Preprints 2022 der Zeitschrift *BIBLIOTHEK – Forschung und Praxis*, BFP.2022.0011
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Library Technology – Between Local Tools and Global Solutions

Abstract: Digital information infrastructures such as Google or Wikipedia are often compared to libraries. As traditional libraries, they support the circulation of knowledge resources. However, they are neither operated by nor designed for library institutions. In order to describe the contribution of libraries to the digital infrastructures of the 21st century more precisely, the term Library Technology is applied in this text. Library Technology will be demarcated from terms such as Digital Libraries, a frequently used concept in Computer Science and colloquial language. The focus lies on present and future developments of infrastructures in science, such as the European Science Cloud (EOSC). It is suggested that the original contribution of libraries to current and future data infrastructure is present but not explicitly visible or referenced in communications. This rather hidden, implicit role is interpreted to be detrimental to the library identity in the 21st century. It is recommended to reference the role of the library more explicitly.

Keywords: Library technology, knowledge infrastructure, information infrastructure, data infrastructure, Digital Libraries, European Open Science Cloud (EOSC)

Bibliothekstechnologie – Zwischen lokalen Werkzeugen und globalen Lösungen

Zusammenfassung: Digitale Informationsinfrastrukturen wie Google oder Wikipedia werden oft mit Bibliotheken verglichen. Wie traditionelle Bibliotheken unterstützen sie die Zirkulation von Wissensressourcen. Sie werden jedoch weder von bibliothekarischen Einrichtungen betrieben noch sind sie für diese konzipiert. Um den Beitrag von Bibliotheken zu den digitalen Infrastrukturen des 21. Jahrhunderts genauer zu beschreiben, wird in diesem Text der Begriff Bibliothekstechnologie verwendet. Bibliothekstechnologie von Begriffen wie „Digital Libraries“, einem häufig verwendeten Begriff in der Informatik und der Umgangssprache, abgegrenzt. Der Fokus liegt auf aktuellen und zukünftigen Entwicklungen von Dateninfrastrukturen im Wissenschaftsbereich, wie beispielsweise der European Science Cloud (EOSC). Der ursprüngliche Beitrag von Bibliotheken zur gegenwärtigen und zukünftigen Dateninfrastruktur ist präsent, aber in der Kommunikation nicht explizit sichtbar. Diese eher versteckte, implizite Rolle ist der Bibliotheksidentität im 21. Jahrhundert abträglich. Es wird empfohlen, expliziter auf die Rolle der Bibliothek hinzuweisen.

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Schlüsselwörter: Bibliothekstechnologie, Informationsinfrastruktur, European Open Science Cloud

Library Technology is a concept with diverse meanings.[1] It might be associated with online catalogues, digital images or scanners used to produce them, with RFID (radio-frequency identification), with long-term-archiving or linked-open-data. Library Technology is related to Digital Libraries. However, it is to be differentiated. Digital Libraries is a term frequently used in Computer Science[2] and thus misleading to what could be understood as Library Technology. Closer to Library Technology is the connotation of cultural heritage materials in Digital Libraries (Crane and Wulfman 2003). There are librarians who engage in the field of Digital Libraries, and computer scientists employed in libraries. Thus, there is an entanglement between Digital Libraries and Library Technology. However, Library Technology can more precisely be characterized as technology that is utilized to operate a library as an institution which has a physical presence. There are forms of generic technology that is applied in libraries, say RFID, that has not been developed specifically for or by libraries. These technologies can be characterized as *circumstantial* Library Technology. And then, there are technologies that are specifically customized for libraries and can be characterized as *genuine* Library Technology. Examples of genuine Library Technology would be catalogues and library management systems (Peterson 1995), institutional repositories (Lynch 2003), protocols such as Z39.50 (Lynch 1991, 50) or OAI-PMH (Sompel et al. 2004), imaging workflow systems (Hankiewicz 2016), or developments of library metadata systems, content hosting and archiving systems.

