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PHYGITALIZATION OF LIBRARY SERVICES: OPPORTUNITIES AND CHALLENGES

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Introduction.

Digital transformation (DT) is a fundamentally new phenomenon in the development of modern society, the prospects and risks of which have been insufficiently studied. For an adequate assessment of this phenomenon, it is necessary to consider it in inseparable unity with the changes taking place in the most important spheres of social functioning (economics, politics, science, culture, education).

Phygitalization is the process of interaction of digital technologies with physical processes, creating a synergy between online and offline experiences. The term "phygital" was coined in 2007 to describe the connections between the physical and digital worlds [Introducing, 2020]. Since then, a number of authors have paid attention to the disclosure of the theoretical foundations and managerial possibilities of applying phygitality [Batat, 2019]. Among the immersive technologies that enable this transformation, researchers name such as augmented reality (AR) and virtual reality (VR), technical solutions based on artificial intelligence (AI), the Internet of Things (IoT), the Internet of Everything (IoE), virtual intelligent agents (chatbots) and management solutions customer relations (CRM) [Del Vecchio, 2023]. However, the term "phygital" does not have a clear definition and offers several interpretations. This conceptual vagueness complicates academic discourse about the possibilities and limits of the phygital phenomenon and its transformation. At the same time, it is already possible to trace the most important aspects of phygitalization. Let's list them:

1. Integration of digital technologies, including the use of AR (augmented reality), VR (virtual reality), IoT (Internet of Things) and other technologies to improve the physical experience of receiving a service;
2. Personalization of service, involving the collection of real-time consumer data to provide a personalized experience in both online and offline environments.
3. Omnichannellity, i.e. ensuring the uniformity of the experience of receiving a service through all channels, including real organizations, websites, mobile applications and social networks, searching for methods of their online and offline channels to create a seamless experience for consumers.
4. Getting an interactive experience that allows consumers to interact with organizations providing relevant services.
5. The use of analytical tools to track consumer behavior and optimize marketing strategies, i.e. what is now called data mining or business intelligence (BI).

In our practice, we have repeatedly explored the problems of virtualization of intellectual and social space [Kapterev, 1993a; Kapterev, 2011].

Despite the fact that we have not been able to identify special works on phygitalization in the Russian library literature, Russian librarians continue to contribute to the research of digital humanities. In Russian library science literature, this problem has been addressed at various times by A. B. Antopolsky, [Antopolsky, 2023], I. P. Tikunova [Tikunova, 2021], Ya. L. Shraiberg [Shraiberg, 2023], M.Y. Neshcheret [Neshcheret, 2024], O.A. Lavrenova and A. A. Vinberg [Lavrenova, 2020], N. A. Sergeeva, who demonstrated the possibilities of working with remote users using the example of Russian National Library [Sergeeva, 2022] and a number of other specialists. Similar research is underway in the world. For example, Bryony Birdi, who studied the characteristics of readers of fiction in connection with their genre preferences using the method of repertory grids [Birdi, 2011], Xiao Lin, Wenjuan Guan, Ying Zhang, who studied the application of data mining technology with an improved clustering algorithm in the library system of personalized book recommendations [Xiao, 2023]. Spanish specialists K. Parcell, J. Moreno and Herrera-Vidma presented a model of a fuzzy linguistic recommendation system that helps users of university electronic libraries to access their research resources and expand opportunities for cooperation within the university and contribute to improving the services provided by the university digital library [Porcel, 2009]. Some works by other authors can also be named. For example, S. Ashraya and V. Tipanna published an overview of marketing strategies for public libraries in the digital age, including the example of the Edmonton Public Library [Acharya, 2023],

and Melissa Fraser-Arnott investigated how the marketing approach in academic libraries changed their functionality [Fraser-Arnott, 2023].

We argued that the digital transformation of libraries will cause essential changes in librarianship as an object of management, in particular:

a) for the purposes of activity;
b) the subject of activity;
c) the processes of library activity;
d) its final results;
e) all types of support (resource, legislative, regulatory and methodological);
f) organizational management and quality control;
g) scientific substantiation of development prospects [Kapterev, 2023].

Of course, the services analyzed below provide new, previously inaccessible features to library users. At the same time, the main modern trend in library and bibliographic activity is customer orientation, which implies greater personalization of products and services.

Phygitalization in public and scientific libraries brings many innovations that transform traditional library services. However, as in any other field, it is accompanied by both successes and problems. Many of the library and bibliographic technologies combine traditional processes in the physical environment and virtual communication, i.e. they are phygitalized.

