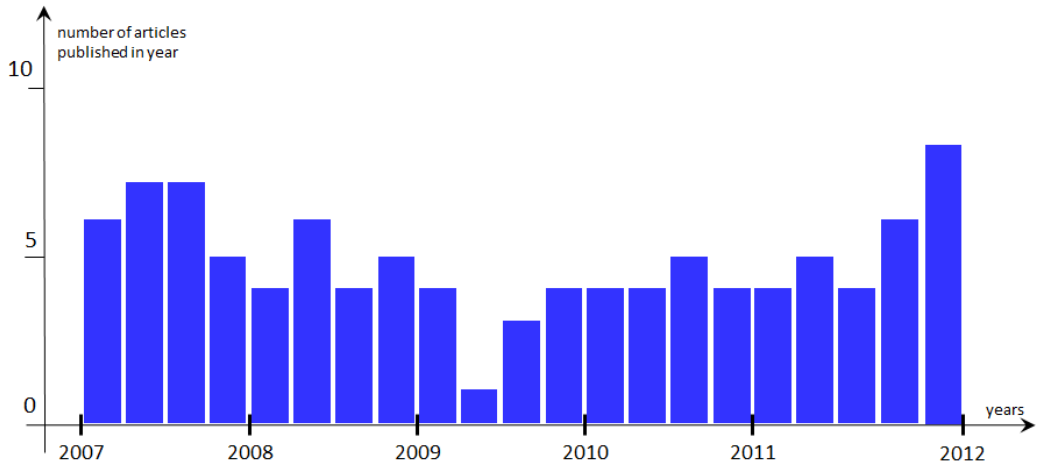

Fig. 13. Number of Papers Published in the Period 2007-2012.

one paper was cited 16 times. This is the paper of Suh I.-S., entitled "Intelligent wireless EV fast charging with SMFIR® Technology, in Volume 15, Number 3) which was referenced by 16 other publications.

6.4. Convalescing - The fourth five years

Concerning the following years of the fourth epoch, the statistical figures are more positive (**Figure 14**). These figures justify the legacy of the term that I used above to characterize this period. There were 22 papers published in 2012 as well as in 2013, 20 in 2014, 19 in 2015, and 25 in 2016. It was not possible for me to find information about either the total number of submitted paper, or about the yearly proportion of accepted and rejected papers on the professional media or the publisher website. Neither are figures about the number and proportions of the submissions (i) accepted as is, (ii) accepted after minor revision, and (iii) accepted after major revision publicly available. However, it can be traced back that the yearly Volumes appeared with a significant publication delay.

There were three papers published that were cited at least or more than 15 times. The first one of Nguyen, T.A., and Zeng, Y., “A theoretical model of design creativity: Nonlinear design dynamics and mental stress-creativity relation”, which was published in Volume 16, Number 3 in 2012, was cited 38

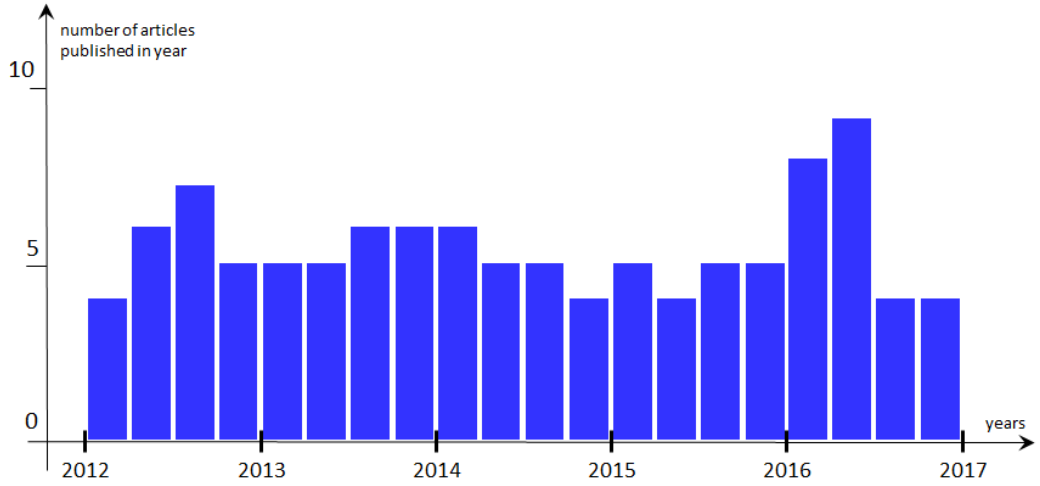

Fig. 14. Number of Papers Published in the Period 2012-2017.