1 Genuine Library Technology

The focus of this text is on *genuine* library technology. In a functional sense, genuine Library Technology is essential and uniquely purposed to fulfill the mission of a library as an institution (see Table 1 for a differentiation). A library's mission is, in this text, pragmatically defined as a permanent system of people, physical spaces, materials and virtual applications that enhances the circulation of knowledge resources.

Table 1: Examples of library technology according to the characteristics defined in the text.

	Enhances circulation of	Operated by a library Institution	Designed for use in a	Type of Library Technology

[1] Buckland (2017).
[2] Adam et al. (1996).

	knowledge resources		Library institution	
RFID	Yes	Yes	No	circumstantial
Scanner	Yes	Yes	No	circumstantial
Catalogue (OPAC)	Yes	Yes	Yes	genuine
Institutional Repository	Yes	Yes	Yes	genuine
Digital Library of the Middle East	Yes	Yes	Yes	genuine
Digital Library of Game Boy	Yes	No	No	none
Wikipedia / Google	Yes	No	No	none

2 Information Infrastructure

Information infrastructure is a concept that is more commonly used than Library Technology. The Council for Information Infrastructures in Germany defines it as “technically and organizationally networked services and facilities for accessing and maintaining databases, information bases, and knowledge bases” (Rat für Informationsinfrastrukturen 2016). This definition implies that Information Infrastructure is genuinely digital and, thus, it represnts a narrow sense of Information Infrastructure, similar to the term ‘e-infrastructure’ (Andronico et al. 2011) or ‘cyberinfrastructure’ (Hey and Trefethen 2005). With respect to libraries, the connotation to the digital is a relevant aspect, since libraries are also physical infrastructures with physical information resources. A wider definition would be agnostic to the form of representation (digital vs. analogue) and is more useful in this text: “Information Infrastructure refers to the overall system of information resources worldwide that comprises digital and analogue materials, buildings and technological devices, people and software, organizations and processes” (own definition).

This wider definition of Information Infrastructures and the presented concept of genuine Library Technology define the scope of this text. The question is: “What is the role of technology operated by and designed for libraries in the overall system of information resources worldwide?”

3 The Knowledge Pyramid

It should become clear at this point that a precise analysis of the scope of this text is required to adress the question appropriately. Further differentiations, demarcations and qualifications need to be given. One differentiation is between ‘information’, ‘data’ and ‘knowledge’. The so-called “knowledge pyramid” is an often described approach to show the relation between data, information and knowledge and further uses the term ‘wisdom’ (Frické 2009). There have been many analyses and critiques, which shall not be reviewed. It is somewhat intuitive that going up the pyramid – from data as a basis of the pyramid, to information , to knowledge and peaking in wisdom – implies to increasingly find more ‘meaning’ in the pyramid. Data units entail less meaning for humans or computers than information units, and information units less than knowledge units. While this notion of ‘meaning’ might be intuitive, it will only be used in this text as a simple explanatory proxy for a more complicated issue about semantics.

This text deals with infrastructure. To allocate ‘meaning’ to different types of infrastructure is not straightforward. Data infrastructures and information infrastructures are common terms and the units of data and information in the infrastructure, having more or less ‘meaning’ is intuitive. Knowledge infrastructure is also an established term (Borgman 2017) but represents a boundary case. Knowledge infrastructure implies that the representations processed in the infrastructure are *designed for* creating knowledge – knowledge itself can however hardly be conceived as being the unit *in* the infrastructure. Wisdom infrastructure is not a frequently used term. When it comes to infrastructure, there is a dissociation in the knowledge pyramid between ‘data’ and ‘information’ on the one hand where the units in the infrastructure can be conceived as constitutive for the infrastructure, while, on the other hand, ‘knowledge’ and ‘wisdom’ are not constitutive for the infrastructure but the infrastructure is constitutive for knowledge and wisdom.