The success of phygitalization in libraries can be safely attributed to:

- electronic catalogs that allow users to search and reserve books online, which greatly simplifies access to library resources;
- access to digital collections provided by libraries to digitized sources in their collection - books, magazines, audiobooks and other digital resources;
- self-service terminals that allow users to independently issue and return books using barcode and QR coding;
- interactive educational spaces - areas with touch-screen displays and access to digital tools for learning, coworking and collaboration;
- virtual exhibitions and tours, including those using immersive technologies;
- virtual help desk, often available around the clock;
- online courses, webinars and other educational resources available through library websites;
- news information about planned and ongoing events;
- branded channels in messengers and social networks;
- mobile applications for accessing library services;
- extension of the period for booking publications in the reading room remotely;
- remote methodological support for the assessment of publication activity;
- remote compilation and revision of bibliographic lists of publications.

Phygitalization most often involves not just transferring physical processes to a digital environment, but also creating a unique experience that combines the best of both worldsOf course, critics of this view may point out to the author that many of the listed services are more focused on digitalization and automation of processes than on creating an integrated phygital experience. Yes, we agree with this objection, but they are an important step in the phygitalization of working with information, since they expand the possibilities of traditional methods and create new forms of interaction with information. Nevertheless, we believe that these tools are in fact only the beginning of the process, and its further development is associated with the implementation of such functions of phygitalization as: (a) digital monitoring, which involves not only the digitization of traditional products and the digitalization of individual technological processes, but also a constant analysis of the goals, resources, volumes and rates of digitalization; (b) digital marketing, which involves constant analysis of the target audience and the use of digital interaction technologies with the target audience (CRM); (c) digital consulting, involving the personalization of services based on modern digital communication technologies.

Methods and results.

1. Bibliographic managers.

The currently common examples of virtual bibliographic assistants (called bibliographic managers in foreign literature) can be considered as phygitalization tools in the sense that they provide digital support for

working with information that has traditionally been performed in a physical format (for example, paper bibliographic indexes, traditional library card catalogs and analytical and synthetic document processing, conducted by de visu).

As arguments in favor of the fact that the digital services listed below are precisely tools for the phygitalization of library and bibliographic activities, we name the following:

1) all these services are digital tools that integrate with traditional methods of working with information, improving them and making them more effective;

2) digital services make information more accessible by allowing users to receive and process data regardless of their physical location;

3) these tools provide a user experience that can be personalized to specific needs and preferences, which is a key aspect of phygitalization;

4) virtual bibliographic assistants (managers) and text mining systems support online collaboration, which combines elements of physical interaction (teamwork) with digital means of communication;

We will conduct a comparative analysis of some common information systems that we consider as tools of phygitalization.

The most popular virtual bibliographic assistants (bibliographic managers), which are widely used around the world, are the following systems:

1. EndNote (https://endnote.com/) — one of the most well-known and respected tools for managing bibliographic references, widely used in scientific research; paid, with the possibility of trial use. There is good integration with MS Word and other text editors. Includes advanced features for searching, organizing, and managing links.

2. Mendeley (https://www.mendeley.com/search/) — a bibliographic assistant and a social network for scientists that allows you to manage research data and collaborate online; free basic level, paid options for additional storage. Integration with MS Word and browsers for link import; includes networking features for collaboration and data exchange;

3. Zotero (https://www.zotero.org/) — free with the option of a paid storage extension and an open tool for collecting, managing and quoting research materials, popular among students and scientists; good integration with text editors and web browsers; convenient link management and collaboration support.

4. ReadCube Papers (https://apsgo.com/en/store/product/papers) — a bibliographic list and link management platform that offers integration with academic databases and convenient functions for reading and annotating articles; paid, with trial use; integration with remote databases and link import; PDF reading and annotating, link management and collaboration support

5. RefWorks (https://refworks.proquest.com/?legacy=true) — a cloud service for managing bibliographic references, which allows users to create personalized full-text databases and share them; paid, often provided by educational institutions for students; there is integration with various research tools and databases; there is link management and creation of bibliographic lists.

6. Sciwheel (https://sciwheel.com/?lg) — a tool for managing bibliographic lists and links, which offers functions for collaboration and integration with Word to simplify the citation process; paid, with the possibility of trial use;

7. Paperpile (https://paperpile.com/) — cloud-based bibliographic assistant, with an emphasis on simplicity and intuitiveness of use; paid, with the possibility of trial use; simple and user-oriented Google, because there is deep integration with Google Docs and Google Scholar; link management and PDF files, collaboration.

The choice of a specific virtual bibliographic assistant depends on individual preferences, functionality requirements and user tasks.