times. The second one is from Cascini, G. on "TRIZ-based anticipatory design of future products and processes" (Volume 16, Number 3) which earned 30 references so far. The third one is the submission of Suh N.P., "Fundamentals of design and deployment of large complex systems: OLEV, MH, and mixalloy", Volume 16, Number 3, with 15 citations. One paper, presented by Kudrowitz, B., and Dippo, C. in 2013, under the title "When does a paper clip become a sundial? Exploring the progression of originality in the alternative uses test" (Volume 17, Number 4) reached 20 citations. The best up-runner is the work of Stachel, J., Marghitu, D., Brahim, T.B., *et alias*, entitled "Managing cognitive load in introductory programming courses: A cognitive aware scaffolding tool" (Volume 17, Number 1) with 14 citations so far. None of the papers published in 2014 was cited more than the above threshold (15). Published in 2015, the paper of Zeng, Y., "Environment-based design (EBD): A methodology for transdisciplinary design" (Volume 19, Number 1) was cited 14 times. In front of four up-runners, the paper of Khan, M.W., Sharif, M., Yasmin, M., and Fernandes, S.L., "A new approach of cup to disk ratio based glaucoma detection using fundus images", published in 2016, in Volume 20, Number 1, was cited 19 times.

6.5. Unfolding - The fifth five years

The figures characterising this epoch are shown in **Figure 15**. Statistically, there were 23 papers published in 2017, 19 in 2018, 23 in 2019, and 17 in 2020 so far. An observable fact is that the Numbers of the various Volumes still appear in delay. It has been recognized that systems have significant contribution to convergence in dealing with multidisciplinary design and processes, integration of human and system knowledge, and harmonization of hardware, software, and cyberware development methodologies, and the journal opened toward systems centred special issues.

At assessing the citation tendencies of the papers published in this epoch, we must consider that they were not published just a few years ago. That explains why the maximum number of citation was 12 concerning the papers published in 2017 (Mokhov, S.A., Song, M., Chilkaka S., *et alias*, "Agile forward-reverse requirements elicitation as a creative design process: A case study of Illimitable Space System v2", Volume 20, Number 3). In the case of papers published in 2018, it is 5 (Huang J. "Building intelligence in digital transformation", Volume 21, Number 4). The highest figures related to papers released in 2019 are 9 (for Rupal, B.S., Garcia, E.A., Ayranci, C., and Qureshi, A.J. "3D printed 3D-microfluidics: Recent developments and design challenges", Volume 22, Number 1), and 8 (for Gherardini, F., Mascia, M.T., Bettelli, V., and Leali, F. "A co-design method for the additive manufacturing of customised assistive devices for hand pathologies", in the same Volume and Number). Published in 2020 in Volume 23, Number 2, the paper of Cascini G., Fiorineschi L., and Rotini F., entitled "Impact of Design Representations on Creativity of Design Outcomes" received 5 citations so far.