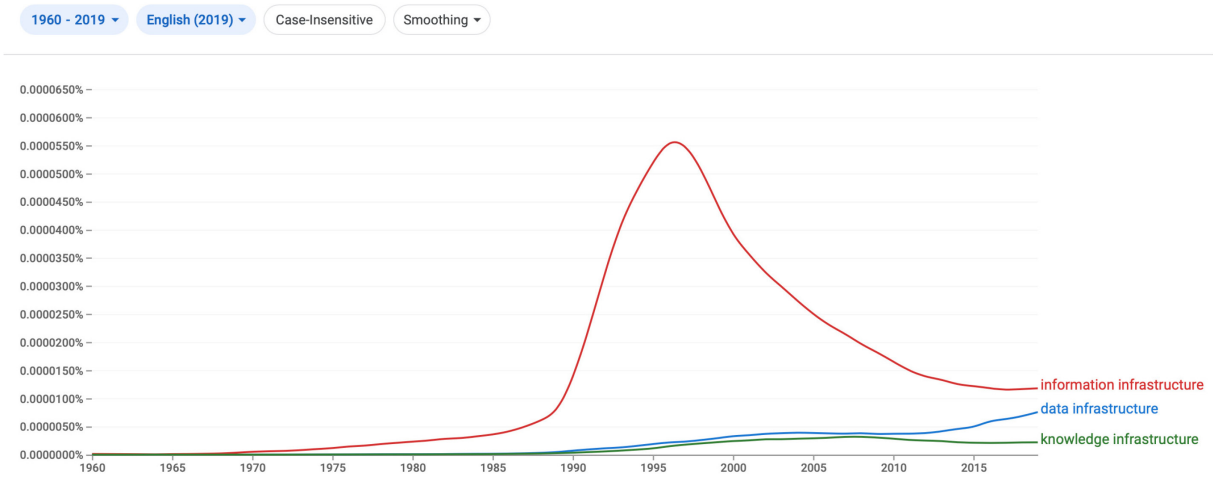

Fig. 1: Frequency of three types of infrastructure terms over time in NGRAM

4 More or less 'meaningful' infrastructures

The frequencies of the three infrastructure terms as represented in the Google NGRAM Viewer (see Fig. 1, https://books.google.com/ngrams, 28. March 2022) show a pattern: "Information infrastructure" had its rise during the development of the internet while its use decreased over time. "Knowledge infrastructure" became more frequently used between 1995 and 2010 when the use of "information infrastructure" decreased, suggesting a trend towards an infrastructure with more 'meaningful' units. In recent years, the term "data infrastructure" became more frequently used, trending towards a similar usage frequency as "information infrastructure". Applying recent trends to the knowledge pyramid, could suggest a transition from more 'meaningful' units to less 'meaningful' units represented in the infrastructures. If that was true, what implications does it have for the future of more 'meaningful' units such as 'knowledge'? Does the rise of data infrastructure as a concept imply that more 'meaningful', contextualized resources become less relevant or even obsolete over time? Since the character of libraries can be associated with 'knowledge', do libraries need to engage increasingly in data infrastructures to remain relevant? What is the form of technology needed in data infrastructures? Library catalogues do not seem apt as an organization system for data. Will cataloguing, in terms of metadata production, be relevant for data infrastructures? Is long-term preservation of data a genuine library task?

5 Data, Information or Knowledge Society

It seems not clear to which infrastructure (or which part of the knowledge pyramid) Library Technology should be applied. The societal dimension is also relevant for Library Technology. It is the library's mission that defines Library Technology (see above) and the mission of a library has a

