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## Digital Publications beyond Digital Communication

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**Abstract:** Since more than twenty years different stakeholders involved in scholarly publishing have tried to fundamentally rethink the shape of publications in a digital environment. In contrast to these abundant activities with their highly experimental character the same stakeholders continuously regret that the dominant form of digital publications is still the PDF. In the research literature, the situation of digital publications is often compared with the era of the printing press. While this comparison might be helpful to create awareness about the dimension in which changes are taking place it certainly also blurs significant differences. In the situation that was described before it is even more important to identify the peculiarities of the process of change. Fortunately, the story of digital scholarly publications is long enough to tell it in a way in which these peculiarities become more transparent. The study at hand is an attempt to do so. At its end, it becomes clear that the major issue in digital publishing is not so much connected to the questions how publications look digitally but what we may perceive as a publication in a digital environment.

**Keywords:** digitale Publikationen, wissenschaftliches Publizieren, Multimodalität, Kommunikation, Technikgeschichte

digital publications, scholarly publishing, multimodality, communication, history of technology

# Digital Publications beyond Digital Communication

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## Abstract

Since more than twenty years different stakeholders involved in scholarly publishing have tried to fundamentally rethink the shape of publications in a digital environment. In contrast to these abundant activities with their highly experimental character the same stakeholders continuously regret that the dominant form of digital publications is still the PDF. In the research literature, the situation of digital publications is often compared with the era of the printing press. While this comparison might be helpful to create awareness about the dimension in which changes are taking place it certainly also blurs significant differences. In the situation that was described before it is even more important to identify the peculiarities of the process of change. Fortunately, the story of digital scholarly publications is long enough to tell it in a way in which these peculiarities become more transparent. The study at hand is an attempt to do so. At its end, it becomes clear that the major issue in digital publishing is not so much connected to the questions how publications look digitally but what we may perceive as a publication in a digital environment.

## Schlagwörter

digitale Publikationen, wissenschaftliches Publizieren, Multimodalität, Kommunikation, Technikgeschichte

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## 1 Why and How to Write a History of Digital Publishing

Digital Publishing or formerly Electronic Publishing is a field and a term which appeared without any delay at the same time as computers started to become part of everyday life and bigger network environments like the web established. Ever since then, researchers, libraries, publishers, academic institutions and political policy makers have put tremendous efforts into the design and implementation of new and innovative publication formats which were supposed to exploit the potentials of digital technologies and better serve the needs of researchers and other stakeholders. In contrast, there is a recurring evaluation within this field that complains about the lack of impact these initiatives have on the overall area of academic publishing as such. More recent approaches like Data Papers are perceived as mostly conservative and with regret people notice that the PDF is still the dominant form of publishing (Lord, Cockell, and Stevens 2012).

The tension behind these two observations can be re-phrased as an opposition between technology as a driver for creative thinking and experimentation on the one hand and technology as a nexus of social interaction on the other hand. The initiatives in digital publishing emphasize the potentials of these technologies and try to substantiate them in the domain of publishing. To do so, they work on the ground of explicit or implicit definitions about what digital technologies are and what publishing is. Recurring statements about the impact and acceptance of digital publications mirror the social realm. It is important to mention that the social as a theoretical theme needs to be stressed further than just the experience of obstacles for the implementation of digital publications within in a given time frame. As a theoretical idea the social realm stands for the acknowledgement that despite of any believes on necessity in progress and impact of technology there is an entanglement between this necessity and the way it unfolds within social interactions that does not permit us to productively carry out research on the ground of such an idea of necessity. The social is not just the reason why it needs time to implement things.<sup>1</sup> It is what remains contingent about what will be implemented in the future. This is the very idea about research areas like Social Construction of Technology (SCOT) (Bijker 2009) or Actor-Network-Theory (ANT).

However, in order to understand the interplay between technology and the social realm research can refer to history. In fact, research in the area of digital publishing is exactly doing this (Kircz 1998; Casati, Giunchiglia, and Marchese 2007; Roure 2010; Willinsky, Garnett, and Pan Wong 2012). A comparison which is often made analyzes the impact of digital technologies on publishing against the background of the impact of the printing press in the 15th century. Accordingly, the realization of the potentials of digital technologies as we may perceive today is basically a matter of time. Qualitatively, this analogy proposes another scientization in science. There are many peculiar reasons why this comparison can be challenged (Owen 2006).