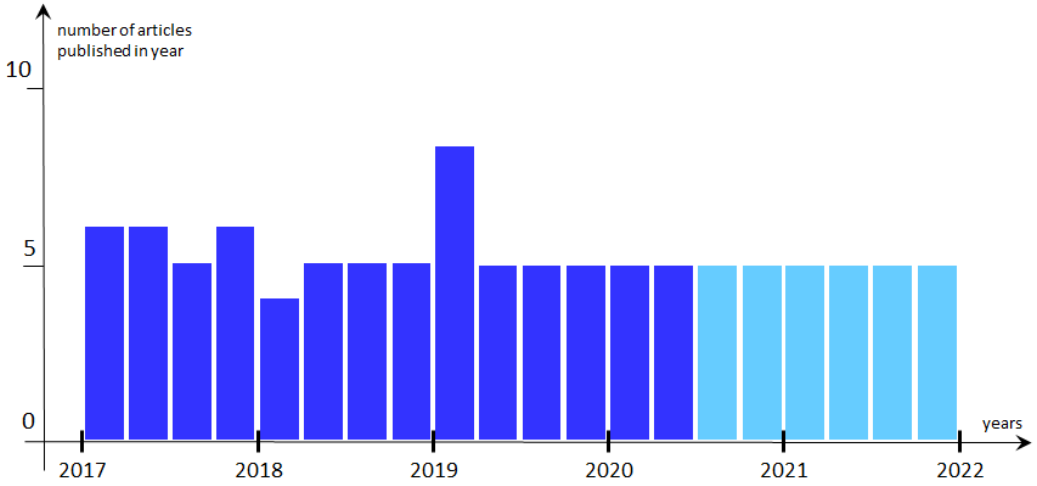

Fig. 15. Number of Papers Published in the Period 2017-2022.

The Green or Bronze Open Access forms of publication did not result is measurable differences. The above displayed figures have been extracted based on the Scopus repository.

Finally, a brief overview of the authors who contributed with most to the contents published by the journal is as follows: (i) Itoh, K. is mentioned as author/co-author in 26 paper, (ii) Zeng, Y in 24, (iii) Kawabata, R. in 16, (iv) Tanik, M.M. in 14, (v) Gonsalves, T. in 11, (vi) Madni, A.M. in 10, (vii) Sobrinho, F.G. in 9, (viii) Ekwaro-Osire, S. in 8, (ix) Cascini, G., Juric, R., Kim, K.Y., Kumagai, S., and Padberg, J. in 7, and (x) De Argollo Ferrão, A.M., Ertas, A., and Nguyen, T.A.in 6.

7. Target Application Domains of the Scientific Contributions

The preceding sections provided insights in the epistemological domain of scientific contributions, the distribution of research, development, and application themes in the various domains, the statistical distribution of the papers in the domains and the themes, and exposed the most cited papers and their topics over the subjectively introduced five epochs of existence of the journal. This section intends to provide an overview of the disciplinary relevance of the contributions to so-called target application domains (TADs). In the process of finding the characteristic applications domain, the descriptions included in the title, the abstract, or the body of the papers were extracted, syntactically harmonized, and statistically processed. The result of this specific overview is shown in **Figure 16**. The total number of TADs is 33. This histogram shows that certain TADs were targeted by many publications, while others by much less. The average number of paper per TADs is 16.3.

The most popular TADs are (i) software engineering - 56 papers, (ii) design science and knowledge - 45 papers, (iii) healthcare technology and systems - 33 papers, (iv) information engineering - 26 papers, and (v) educational science and systems - 25 papers. Of average interest were: (i) computers and algorithm science - 19 papers, (ii) process engineering - 18 papers, (iii) knowledge engineering and management - 17 papers, (iv) process science - 14 papers, and (v) systems science and cross disciplinary convergence, respectively - 13 papers. The least addressed TADs are such as (i) mining technology and industry – 1 paper, (ii) pharmaceutical science and industry - 1 paper, (iii) space technologies and systems - 2 papers, (iv) science and technology management - 2 papers, and (v) architectural design and management - 2 papers. Chemical engineering and systems was addressed as TAD four times. As an incoming TAD, cyber-physical systems development was represented by four papers. Further analysis would be needed to cast light on the relationships between the epistemological/scientific contribution domains and the TADs.

8. Major Findings … (without implicative propositional conclusions)

Abandoning the usual way of discussing and concluding about the approach and results of scientific research, here I restrict myself to a summary of the major finding, which is as follows:

Mission: The journal aims at (i) establishing a transdisciplinary notion of design and processes, (ii) investigating both philosophical (theoretical) and practical (pragmatic) aspects of it, (iii) understanding design and processes across the boundaries of natural, human, and built environments, (iv) exploring efficient novel principles, methods, and tools, and (iv) facilitating the application of transdisciplinary design and process science to engineering, healthcare, and social life.