societal dimension in terms of making resources widely accessible and guarantee their availability as cultural heritage. The seemingly technical question about the role of Library Technology in Information Infrastructure can take the form of a rather complex question about the role of libraries in information society. “Information society” or “knowledge society” are familiar terms. But what about “data society”? The corresponding NGRAM suggests that “data society” is not a frequently used term (see Fig. 2). Additionally, “knowledge society” and “information society” are in reversed order as compared to the original knowledge pyramid, which might be explained by the overall dominance of the term ‘information’, when it comes to infrastructural and technological usages. Striking, however, is that “data infrastructure” is a more frequently used term trending upwards, but “data society” is not. ‘Knowledge’ and ‘information’ can be found combined with both ‘infrastructure’ and ‘society’. Does this imply that ‘data’ are not constitutive for society? Is it a possible role of Library Technology to bridge between society and data? Of course, these thoughts are speculative and the method of considering NGRAMs has limitations (e.g. that the corpus is Google-Books) but it is an interesting observation to be returned to (see below).

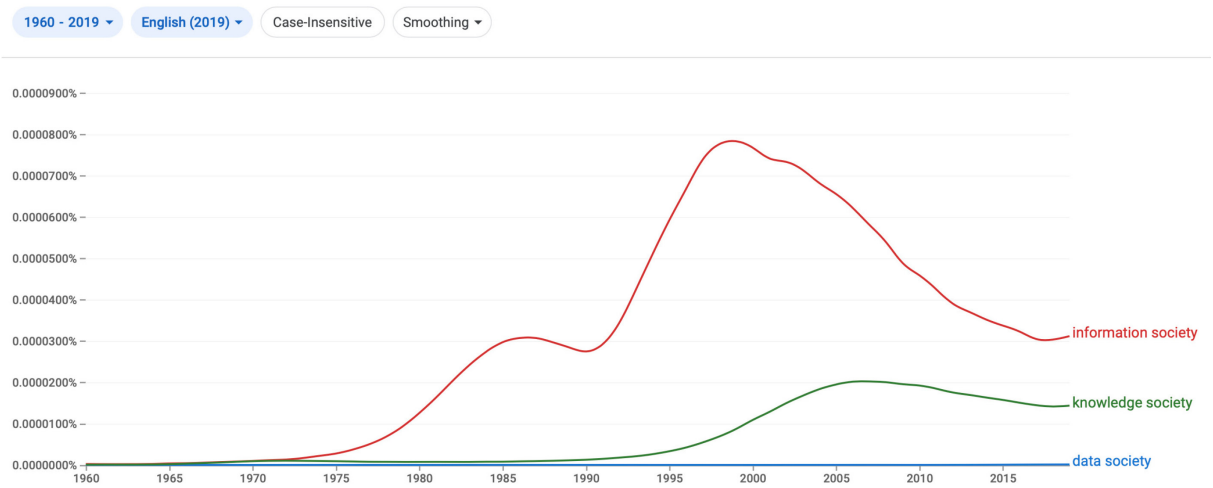

Fig. 2: Frequency of three types of society terms over time in NGRAM

6 EOSC as an exemplar of infrastructure

After rather abstract terminological exercises, the questions about the role of Library Technology shall be analyzed with respect to concrete, current and future infrastructures. What the future form of infrastructures will be, is not entirely predictable. In order to find an exemplar for current and future infrastructures, areas in which the demand for innovation is high, might serve as good starting points. Science is an area, in which the requirements for innovation are high, and the future development of infrastructures is ongoing. And science can provide an adequate background for analyzing the role of library technologies. The European Open Science Cloud (EOSC) shall, thus, be

taken as an example. EOSC is a current, large-scale development funded by the European Commission (Budroni, Claude-Burgelman, and Schouppe 2019) with a dedicated legal entity to govern its development and operations. EOSC provides, among other things, a 'marketplace' (https://marketplace.eosc-portal.eu). The portfolio of services on this marketplace can be used for the purpose of analyzing contributions of genuine library technology to infrastructures for data, information or knowledge.

To make this analysis more specific, four exemplars of genuine Library Technology – catalogues, imaging, repositories and long-term preservation – will be briefly presented and discussed with respect to their different dimensions, i.e. the technological, functional and societal dimensions. The exemplars derive from the traditional service portfolio of the library, related to books and other physical materials to elucidate the possible *genuine* library contributions. After each introduction of an exemplar of Library Technology, it will be analyzed whether they can be found in the EOSC marketplace and discussed what role they play.