Nonetheless, there is also a general one which might look trivial in the first place: printing technology is not digital technology or to put it in general terms: given that the history of the printing press reveals something about the development of digital technologies these insights unfold in minds that are still minds shaped by the printing press. In contrast to the way this argument is often used to

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<sup>1</sup>Such a viewpoint is intrinsic to expressions like the one of Cameron Neylon when he remarks that the scholarly monograph sector should adapt or just disappear (Neylon 2012). Since Neylon is convinced that the future is sorted out the resistance of certain stakeholders equates to different velocities in adopting the future.

favour technology-deterministically viewpoints (P. E. Bourne 2010) I suggest to interpret it differently. Accordingly, the real unthinkable does not refer to the way certain potentials of digital technologies might be realised. The actual unthinkable is the modification of digital technologies themselves provoked by the social realm which re-organize itself while digital technologies realize their potentials. This change is a second-order change. In this respect scepticism and euphoria are both expressions of the same mental framework and reactions to a given situation that is and can not be decided yet. Having this said, the analogy becomes also problematic for arguments about the dynamic in which digital technologies will become part of the social or more precisely shape the ecology of publishing.

The point might seem to be essentialist. However, it seems appropriate to get back to an essentialist position at a first place when strong claims are still made on the ground of this analogy. Furthermore, it encourages to look for new inspirations to understand and engage more sustainably in this process. In fact, it is not hard to get there. The argument, I want to make in the article at hand is that despite all pessimism there is already a comprehensive history of digital publication designs. Surprisingly, rare attempts have been made to analyse this history for the support of the field itself.<sup>2</sup>

Not only are these attempts rare in number they are also pessimistic about the implementation of the more innovative elements in digital publishing. These results resemble the frustration expressed by the implementers themselves which has been previously mentioned. Thus, these surveys are trapped within the same binary between a history that was never there and the future which will never be. This binary simplifies the issue of digital publishing to a controversial between innovative thinking and hype-thinking. In this constellation more subtle indicators which might offer insights about the prospect of hype and innovation for concrete ideas become hard to find.

In this situation an approach which evaluates the history of digital publishing for the sake of clarifying the state of publishing today instead of just referring to it strategically seems attractive. It promises to narrow down the scope from which discursive material is taken thereby reducing the influence of certain ideological dimensions of digital publishing. It enables to develop something like a low theory for digital publishing which proofs to be more productive for some issues today (Wark 2015).<sup>3</sup> Finally, such an approach permits to analyse different steps and implementations in digital publishing in relation with and as a result of an interplay with social dynamics. It makes it easier to not just look at the social realm as the resisting border to innovation. Instead, it unfolds this border as complex thing which has a lot to offer to make progress in the field of digital publishing.

## 2 The History of Digital Publication Designs

### 2.1 *The Beginning*

In this paper, the history of digital publications begins in the year 1995. This fact might be surprising at a first glance. For instance, (Owen 2006, 1) mentions that the very first electronically published journal

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<sup>2</sup>Exceptions are Peek and Pomerantz (1998), Owen (2006), Sierman, Schmidt, and Ludwig (2009) and Bardi and Manghi (2014)

<sup>3</sup>The adjective "low" does not refer the level of complexity but to the way it is embedded in practice

was published in the year 1987. The term “Electronic Publishing” exists even longer, not just as a term but as a term which labels the vibrant field of research in the eighties. However, there are good reasons to begin with the mid-nineties. Google’s Ngram indicates a decline of the term “Electronic Publishing” and a rise of the term “Digital Publishing” (“Ngram for Electronic Publishing and Digital Publishing” 2015) in exactly this period.

Google Ngram is not a good source to build an argument, yet it is an opportunity to start a line of arguments when there are also other indications. More precisely, 1995 was the year in which Denning and Rous published their well cited paper on “The ACM Electronic Publishing Plan” (Denning and Rous 1995). This paper is important not so much because of its number of citations but also because it calls for a radical rethinking about the extent to which digital technologies would impose changes to the area of publishing. Moreover, it demands from publishers to consider these changes by claiming that otherwise the publishing system would break down. The reason for this strong claim is the observation that all kinds of innovative publishing strategies have already taken place but on account of individuals, researchers and informal groups.