2. Selective Dissemination of Information (SDI)

Selective Dissemination of Information (SDI) provides relevant and personalized information to users based on their specific interests and preferences. It is a proactive approach to information dissemination, where the provider creates a profile of the user's information needs and regularly updates new publications, research papers, news articles, or any other relevant material matching the user's profile.

In line with the trend of phygitalization of library and bibliographic services that we are studying, relatively common selective information dissemination (SDI) services, such as those listed below, are of particular interest.

1. Google Alerts (https://www.google.co.zm/alerts?hl=en&gl=zm&cd=dym8_3b-k_o) — free service from Google that allows users to receive email notifications about new search results (for example,

news, articles, blogs) for their queries; a resource that allows you to customize keyword queries, notification frequency and sources; includes a wide range of topics and sources, including news, blogs and web pages.

2. PubMed Alerts (https://pubmed.ncbi.nlm.nih.gov/advanced/) — service from the PubMed database that provides notifications of new publications in medical scientific journals on selected topics; is aimed at medical professionals; provides subscriptions to notifications of new publications on certain medical topics.
3. Scopus Alerts — a feature in the Scopus information and analysis system that allows researchers to subscribe to notifications of new publications, citations, or changes in author profiles; a subscription to Scopus is required.
4. Web of Science Alerts — a service from the Web of Science information and analytical system that offers notifications of new articles and citations in various scientific fields; a subscription to Web of Science is required.
5. Zotero Groups — a feature in the Zotero Virtual Bibliographic assistant that allows users to create groups to share and track research materials and updates; free basic level, paid options for extended storage. An example of using this assistant in the practice of domestic libraries is the experience of the Library of Natural Sciences of the Russian Academy of Sciences [Ivanovsky, 2019, 117]. The Zotero-based SDI system has been operating in LNS RAS on an experimental basis since 2016. The main task of the system is to provide the user with complete bibliographic descriptions of foreign articles on the subject specified by the user or a list of journals. Also, this library has implemented an attempt to develop its own SDI system, combining the capabilities of various bibliographic assistants based on an "object model", including objects such as a subscriber, librarian, journal, query, etc.
6. Feedly (https://feedly.com/) — popular content aggregator that allows users to subscribe to RSS feeds of news, blogs and scientific journals to track updates on topics of interest; free basic level, paid options for additional functions; a wide range of topics, including news, blogs, scientific journals.
7. ResearchGate Alerts — social network service for scientists registered with ResearchGate, which provides notifications about new publications and research in certain fields of science. It is free for registered users; it sends notifications about new publications and research in certain areas, as well as about the facts of accessing the publications of a registered user.

3. *Text mining systems.*

Text mining systems provide services for automating processes that previously required significant effort, and provide analytical data for decision-making. This is necessary for library managers who are focused on a data-driven approach to management.

There are dozens of systems that focus not only on bibliographic search, but mainly on the intellectual analysis of documents and the extraction of conceptual (conceptographic) information from them, i.e. on the intellectual analysis of texts and their summarization (annotation and abstracting, which in our industry has traditionally been called analytical and synthetic processing processes). The most common are the following: Mon key Learn, PDF, Thematic, Lexalytics, Chattermill, QDA Miner, MS Azure AI Language, InMoment Text Analytics, Lang.ai, Aylien. These tools offer different levels of complexity and functionality, and the choice of the appropriate one depends on the specific needs and tasks facing the organization or the user.

Text mining systems are designed to help obtain high-quality information from the input text. It is estimated that about 80% of management-related information comes from unstructured data, most of which is text messages such as emails, reports, and even social media posts. There is a lot of valuable information hidden inside this unstructured data, but without technological tools to organize the data in any way, it can be very difficult to find it. This is where the intellectual analysis of texts is needed. Text mining systems are a powerful tool that helps individual users and corporate entities extract valuable information from unstructured data. These systems differ in functions and capabilities, but the goal remains the same: to help understand unstructured data. Text mining systems help analyze text data and sort it to make it easier to identify relationships. When talking about text analytics, there are several concepts that should be distinguished: taxonomy, folksonomy, natural language processing (NLP) and large language models (LLM).

Natural Language Processing (NLP) is a branch of artificial intelligence (AI) that studies the human-machine interface. After all, despite the fact that the WIMP interface[1] has been familiar to all of us for more

[1] WIMP – interface based on windows, icons, mouse, pointer.

than 50 years, we continue to use it, but we dream of communicating with technical devices as with people. NLP focuses on allowing computer programs to recognize, interpret, and generate natural language in a way that is both understandable and useful to the user. The main goal of NLP is to bridge the gap between human communication, which often includes unstructured and polysemic text, and the structured and precise nature of computer languages. NLP allows computer programs to process, analyze, and extract information from huge amounts of text data in the same way that humans do, but often better and faster.