7 Catalogues

Catalogues are probably the most iconic tool in libraries. They transformed from being a physical device to being library technology in the 70s and 80s of the 20th century, when Online Public Access Catalogues were introduced (see e.g. Borgman 1977). Opposed to the rather conservative image that libraries are associated with, OPACs are early examples of enterprise systems, often established before other enterprise systems (e.g. for finance or facilities) have been introduced in larger organizations. Being operated on mainframes since the 1970s, library catalogues can even be seen as early supercomputing applications. The further development of OPACs led to the addition of further functionality such as acquisition or circulation of books and other core library functions, yielding a so-called (integrated) Library Management System that represents a comprehensive system of organizational automation. The virtualization of computing technology allowed to outsource the operations of LMS to external service providers or even become entirely cloud-based. Currently, most libraries are in the process of or have finished to migrate to cloud-based solutions (see e.g. Singley and Natches 2017). A search on the EOSC marketplace[3] for the term 'catalog' yields 11 out of 294 results (28 March 2022), none of them being a genuine library catalogue. The majority represent a catalogue of services rather than data, information or knowledge resources, two represent software for producing catalogues of data, one for exposing metadata. Of course, it is obvious that library catalogues are services that are localized – they refer to localized physical resources such as

journals or books – and therefore do not lend themselves immediately to become a resource in a virtualized, international infrastructure. However, the question remains, why essential resources for performing science that are available in highly developed infrastructures are not present in an infrastructure that is dedicated to perform science? A closer look in the EOSC marketplace reveals that resources that are represented in libraries can be found in EOSC. The search term 'literature' yields one result for a service that links research data to literature. And the search term 'knowledge', which can be supposed to be closer associated with the mission of libraries (see above) then shows several services for knowledge graphs that could be seen as an alternative version to a catalogue. Given that bibliographic records increasingly are used as generic metadata, the search term 'metadata' yields 25 results that resemble certain functions of a Library Technology. Thus, technology that is used in libraries is well represented in EOSC, however, it is not genuine Library Technology that is represented. There is hardly any explicit representation of the library role in EOSC.

8 Imaging

Producing digital images from physical library materials such as books and manuscripts are a widespread and large-scale activity in libraries. Well before Google-Books started mass digitization, libraries offered their holdings, specifically the rare and precious collections, as digital images. These services are often called "Digital Libraries" and are often confused with the concept of digital libraries in computer science, which represent more generic information management systems (see above). There is no comprehensive global search engine for digitized images from library holdings. But Europeana – interestingly a search engine for rather cultural non-science contexts – can serve as an example (Petras et al. 2017). Europeana contains 28.742.462 records of images from libraries (28 March 2022). The technology behind these digital images is partly generic, such as is the case with photographic and scanning devices. Parts of the technology, such as the workflow software, is genuine library technology (see above). The workflow of retrieving material in a given library, assessing conservation status, adding metadata and integrating it into an internet-based service is customized to the specific needs of libraries and, maybe, other memory institutions. A search for 'image' in EOSC yields 37 services (28 March 2022). Again, most of the results are not library related, or only remotely, for example generic systems that could only potentially be applied. One result is at least a data resource from the social sciences.

9 Repositories

Integrating digital images into a system that provides a coherent collection for public use (a "Digital Library" in a library institution, see above), requires a specific technology. The term "institutional

repository" (see above) demarcates this library technology from a more generic use of a repository, for example a software repository in generic digital engineering. Institutional repositories derive from software for digital images, electronic thesis and dissertations and as system for scientific publications of a given institution. Recently, research data repositories have been added and even software can be included. Since the development of the term repository goes full circle – from a software repository to an institutional repository that contains software – the generic term repositories will be used for the purposes of this text. Repositories traditionally combine a database technology with metadata management, object ingest and storage, indexing and display functions for public access. Even though repositories are widely applied, they can be considered a genuine library technology since they fulfil critical missions of a library, andare often designed for and operated by libraries. Even protocols such as OAI-PMH (see above) for the worldwide exchange of content exposed by individual libraries has been designed and widely applied to build global networks (Pieper and Summann 2006). A search in EOSC for the term 'repository' yields 42 results (18 March 2022), most of them technology resources, however, several also with data resources. None of them has an explicit relation to libraries.