Electronic publishing was primarily about burning articles on CD-ROMs and putting print versions of articles online. No substantial changes were applied to the concept of publications. Neither did those digital copies make use of more advanced possibilities provided by the architecture of the web as was comprehensively evaluated by Hitchcock, Carr, and Hall (1996), Alsop, Tompsett, and Wisdom (1997) and Peek and Pomerantz (1998). In this sense Hitchcock describes the time before 1995 as “the calm before the storm”. Regardless of whether the time afterwards deserves this label, the term storm means a serious attempt to think publishing from the very beginning again. Having all this said, the shift between Electronic Publishing and Digital Publishing is the shift between the attempt to represent something under new conditions to a proactive attempt to let these new conditions modify the thing itself. For the reasons that were just outlined the year 1995 puts an appropriate temporal marker on this shift.

One of the most outstanding aspects of the ACM Publishing Plan besides being a turning point in the history of digital publishing, is the fact that it already indicates most innovations which were announced and tested afterwards even until today. Among them are more or less precisely articulated prognostics that:

- publications become like communication channels or streams,
- publications will be structured like databases,
- multiple versions of a paper will go along with something we would call Open Peer Review today,
- publications can be decomposed and re-packaged,
- multimedia-resources will play a crucial role; publications will live in “networked services”,
- and that Mark-Up will be important part of them. (Denning and Rous 1995, 100)

Although Peek and Pomerantz (1998) summarised that the “[...] future of the electronic scholarly journal remains unclear” (344) a first more organised attempt “to revolutionize the ‘Scientific Journal Publishing Technology’” (Singh, Chudoba, and Gopal 1998, sec. Recommendations) appeared under the term “Interactive Multimedia Journal” (IMMJ) (Singh, Chudoba, and Gopal 1998; Burg et al. 2000). As the

name suggests the two main points of these journals are the use of other media than text and the inclusion of interactive components like simulations. "Living Reviews" presented by Wheary et al. (1998) was first implementing the idea of publications as "Streams" which are continuously updated and thus do not reach a final state.

All these approaches had limited impact. They struggled with a technological environment that was still in its infancy and thus highly dynamic. XML which due to its compliance with web standards gave a significant push to innovations in publishing later on had just been adopted in 1998. Any form of interactivity relied on Java Applets as in the case of IMMJ. The struggle with technology led to a situation where most contributions remained in a state of proposal and the ones that did not did not last very long.

The next significant contribution to the field of digital publishing was the so called "Modular Article" (Kircz 1998; Harmsze 2000). The importance of the Modular Article has different facets. It was the first contribution which radically illustrated how a scientific article could look like when it is perceived as hypertext structure in itself. Reshaping text as hypertext was a popular issue in many research disciplines at that time (McGann 1994; Dicks and Mason 1998). However, emphasis was put on narrative and epistemological aspects.

In correspondence with positivistic ideas about meaning which treat information as atoms and representation as neurological brain patterns (Harmsze 2000, sec. 3; Kircz 1998, sec. 4) Kircz and Harmsze try to decompose articles into the smallest information units called modules. These modules albeit published and consumed independently from each other remain interlinked. For the first time in digital publishing the idea of typed links was consequently considered.

Finally, these ideas were implemented into a comprehensive model that was tested out in different experimental science disciplines. The Modular Article heavily anticipated ideas of Semantic Publishing before the project of the Semantic Web that engendered this concept was introduced. Variations and comparable approaches of the idea of modularity in publishing were presented by Darnton (1999), McAdams and Berger (2001), La Manna and Young (2002) and Weiten and Wozny (2002).

## **2.2 The Environment**

The first half of the millennium was less productive in terms of concrete proposals for innovative publication compared to the time before. Yet, it was a very important time in terms of infrastructure, meta-reflection and social organisation that completely changed the situation for new models in digital publishing afterwards.

In 2003 Nentwich carried out one of the first really comprehensive surveys on innovative digital publications (2003). The effort was picked up by Owen (2006) who carried out his own survey for the purpose of an investigation of the historical interdependency between technology and innovation. In the same way Meadows (2006) analyzed how innovative publication types were used and integrated within different disciplines. Apart from Nentwich who maintains an optimistic view about innovative approaches in publishing these evaluations share a pessimistic tone. Different ways of how technology

is integrated into society as well as in which technology becomes beneficial within different social environments are highlighted.