Large Language Models (LLM) are a class of artificial intelligence models that have the ability to interpret and generate natural language. These models are trained on huge amounts of textual data to develop the extraction of meaning from language patterns and structures using deep learning methods. Today, these are the most common and systems based on pre-irradiated transformer algorithms (GPT family).

And what is the difference between taxonomy and folksonomy? A taxonomy is a hierarchical classification system in which content is divided into a structured and predefined set of categories. It uses tables where categories and subcategories are defined by developers. Librarians are very familiar with the classification tables used in all countries.

Folksonomy is the practice of co-categorizing information through randomly selected labels called tags. It is known as co-tagging, social classification, social indexing, and social tagging. This is a bottom-up approach, as users assign their own tags based on their understanding and context, without a predefined structure.

Text mining systems can be compared according to a number of criteria that will help assess their effectiveness and applicability to specific tasks. There are quite a lot of such criteria. Here are some of them:

- the accuracy of the analysis, i.e. the ability of the system to correctly interpret and analyze the text, including understanding the context, semantics and syntax;
- Natural language Processing (NLP), i.e. determining the quality and depth of natural language processing algorithms, including sentence parsing, entity recognition, relationship extraction, and sentiment analysis;
- scalability, i.e. the ability of the system to work efficiently with large volumes of text and scale to various loads;
- language support, i.e. the number of supported languages and the quality of analysis for each of them;
- integration with other systems, i.e. the possibility of integration with other software products and services;
- user interface and usability;
- customization, i.e. the ability to adapt the system to the specific needs of the user or project;
- security and confidentiality, i.e. measures taken to protect data and ensure the confidentiality of information;
- processing speed, i.e. the time it takes for the system to analyze the text and provide the results;
- availability of detailed documentation and quality of technical support;
- total cost of ownership of the system, including licensing, support and updates;
- the ability of the system to learn from new data and adapt to changes in language and context;
- functionality and capabilities, i.e. a set of functions that the system offers, including text analysis, summarization, classification, and others.

Let’s name some text mining systems that make it easier to obtain the necessary information from unstructured data.

1. MonkeyLearn (https://monkeylearn.com/) — It is a ready-to-use machine learning model that helps the user perform in-depth text analysis, regardless of the data type. A universal studio for text analysis and data visualization. The advantage is the ability to create custom charts and dashboards (interactive visualization panels) incredibly quickly. In addition, this versatile text analysis tool has several built-in business templates that help users complete analytical processes in seconds. Moreover, users can also create personalized tables and charts to present ordered data in any format of their choice. There is compatibility with other business intelligence (BI) tools for better text analysis.
2. Thematic (https://getthematic.com/) — It is an integrated artificial intelligence platform capable of converting disorganized user reviews into accurate information for better analysis. This tool empowers the user through text analysis technology using artificial intelligence, which helps to understand unstructured responses to reviews. Many researchers and experts trust this text analyzer of the blogosphere, which allows you to extract valuable information. In addition, this tool can facilitate the collaboration of team members, while ensuring data security through automatic data editing. Librarians can also use this tool to improve the management of their services by analyzing users' problems and pain

points.

3. Lexalytics (https://www.lexalytics.com/) — It is a text analysis software using artificial intelligence that supports more than 29 languages. NLP technology can transform complex data into valuable information. This tool is suitable for emotional analysis of text in documents to determine its tonality. In addition, this text analyzer with artificial intelligence has built-in industry packages to improve the results of various analytical processes. This feature also helps the system to better identify the subject, mood, and categorization of data from various industries.
4. Chattermill (https://chattermill.com/). This tool collects all customer feedback data in the form of comments, emails or reviews and analyzes this data in one place to get valuable information. It will combine customer data on various platforms and analyze it using an artificial intelligence-based system to better understand cause-and-effect relationships.
5. QDA Miner (https://qda-miner.software.informer.com/) — An easy-to-use computer program designed to conduct qualitative research. It can be used to encode, comment and analyze large and small volumes of documents and visual information. QDA Miner can be used to analyze interviews, official documents, periodicals, books, as well as paintings, photographs, sketches and other visual sources. The program uses an additional WordStat module to analyze the text. The module is designed for content analysis, text analysis and sentiment analysis. It can be used to analyze websites and social networks, as well as for business intelligence. There are several data visualization tools that will help you better interpret the results of the program. There is a free Lite version.
6. Bismart intelligent folksonomy (https://bismart.com/en/) — Folksonomy software uses intelligent tags based on generative artificial intelligence (GAI) and Large Language Models (LLM) to sift through unstructured data archives in search of specific information. This means that you no longer have to go through the long and tedious process of defining tags and categories. You can configure the program in different ways for different needs. There is also an opportunity to restructure it in real time for various purposes. The tool is fast, easy to use and with many different options, which makes it ideal for collaborative projects.
7. UPDF (https://updf.com/updf/) — a software tool for editing text and images in PDF format. It has the ability to edit the font and size of the source text, as well as resize, move, replace, copy, delete or crop images without leaving PDF files. UPDF can be used to quickly and accurately convert PDF to Word, Excel, CSV, PowerPoint, RTF, text, images (PNG, JPEG, BMP, TIFF, GIF), HTML, XML and PDF/A with 100% format and layout preservation. PDF provides intuitive navigation tools and extensive annotation tools to directly add selections, text fields, attachments, shapes and other elements to PDF files in 38 languages. There is a free version.