10 Long-Term-Preservation

Repositories in libraries are meant for immediate public access. But libraries also fulfil the societal function as memory institution. Library materials are usually curated and quality assessed and meant to be or become cultural heritage. Not surprisingly, thus, Long-Term-Preservation has been a technological subject of libraries (Hedstrom 1997). Work concentrated on requirements analysis and standards (Dillo and De Leeuw 2018; Dobratz and Neuroth 2004; Giaretta 2011). IT service providers developed preservation solutions at the level of bitstream preservation (Traczyk 2017) that can recover a copy of the mere digital representation from redundant and tailored hardware that have longer life-cycles than storage devices for everyday use. However, actual Long-Term-Preservation requires not only the storage of bitstreams but also addresses the rendering (interpretation) of the complete application. Even a standard digital library cannot be said to be preserved if the underlying repository is not running. Also, formats of images become obsolete and might not even be rendered by standard viewers. Thus, format migrations, emulation or security updates for technology stacks make technological solutions for Long-Term-Preservation complex and expensive to operate. Only examples exist and commercial offers are scarce. A search for the term "preservation" in EOSC yields 7 examples (28 March 2022), none with a library relation.

11 Library technology is not explicitly acknowledged

Considering catalogues, imaging, repositories and long-term-preservation as four exemplars of library technology shows that there indeed is genuine Library Technology, operated by and designed for libraries, fulfilling functional and societal missions of libraries as an institution. Library Technology can be characterized as mature, widely adopted, in large parts globally networked and has been even pioneered by libraries as innovative or large-scale technological operations. Library Technology is nowadays certainly constitutive for the identity of a library, considering the library catalogue or images of the libraries' historic holdings on the web.

When it comes to current infrastructural developments, such as EOSC, however, Library Technology is not well visible. The library-related concepts, for example, of catalogues or repositories have a different, more generic, meaning and did not unfold an identity as a genuine library technology. The explicit connection between the societal function of libraries is not being transferred to the EOSC. Libraries as a societal institution are not a visible part of EOSC. The contrary is true for a counterexample, namely computing centers. The terms 'computing' or 'storage' is pervasive in EOSC, being found 53 and 42 times, respectively (28 March 2022). The identity of computing centers is therefore explicitly represented in EOSC.

It is also unclear, in which sense actual technological contributions by libraries such as the software code underlying repositories are actually part of the services offered in the EOSC marketplace? There are exceptions such as OAI-PMH which can be found underlying several EOSC services (139 counts on 28 March 2022) and several libraries are acting in consortia providing services in EOSC, particularly through OpenAIRE (Manghi et al. 2010). But, in general, it is not a direct transfer from operations in libraries to operations in EOSC. The opposite is true, again, for computing centers.

12 Library Technology is localized and globalized in a special way

One possible explanation for the weak identity of Library Technology is that it is proprietary – not in the sense of IPR protected software, but proprietary in the sense of relating to local, physical materials in libraries or digital correlates of them, i.e. catalogue records of books, or images of historic library materials. Localized resource management might have to take a special route to globalization: cloud-based catalogue services (see above) contain specific functions for dealing with local information (like shelving or circulation) and the development of global search engines for repositories such as BASE (Pieper and Summann 2006) apply specific conventions for referencing the repository representing a local library. Research data repositories, on the other hand might contain a link to the source or the institutional affiliation of an author, but impose weaker constraints on how

to display and manage resources. This might be one reason why the globalization of genuine Library Technology takes a rather independent path from current infrastructure developments, such as EOSC.