On the other hand certain scientific environments began to actively shape these changes. An important example of this process was the foundation of SPARC (Scholarly Publishing and Academic Resources Coalition). SPARC brings together different stakeholders from academic publishing for the purpose of increasing the autonomy of research libraries and academics from commercial publishers. The effort is closely connected to the Open Access movement which demands among others that publicly funded research output is publicly available. A stronger research driven derivative of Open Access appeared a few years later (Creative Commons 2005) called Open Science. Open Science extends Open Access in terms of considered resources like data (Open Knowledge Foundation 2010) and guidelines how to conduct science (Creative Commons 2005). The higher degree of social organisation around digital publishing is an important factor for a second wave in publication designs later on. Finally, this dynamic is also a consequence of the observation that not only publishing is changing but the way to conduct science as well (Borgman and Wallis 2007).

Limited success of digital publications due to the state of the technological environment has been highlighted before. This situation changed dramatically in the period currently described. Innovations in the technological infrastructure which affected publishing are observable in two areas:

- extensions which were made for the web architecture,
- first attempts to create a socio-technological infrastructure for digital publications.

In 2001 the creator of the WWW introduced a set of technologies for the publication of data in the same way HTML models the publication of documents (Berners-Lee, Hendler, and Lassila 2001). The Linked Open Data initiative which appeared later on (Berners-Lee 2009; Heath and Bizer 2011) adds guidelines and a set of social stimuli around this more technologically oriented beginning. Finally, the Open Archive Initiative defined a model on top of Semantic Web technologies which enables to identify sets of data and aggregations of resources within the Semantic Web called OAI-ORE (Lagoze and Van de Sompel 2007). Furthermore, relationships between elements in such aggregations can be described. The majority of next generation digital publishing efforts heavily rely on these developments. The other type of infrastructure developed concrete software that should facilitate the interaction between stakeholders connected to publishing workflows (Kennedy 2003; Sanchez, Morales, and Flores 2004).

### **2.3 The Outburst**

By virtue of an environment that changed fundamentally to support new implementations of innovative publications a significant boost in projects which do so can be observed starting from 2007 onwards. This boost engendered concepts like the Open Laboratory Book, Semantic Publishing, Research Objects, Enhanced Publications, Nano-Publications, Multimodal Publications and many more, which will be described in greater detail in the next paragraphs.

In 2008 Elsevier launched the "Article 2.0" contest (Elsevier 2008) a predecessor of the "Article of the Future" contest ("Article of the Future" 2011). With this initiative Elsevier wanted to create "a competition

challenging individuals to develop creative and useful solutions for rendering journal articles on the web". In fact, it is a striking feature of this period that individual researchers do appear on the scene as creators and promoters of digital publication concepts.

A good example for this development is the Open Laboratory Book (hereinafter OLB). In OLBs researchers in chemistry and biosciences try to move "Scholarly Blogging" as a new type of publishing (Puschmann and Mahrt 2012) to a next level (Bradley 2007). Laboratory Books are notebooks which researchers use to document their research process and the execution of experiments. The digital version of these notebooks should enable to publish any kind of data and resource from the research process and to move to a form of publishing which constitutes a live stream to research (Neylon 2009). Both goals link to an openly expressed critique of historical publishing in which the research process is synthesized at the end and which does not hold primary resources (Bradley et al. 2010). The whole project is closely connected to the Open Science movement and adopts its ethos of transparency and reproducibility. At the same time it anticipates a struggle which is called "Publishing Without Publishers" later on (Kuhn et al. 2014).

Obviously, many publishers do not share this interest which would undermine their business models. Clearly, digital publications challenge the traditional relationship between stakeholders. Therefore prize-winning contributions at the Article 2.0 contest do not challenge the article as the gravity zone of scholarly publishing. Another approach which does the same and which is one of the most successful and widely discussed approaches is the Semantic Publishing (hereinafter SP). Introduced by (D. Shotton et al. 2009) a Semantic Publication is very similar to a Modular Article but heavily influenced by the benefits provided by the Semantic Web architecture.

Semantic Publications are publications in which any entity and resource is formally annotated by markup which makes use of formal semantics and authority files. Additionally Semantic Publishing tries to formalize the discursive (rhetorical and logical) structure of articles. By doing so the whole research process as reproduced as a formal meta-text from within the article. The unit of an article remains an un-replaceable unit for scholarly communication (D. Shotton et al. 2009).

The main concern of the Semantic Publishing initiative is the provision of ontologies which provide the formal semantics that are in demand. Examples include CiTO an ontology to model the function of citations or FABIO, an ontology for bibliographic elements (David Shotton and Peroni 2012).