Uniqueness: The focus of the journal on scientific convergence with regard to design and process science is exclusive. This focus played an important role from both theoretical and practical points of view in the past almost 25 years, and can be considered at least as, if not more, important in the forthcoming 25 years. In addition to dedication and perseverance, cultivation of this field assumes a sharp vision, mission, strategy, and a strong supporting society.

Prospects: If ever, then in the 21st century there for sure will be a strong need for (i) cross-domain fertilization, (ii) generation of synthetic knowledge, (iii) demolishing delineations among key technologies, and (iv) cross-domain research and innovation approaches. However, a shift (a context change) is observable from information-based convergence to intellect-based convergence.

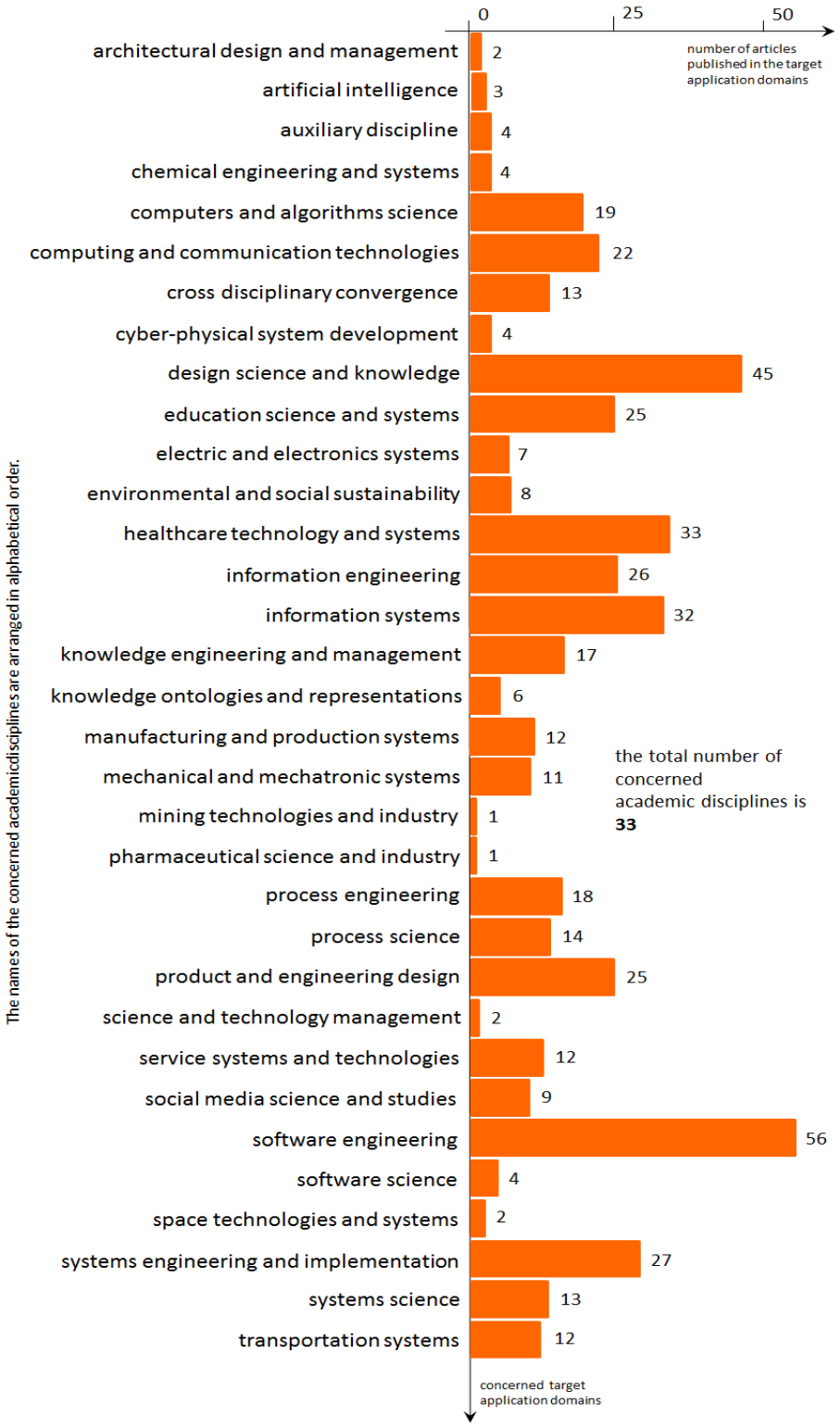

Fig. 36. Target Application Domains and the Related Papers.