Conclusion.

It is important to note that the effectiveness of these systems may vary depending on the specific needs of the user, the area of his research and how he uses the tools. Researchers often use a combination of these systems to provide comprehensive coverage of their areas of interest.

Of course, the analyzed services provide new, previously inaccessible features to library users. They are an important step in the phygitalization of working with information, as they expand the possibilities of traditional methods and create new forms of interaction with information. However, it makes sense to access them through the library's website only when the library itself is a subscriber to these services and can provide free access to its readers. At the same time, the main modern trend in library and bibliographic activity is customer orientation, which implies greater personalization of products and services. The next step in this direction may be the modeling, formation and use of digital user profiles in library services. All these innovations, of course, become challenges not only for library and bibliographic practice, but also for the system of specialized education, about the need for changes in which we wrote 30 years ago [Kapterev, 1993b; Kapterev, 1993c].

Phygitalization in libraries is an ever – evolving process that requires adaptation to new technologies and changing user needs. The library community will have to master:

(a) expanding the use of virtual, augmented and mixed reality (VR+AR+MR) for educational and cultural programs;
(b) integration with artificial intelligence systems for personalized recommendations and assistance in finding information, which implies, for example, in the future providing registered users with access to paid AI services;
(c) expanding the scope of digital curation, i.e. thematic support for users' research and educational projects;

(d) developing tools for collaboration and learning in a digital environment;
(e) improving the accessibility and usability of digital resources for people with disabilities;
(f) widespread dissemination of courses to improve digital literacy and information and network competence of users and staff.

Of course, on such an innovative and thorny path, some problems of phygitalization in libraries are already obvious:

1) libraries of different status, profile and regions have different opportunities to access digital technologies and the Internet.
2) funding for technology upgrades and support for digital services may be limited.
3) compliance with the legislation on mandatory copies, copyrights and related rights when providing access to digital materials is not always transparent and guaranteed.
4) the need to train employees in new technologies and digital services.
5) the problems with format compatibility, data security, and IT infrastructure support.

ԱՄՓՈՓՈՒՄ

Ներկայացված է գրադարանային պրակտիկայում թվային փոխակերպման գործիքների ակնարկ: Համառոտ կներկայացվեն. 1) թվային փոխակերպում հասկացությունը, 2) գրադարանային ոլորտի հետազոտություններում թվային հումանիտար գիտությունների փորձը, 3) տեղեկատվական հիմնական ծառայությունները՝ որպես գրադարանների թվային փոխակերպման գործիքներ, ա) վիրտուալ մատենագիտական օժանդակ գործիքներ, բ) տեքստերի ինտելեկտուալ վերլուծության համակարգեր, գ) ընտրովի տեղեկատվության տարածման ծառայություններ, 4) ներկայացվելու է վերոնշյալ տեղեկատվական ծառայությունների տեսակների համեմատական վերլուծություն՝ ըստ մի շարք չափանիշների, 5) ներկայացվում են գրադարաններում թվային փոխակերպման որոշ հաջողություններ, 6) սահմանված են այս միտումի զարգացման խնդիրները, 7) թվարկված են Ռուսաստանի գրադարաններում թվային փոխակերպման ավելի լայն տարածման հեռանկարները:

Ցույց է տրվում, որ հանրային և ակադեմիական գրադարաններում թվային փոխակերպումը հանգեցնում է բազմաթիվ նորամուծությունների, որոնք փոխակերպում են ավանդական գրադարանային ծառայությունները:

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