Ruiz-Iniesta and Corcho (2014) stress that the number of ontologies grew significantly in the same way Semantic Publishing became an important factor in publishing. There is an important discussion going on if the effort that is needed to annotate articles in the way Semantic Publishing demands is reasonable or not (Giunchiglia et al. 2010). Obviously, automation are a means that is frequently proposed to limit the effort. Nevertheless, the "tacit knowledge" (D. Shotton et al. 2009) of the authors remains a source of knowledge that seems un-replaceable even in the eyes of Semantic Publishing advocates.

SP decomposes articles which remain stable units of publishing. They markup smaller units within the article which thereby can be processed independently. Scientific Publication Packages (hereinafter SPPs) and later Research Objects (hereinafter ROs) choose the opposite approach. Both publication types aim at aggregations of resources from an entire research process. The core of an aggregation is the structure of so called workflows. A workflow resembles an idealised version of an experiment. When the workflow is carried out specific resources are used, tasks are executed and probably new resources

are produced. The RO gathers all these resources and provides a description of their dependencies within the research process. Articles may but do not need to be part of ROs.

Correspondingly, ROs are technically not more than a description of relevant resources and dependencies. In their pure form they do not include content but only links to content. This approach suffices because ROs are designed for the Linked Open Data (hereinafter LOD). Linked Open Data is an attempt to realize a web of data in the same way as HTML and the WWW created a web of documents. Thus, to use a data resource it is enough to just include the URI (a link) to a resource which then can be accessed by dereference the link.

Research Objects consider experiments the general model for research because they are part of an overarching program which is known as e-science. E-science emphasizes the crucial role of computation in science today by arguing that "every aspect of it is touched by computation" (P. E. Bourne 2010, 1). Phrases like "The End of Theory" and "The Fourth Paradigm" shall suggest that computation does not only enriches scientific methodology but also replaces historical methodologies. Accordingly, science today is dominated by inductive research strategies and results that are correlative in nature. Consequently, the experiment model which is represented in computational workflows meets the requirements for both bioinformatics or musicology (De Roure 2014) in the same way. Furthermore, it allows automation which in terms of e-science is the only way to adequately deal with the amount of data that is produced today.

Both SP and ROs besides any differences stick to the idea that publications should become databases like Bourne proclaimed in 2005 (P. Bourne 2005). While SP focus on the serialization of articles as databases - so that their content can be used as data - ROs are hardly more than just data about content. Technically, these two approaches resemble the use of RDFa for SPs and OAI-ORE for ROs. However, both approaches promote computational access to publications. Multimodal Publications carry out a completely different point of view.

The term Multimodal Publications (hereinafter MP) is introduced by the research presented in this paper and has not been used before. Instead, Multimedia Publication is a more common label. However, this label does not describe well its main goal. The use of different media with equal rights is part of nearly all digital publication designs. Multimodal Publications like the ones presented by Sophie ("Sophie" 2011) and later Scalar (Alliance for Networking Visual Culture 2015) do not only intensively use different media types within publications. Their goal is to use different media to produce more comprehensive meanings. The assumption is that each media is capable to express its own type of meaning which can never be completely translated to other media. Thus, any kind of media has its own right and there is no hierarchical relationship in communication between them.

The original field of research in which this idea was first outlined is Multimodal Analysis. Consequently, the term seems appropriate to make a distinction to multimedia which uses different media without specifically trying to explore multiple ways of meaning making and their interplay. There are less complex version of this approach projects like the DH Journal ("Journal of Digital Humanities," n.d.) which do not publish multimodal articles but videos and other media as publications in their own right.

It was indicated previously, how different publication designs like SP and RO adopt the metaphor of publications as databases. The difference consists in the target to which the metaphor is applied. A third interpretation exists. Semantic Publishing decompose publications into smaller pieces like claims in

the case of SWAN. Research Objects try to aggregate all resources into a publication that represents the research process. However, no approach envisioned a publication out of a single statement before - or to stay with the metaphor, a single piece of data. This is the approach which is taken by Nano-Publications (Mons and Velterop 2009).

Nano-Publications are defined as claims formalized into RDF triples. These triples are identical to scientific assertions about a concept. The concept is taken from sources which provide canonical names for entities that are important in a peculiar research domain like the concept wiki ("ConceptWiki" 2016). To the end of becoming a publication assertions include attribution and provenance data (Kuhn et al. 2013, 1).