Ranking: According to the SCImago Journal Ranking, which shows the visibility and measures the scientific influence of journals contained in the Scopus database from 1996, the overall rank of the journal

is 23176, with an indicator value of 0.15. This considers the number of citations received by a journal and the importance of the journals from where these citations come.

Scope: The IOS Press website of the journal informs that preferred subjects are such as (i) technology, engineering, and architecture, (ii) computer sciences and engineering, (iii) mathematics and statistics, (iv) information sciences, and (v) all areas of design and processes. The completed scientometric and bibliometric analysis explored rather wide sets of contribution domains, themes, and topics.

Visibility: A recent Google search using the search term 'Journal of Integrated Design and Process Science' resulted in some 13.200 hits. At the same time, the number of websites and forums (comparable to Fatcat.wiki, JournalSeeker, Semantic Scholar, CiteSeerx, etc.) that display the journal and its scientific contributions has been found less than 50.

Liveliness: The total number of papers published from September 1997 until September 2021 is 539. It means that approximately 24 papers were published in every year. This figure, as well as the novelty and academic/social value, is directly related to the possible scientific contribution and overall professional impact of the journal. The relationship of convergence to industrial knowledge needs and to innovation is an associated concern.

Impacts: It was found that the Journal Impact Scores, the Journal Citation Indicators, the Journal Impact Factors have a modest value in comparison with resembling/comparable international journals. The distribution of the five-year impact factors shows a largely fluctuating character, with a linear tendency in the last ten years. The H-index and the total number of independent citations are in obvious relation with the scope, visibility, and ranking of the journal. The self-citation ratio is radically fluctuating over the epochs of the existence of the journal. In the last ten years, there are significant differences in the figures even in the subsequent years.

Contribution domains: The twelve scientific contribution domains found hints at a rather broad spectrum. The domains are variously populated with themes and topics. The largest number of published papers has been contributed to the domains of methodologies (155), technologies (103), and designing (49). The least number of papers addressed the domains of intelligence (13), applications (9), and artefacts (3). The supplemental domain includes 32 papers outlying from some aspects.

Contribution themes: Altogether 100 themes have been identified inadvertently. The most attended themes are: problem solving methods (44), methodological approaches (41), modelling (20), technological enablers (21), technological frameworks (20), design problems (14), focused studies (14), and disciplinary knowledge integration (14). The themes of the Supplemental papers include altogether 19 topics.

Historical developments: There are different parts of the lifetime of the journal. Therefore, it has been broken up into five epochs. This allowed casting light on and highlighting important, time-related operational and managerial features of the journal. The selected names of the epochs (inauguration, stabilization, destabilization, convalescing, and unfolding) are indicative with regard to the characteristic periods of the journal's operation.

Disciplinary targets: It was found that the most recurrent target application domains were (i) software engineering, (ii) design science and knowledge, (iii) healthcare technology and systems, (iv) information engineering, and (v) educational science and systems. The least addressed TADs are (i) mining technology and industry, (ii) pharmaceutical science and industry, (iii) space technologies and systems, (iv) science and technology management, and (v) architectural design and management. In this context, the demands and efforts are juxta-positioned with comprehensiveness and efficiency, as well as with usefulness and influences of integration/fusion

A camera obscura just maps the projected part of the world as it is. It does not add or remove anything and does not make it lighter or darker. However, it lets the projected image be seen from inside and from outside concurrently. Eventually, these views do not differ since they are about the same part of the reality and its image. The up-side down image can be made straight, but neither this has to do anything with the content of the image. I mention these again to emphasize that this survey did not want to do anything more than to display the journal so as a camera obscura would do it, i.e. providing an objective

image and leaving all conclusions, implications, and argumentations for those interested in making objective decisions based on an objective image. For them I tried to let the facts speak for themselves …

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