But it is an obvious contradiction, that, on the one hand, international infrastructures of library technology have been already in existence before novel developments such as EOSC and architectures might have been paradigmatic for EOSC and, on the other hand, Library Technology is not explicitly represented in EOSC. It remains striking that EOSC is developing in a direction that is rather dissociated from Library Technology – and almost unintelligible that an infrastructure for science is neglecting large parts of what is supposed to be an infrastructure for the production of knowledge. Note that 'Scientia' is the latin word for knowledge (see below).

13 Obsolescence, extinction and absorption

Another possible explanation for the weak identity of Library Technology is obsolescence. There are two forms of obsolescence that need to be distinguished. On the one hand, Library Technology can lose relevance, leading to *extinction* of Library Technology, on the other hand Library Technology can be taken over by service providers not associated with libraries, leading to *absorption* of Library Technology.

An example of an extinction phenomenon in Library Technology can be found in the catalogue records of printed scientific journals. The extensive shelves of larger volumes of scientific journals lost relevance in the 1990s. Journals are nowadays mostly distributed exclusively in electronic form and the demand for accessing the print volumes in the libraries has almost vanished. Their representation in OPACs is obsolete. However, this extinction phenomenon has little meaning for catalogues as library technology, in general. And the other exemplars of Library Technology discussed here, imaging, repositories and long-term preservation, do not show apparent extinction phenomena. It can be tentatively concluded that missing relevance is not the most likely explanation of Library Technology not being highly visible in EOSC.

A very well-known absorption phenomenon with respect to library technology and library identity is, of course, a Google. Google was, in fact, partly developed under a digital library programme (The Stanford Digital Libraries Group 1995) for finding data, information or knowledge resources. Google built its own identity that is not anymore associated with libraries as an institution. Rather exclusive societal functions of libraries – being the place where to perform research, gather intelligence, corroborate hypothesis with findings from others – have been absorbed by Google and other, similar services such as Wikipedia. Again, what is left for libraries is the connection to actual resources held

in libraries. In EOSC, it could also be speculated that former functions performed by libraries are taken over by other service providers such as computing centres – not deliberately in the sense of a hostile take-over but simply as a collateral effect of providing generic non-library services, for which library functions are added incrementally.

The examples shall illustrate, that obsolescence through absorption is a likely explanation of Library Technology not being highly visible in EOSC.

14 EOSC, Google, Wikipedia

Of course, EOSC is not necessarily representative of any form of future infrastructure in that Library Technology can be integrated. As already explained, there are other infrastructures such as those dedicated to libraries, e.g. cloud-based catalogues. And there are infrastructures that are more generic and much more pervasive, e.g. Google and Wikipedia. However, Google and Wikipedia proved to be rather inert to a close integration with libraries worldwide. Google has eventually a commercial background and it is unlikely that the entanglement with the far more public system of libraries can service as a sustainable pillar for society that provides the function of public access, quality control and preservation of cultural heritage. Wikipedia, on the other hand, has the principle of not allowing people to contribute in a professional capacity, which excludes the systemic collaboration between Wikipedia and libraries. Considering these caveats, EOSC is actually an adequate example of a future infrastructures because all possibilities to have a deep integration of library technologies are present.

15 Is Science dissociating from knowledge?

It is striking that EOSC seems to be primarily about software and not about ‘meaningful’ materials. After all, the term ‘science’ is derived from *scientia*, meaning ‘knowledge’. It is therefore surprising that Library Technology is not a primary source in EOSC – or not even linked to EOSC. Is the assumption that services for knowledge resources are available elsewhere in the world, that a genuine library infrastructure or Google and Wikipedia will provide knowledge resources? Or is it because knowledge resources become dissociated from science practice? The observation in the NGRAM that the term “data infrastructure” is trending upwards but the term “data society” is not frequently used (see above) is pointing in this direction: knowledge is being deconstructed to information and information is being deconstructed to data. The more ‘meaningful’ concepts of information and knowledge seem to lose importance and might eventually be superseded by data. And a future science could theoretically not even be based on data anymore. Not anymore direct

representations of the world such as data, information or knowledge resources would be the subject of research – algorithms could be the subject of research. Researchers would then, in fact need primarily software as it is already represented in EOSC. Library Technology would be unnecessary.