Finally any evidence in terms of data sources that support a claim is referenced as a link. Thus, "Nano-Publications that are rich semantic triples are in essence references" (Mons and Velterop 2009) to data. Nano-Publications renounce any use of narrative and reject the need for it in the context of data publication and claim making. However, uncertainty about this issue reappears in a discussion about the possibility to also allow free text assertions instead of formal RDF triples (Kuhn et al. 2013, 1). On the other hand this problem is secondary to the goals of Nano-Publications. These are the reduction of alleged ambiguity and redundancy in publications (J. Velterop 2010) for the purpose of more efficient and accelerated research (Thompson and Schultes 2012).

There are many other digital publication designs which can not be described in detail. Some will be quickly outlined in the next paragraph to the end to illustrate the wealth of ongoing approaches. Accordingly, Enhanced Publications is a term introduced by the DRIVER project which tried to develop an integrative approach for the first time (Sierman, Schmidt, and Ludwig 2009). It was strongly connected to the repository domain and focused on questions of infrastructure and tools for the support digital publications.

Liquid Publications are publications that try to install principles of software development to publications (Casati, Giunchiglia, and Marchese 2007). Liquid Publications, as the name suggests, put strong emphasis on the open and version oriented nature of software projects. Curiously, this approach has a lot in common with new publication designs in the Humanities which are intended to contrast with publication designs that are based in e-science. Among these are Liquid or Living Books (G. Hall 2011) which are published in the Open Humanities Press. A variation of Research Objects could be found in publications which make use of emulation technology. Projects like Paper Maché depict publications as repositories which are executable in an emulated environment. This assures that every resource exists and is processed in the same way as the creator has intended it (Brammer et al. 2011).

## **2.4 The Conciliation**

In the last two years many activities on digital publications slowed down significantly. Highly funded projects like DRIVER or workflow4ever finished. Projects which are still operational focus on social and infrastructure issues and are less ambitious in terms of new publication designs. Accordingly the OpenAIRE project, a follow-up of the DRIVER project (Manghi et al. 2012) has launched zenodo.org which is a repository solution for the publication of different type of resources.

This does not mean digital publishing stagnates. There are quiet successful examples. Last year the Open Library of Humanities was initiated which combines new funding and dissemination strategies with XML based publishing at great scale in the Humanities (Open Library of Humanities 2015). The OpenEdition project created a pan-European network for Open Access publishing (OpenEdition 2015).

However, there is also a new type of publication which became significantly successful in these years. Data Papers are an approach to support the publication of datasets as first class citizens besides other approaches like Linked Open Data or Nano Publications (Chavan and Penev 2011). The simple idea behind Data Papers is that a common research article describes the background, structure and other information about a dataset that is published separately in a trustful environment. The paper is then linked formally to this dataset.

In contrast to many approaches that have been described before “data journals are now an established phenomenon” (Candela et al. 2015). Candela et al. list 116 data journals published by 15 publishers. Yet, the authors of the aforementioned Liquid Publication project before criticize Data Papers heavily. They reject the heterogeneity of the concept of data papers and the lack of clear guidelines. Furthermore, they complain about missing standards that support more efficient processing of data papers. In consequence, they classify them as belonging to “slow communication”.

### 3 Different Levels of Developments

The brief history of designs for digital publications was indeed a history in the first place. The dominant theme in which the content was organized was sequence and causalities. In such a way emphasis was put on the role of technological innovations at the beginning of the millennium for the vibrant and explorative period afterwards. Correspondingly, the meaning of data papers as a reaction to this period was addressed. To the end of making fully use of an independent history of digital publications a higher level of systematization is necessary. The question remains “Where is digital publishing going?” and “What support does digital publishing require”.

Although, not all digital publications have been presented the number of examples and the variety of approaches are significant. Accordingly, both questions depend on another preceding question: Which aspects of digital publications are dominant or stable.

The present paper suggests to organize activities around innovation of publishing objects into three groups. These groups are *projects*, *concepts* and *ideas*.

The project layer is the most granular layer in which digital publishing efforts can be analyzed. It includes activities which are organised with limited fundings and a clearly expressed goal. The present research considered only projects which posit the task to design new types of publications in the center of the project goal. Good examples for the project layer include *Scientific Publication Packages* or *Liquid Publications*. Both types of publications were designed and implemented in the project context. However, no other project reused this term or the model to explicitly develop this publication type any further.