A science world that is not based on knowledge resources has a dystopic character. The seemingly ever-increasing analytic trend in technology (and infrastructure development) to deconstruct meaningful resources in smaller, less meaningful resources that lend towards automated processing and artificial intelligence is a motor for innovation. This analytic trend, thus, seems to be an inevitable characteristic of technological progress. It is, however, accompanied by phenomena such as disinformation or populist, arbitrary bending of information details – and a general discomfort of humanity to be overwhelmed by the amount of detailed data, information or knowledge that has to be processed in ever smaller increments of time. In this sense, it could be said that what is needed is an increased focus on *synthesis* instead of analysis. How does data form information – how does information form knowledge – how does knowledge form wisdom?

16 The case for Library Technology

It would be exaggerated to state that libraries can solve the problem of turning data into wisdom. But Library Technology can make contributions to adding context to data, information and knowledge:

- Literature, be it books or articles, printed or digital, provide context for data that can help synthesis of decomposed, contextless data.
- Metadata are generally a specialty of libraries. Having metadata on literature always at hand, when displaying contextless data on the web should be an important feature of any information infrastructure.
- Librarians can contribute intellectual curation for contextless data as a new form of cataloguing – thereby augmenting the machine processing of metadata and adding human control to artificial intelligence.
- Libraries can help to develop and sustainably manage novel forms of scholarly communication, new publication formats. The experimental sciences are particularly at risk of getting lost in data or algorithms and at risk of failing to explain science to society. Context provided by libraries could help to unfold their explanatory capacity and ability to contextualize data, information and knowledge.

- Librarians should be considered more seriously as custodians of knowledge. It should be their task to teach data literacy and critical information assessment, provide advice with the problems of disinformation and conspiracy theories and do genuine library research on knowledge formation and epistemology.
- Quality control through libraries should become a filter function for transferring contextless data into cultural heritage in long-term preservation and cultural heritage.
- The physical component of library identity (the library as a place with rooms and materials) should be implemented as an anchor for localization of knowledgein abstract data infrastructures – through the relations to physical forms of information but also through institutional affiliations or local, personal identification.
- The responsible organization for the library (governments, foundations, universities) should foster the libraries' role in distributed and diverse infrastructures, discourage competitive behavior and provide the legal and organizational possibilities to the library to take responsibilities in cooperative initiatives.
- Libraries should drive the building of data, information and knowledge infrastructure rather than staying in the back-seat. This also requires all institutions to build alliances, transcend competitive thinking as well as disciplinary or geographic boundaries.

All these contributions should have practical implications on building infrastructures like EOSC: focusing on content and contextualized information rather than software, using the library's expertise on metadata and long-term-preservation, bringing the capacity of libraries to transform EOSC data into cultural heritage in the foreground, getting libraries in the driver seat for long-term operations of EOSC, strengthen the training and education efforts in EOSC. Libraries could be much more visible in EOSC, by adding services, naming the services accordingly (use the word 'library') and becoming visible as service providers.

It is obvious that this enumeration can be extended and elaborated. And it is obvious that this enumeration is stressing the traditional values of libraries. The novel roles of libraries in research data management or artificial intelligence have not been taken into account here because they would distract from the necessity to transfer the traditional functions of libraries into new information infrastructures. Focusing on genuine Library Technology is one way of realizing a transfer of traditional library functions to the future.

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Preprints 2022 der Zeitschrift *BIBLIOTHEK – Forschung und Praxis*, BFP.2022.0011
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