However, this is not necessarily always the case. Most often, *concepts* glue together projects. In many circumstances a project introduces a certain publication model which is then picked up and further developed in other projects later on. It is common that these projects are carried out by mostly the same actors as the original projects but this is not always the case. For instance, the *myExperiment* project introduced the workflow *package* as a publication. In 2010 the package publication type was extended and generalised into so called *Research Objects* in a bigger project called *workflow4ever* which was funded by the European Union. In this project a variety of initiatives contributed.

There are derivatives like *Social Scientific Objects* which are closely connected. Nevertheless, these derivatives just highlight certain aspects of the general concept and are more or less described by the same actors. A similar link exists between *Enhanced Publications* and *Rich Internet Publications*. It is also possible that in the light of a concept like Research Objects that takes shape over time a former independently developed publication type may appear as part of this concept. In this respect Bechhofer et al. (2014) states that there is no general difference between Scientific Publication Packages and Research Objects.

Having all this said, the layer of concept in comparison to the layer of projects permits to analyse how specific publication types evolve and change across projects. Furthermore, this distinction enables to gather contributions and reviews of different actors and actor groups to a publication type. In the majority of cases a concept is identified by a name which was given to it by a project which introduced this concept. However, there are cases like *Open Notebook Science* or *Nano Publications* which do not directly root in a project but which were more or less efforts of a community or individuals that contributed to these ideas under a shared label. Finally, the concept of *Multimodal Publications* was never used by any project. It is an invention of the research presented in the study at hand which was necessary because some projects like *Scalar* and *Sophie* shared a unique set of ideas about publishing without explicitly referring to an overarching concept.

Publishing *ideas* are the most abstract layer which is still grounded in concrete activities. Ideas are synthetic units of analysis which means that in most cases they are derived from analysis of projects and concepts. For instance, the idea that publications should be open for ongoing changes is promoted by otherwise completely different publication concepts like Living Books, Liquid Publications or the Open Laboratory Books.

Resembling the different background, each concept accordingly promotes other ideas that are not shared by the others. For instance, Liquid Publications also support the idea of executable publications. In these publications computational parts can be executed may it be an experiment or simulation. The Living Book does not make use of this idea. Instead, it instantiates the idea of multimodality in digital publications up to a certain extent. Thus, publishing concepts most often aggregate several publishing ideas. Yet, the consideration of one idea does not categorically include others.

Publishing concepts represent publishing ideas which become an independent unit of analysis in the way they are comparable across publishing concepts. By doing so they enable to cluster the wealth of digital publishing activities and beyond that to analyse the dynamic of ideas for a self-contained history of digital publishing.

Which of these viewpoints provide the most useful insights to improve and stabilize digital publishing? There is not enough space in this article to give a complete answer to this question. Nevertheless, it is certainly possible to derive some insights from what has been done so far.

Obviously, the project lens is not suitable for this task. Projects are not only short term but also highly context dependent. They are also part of a political economy of research funding which encourages to overemphasize minimal distinctions.<sup>4</sup> One idea would be to refer to ideas since ideas do have the highest level of abstraction and enable to find correspondences between otherwise heterogeneous activities. Although, the level of ideas is without doubt the most insightful it is not well suited to guide a sustainable development of digital publishing. The reason is exactly its level of abstraction beyond technical implementation and social embedding.

For instance, semantization of publications — annotations to content of publications by using formal semantics — was mentioned both in the context of Semantic Publishing as well as Research Objects. However, the underlying content and publication concept is completely different. This difference results in different adaptations of the idea of formal semantics and in different semantics. Furthermore, it lead to the tension between RDFa and standoff markup.

Hence, it is the lens of concepts informed by an analysis of publishing ideas which indicates the area where more effort should be applied to. It seems that there is no big difference to what is going on now but yet there is. Until today projects were not only means to establish concepts but concepts were also treated as means to realize ideas on a global level. This lead to untenable claims. The debate of the end of theory which is used by De Roure to argue that future publications represent the idea of computation is a good example for this issue. Undoubtedly, computation is a crucial aspect in many publications today but this means nothing for there are many appropriations of computation which lead to completely different publications. The critique on data papers by Candela address the same problem. Instead of appreciating data papers as a successful implementation of data publication it is attacked by implicitly referring to the idea of publications as a database. To put it in other words, the idea of databases as metaphors for publications does not accept anything that looks different than data itself.

The lesson that could be learned from a history of digital publications is that there is a heterogeneous field of approaches to publishing and that this heterogeneity is a necessary outcome of the liberties digital technologies provide. To accept this situation by appreciating the social dimension would than mean to concentrate on a set of profiled publishing concepts instead of emphasizing the many ways in which they fall behind their ideas. Furthermore, it would mean to stop promoting one concept against the other in the spirit of true innovation. Nonetheless “profiled” means to work with a clear idea of all the publishing ideas that do exist in digital publishing.

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<sup>4</sup>An example for the first issue is the relationship between Scientific Publication Packages and Research Objects. Scientific Social Objects and Rich Internet Publications are examples for the second issue

## 4 Outlook: Beyond Scholarly Communication

The last remark addresses the second possible outcome of the brief history of digital publication designs at hand. More heterogeneity in the landscape of publishing is a fact but which level of heterogeneity reasonably matches the concept lens and what lies beyond. To put it more clearly, which degree of heterogeneity in digital publishing is necessary?

One term was not comprehensively discussed until now: communication. There is not one author that was used in this paper who does not frame her or his activity in the umbrella concept of scholarly communication. As Kircz put it: Communication is “the Essence of Science” (Kircz 2001, 266). In contrast to the abundant use of the term communication in the context of digital publishing there is no substantial analysis of what publishing is in terms of communication. The authors just equate it to communication. Distinctions could be quantitative or qualitative. Quantitative distinctions could arise from an archival perspective in which not everything but selected content is stored. In this sense the publication would be a fraction of communication. Yet, digital publications like Research Objects or Open Notebooks aim at incorporating literally everything into a publication. Additionally, advocates in the context of Open Science put a strong ethical obligation to publish everything because “one person’s trash is another person’s treasure” (P. E. Bourne 2010, 2).

Likewise, there is no qualitative distinction. Not only did the overview show publication designs which communicate in any media type from from event-oriented publications (RO) over narrative publications (SP) to visual communications – videos in the Journal of Digital Humanities and elsewhere – to multi-modal communication in Scalar. There is also a representation for each communicative strategy to create truth. The formal approach of the Semantic Web corresponds with Logicism, Open Notebooks and workflow oriented approaches address empiricism and finally projects like Living Books and again Scalar resemble elements of culturalism. A comparison between Nano-Publication (one claim), Semantic Publications (a story) and Research Objects (the whole research process) reveals that digital publication also aim at any possible unit of communication.<sup>5</sup>

Hence, digital publishing in fact is digital communication in the sense that it evaluates any possible option to communicate by digital technologies. It is the main claim of this paper that this is exactly the source of the frustration that was outlined in the introduction. Additionally, the history of digital publications demonstrates that the conflation between publishing and communication is a driving force behind the proliferation of digital publication designs. This proliferation is often perceived as one of the core problems behind the lack of sustainability of digital publication designs (Adriaansen and Hooft 2010).

In the light of the line of arguments at the beginning of this text as well as informed by the short discussion which has just been carried out the following definition for publications is proposed: publishing is a socially and structurally higher organized form of communication. There is no realm of publishing as such but it unfolds from communication under the conditions of logics and resources in communication at a certain point of time. However, the process of unfolding and the difference between both aspects is a necessity insofar communication is social activity and different communication needs exist.

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<sup>5</sup>A less known approach called Micro-Publication exists too. (Clark, Ciccarese, and Goble 2014)

Candela et al. (2015) criticizes data papers as “slow communication”. Misusing the phrase, it is possible to say that publishing is always in a certain way needs to be slow communication qua definition. However digital technologies have made it difficult to impose distinctions between the two which are not just of theoretical nature. Nevertheless, this is the task that lies ahead if a more viable academic publishing ecology is what is wanted.

## 5 Abbreviations

**ANT** Actor-Network-Theory

**IMMJ** Interactive Multimedia Journal

**LOD** Linked Open Data

**MP** Multimodal Publications

**OAI-ORE** Open Archive Initiative. Object Reuse and Exchange

**OLB** Open Laboratory Books

**RO** Research Objects

**SCOT** Social Construction of Technology

**SP** Semantic Publishing

**SPARC** Scholarly Publishing and Academic Resources Coalition

**SPP** Scientific Publication Packages

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