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**A MEMORY INSTITUTION FOR THE DIGITAL AGE****ОПЫТ РАБОТЫ НЕМЕЦКОЙ НАЦИОНАЛЬНОЙ НАУЧНО-ТЕХНИЧЕСКОЙ  
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The German National Library for Science and Technology (TIB) seizes the opportunity of an epochal change into the Digital Age, inter alia, by maintaining a prestigious research department covering the areas data science & digital libraries, visual analytics, scientific data management, knowledge infrastructures, learning & skill analytics, open science, and non-textual media. Without neglecting the original mission of collecting and curating literature for a widespread access to scientific information, TIB merges well-established processes with intelligent assistance tools. The Specialised Information Service for Mobility and Traffic Science (FID move) is one example of combining the mentioned research areas in order to build a user-centred subject-specific research infrastructure to support and shape tomorrow's scientific work. We give a detailed introduction to the project's action fields: web service platform, information supply with a focus on open access, strategy & structure for reusable research data, research community exchange & networking, communication strategies for the public & for scientists. Exemplary, we present the ongoing activities in building a comprehensive knowledge organisation system for e-mobility.

**Keywords:** *Library, digital library, information infrastructure*

Немецкая национальная научно-техническая библиотека использует возможности перехода в цифровую эпоху, имея в своей структуре исследовательский отдел, который решает задачи в области оцифровки документов и формирования электронных библиотек, визуальной аналитики, управления научными данными, инфраструктуры знаний, аналитики образования, открытой науки и нетекстовых средств массовой информации. Считая задачу сбора, хранения документов и предоставления широкого доступа к научной информации основной миссией, TIB осуществляет обслуживание с применением информационных технологий. Создана специализированная информационная служба изучения веб-пространства и трафика (FID move), которая объединяет исследования в вышеозначенных областях для создания ориентированной на пользователя предметно-специализированной инфраструктуры научного знания, поддержки и сопровождения научной работы будущего. Основные направления деятельности службы: создание веб-сервисной платформы, предоставление научной информации преимущественно открытого доступа, структурирование многократно используемых исследовательских данных, создание сети научных сообществ и обмен информацией между ними, разработка коммуникационных стратегий общественности и ученых. В качестве примера авторы представляют результаты текущей работы по созданию комплексной системы организации знаний e-мобильности.

**Ключевые слова:** *библиотека, цифровая библиотека, информационная инфраструктура*

## Introduction

Information infrastructure institutions, most prominently libraries, face challenges and opportunities of how information science in the sense of preserving and providing information extends from the print age to the digital age. Recent questions deal with stock preservation of various analogue and digital media, transformation processes towards ethically sound science including open collaboration and publication, or imparting so-called future skills like programming, data analysis, and media literacy. Modern libraries combine the experience of the history and methods of archived knowledge with research activities concerned with aspects of the questions mentioned above. All the while, the central elements are our users: students, academic or industrial scientists, and the general public alike. This article addresses the strategy of how the German National Library of Science and Technology tackles these challenges to remain and further develop into a memory institution for the Digital Age.

## Introducing the German National Library of Science and Technology

Our institution located next to Gottfried Wilhelm Leibniz University in Hanover, Germany, has many names and faces. For the students TIB (the abbreviation of the German name *Technische Informationsbibliothek*), pronounced "tib", is a regular university library with attractive peculiarities like an astonishing ostensive supply of literature, especially standards and patents, as well as grey literature. For the library community we are TIB, pronounced "tea-eye-bee", one of the national big players, having the expertise and means for experimenting on and developing the latest innovations in library and information science. For the Leibniz Association, a federation of German extra-university research institutions of which TIB is a member, we are the *Leibniz Information Centre for Science and Technology*. For researchers, TIB with its various names is a new, sometimes puzzling phenomenon, housing information infrastructure and the interdisciplinary science thereof under one roof. Finally, our governmental mandate entitles us to the name of *German National Library of Science and Technology*.

## Our Mission

TIB's statutory remit is to comprehensively collect, archive, and provide access to scientific information irrespective of its manifestation with respect to its defined subjects architecture, chemistry, computer science, engineering, mathematics, and physics. As a legacy of 20th century's science and technology history, in particular the cold war and the rise of the Four Asian Tigers, the library maintains special collections of subject-related literature in the languages of East Asia and Eastern Europe (including Russia). Especially in times of political tensions between the East and the West these collections guaranteed knowledge exchange, a gesture of attentiveness.

## Our Philosophy

TIB follows a holistic, user-centred approach. From a user's point of view the library is a cultural and scientific institution satisfying her curiosity with content acquired in a recent to distant past. In the last three decades information transcends the physical towards so far volatile digital manifestations. As a consequence, accessing literature is no longer logistically but only economically and legally limited. The opportunity of open and free science has to be fundamentally renegotiated with the powers that be to overcome superfluous publishing structures but at the same time upholding and even consolidate author rights. Equally importantly, researching information demands for new tools that abide by established web standards and satisfy user needs in a flood of information occurring in miscellaneous formats. For tomorrow's users the library researches methods and workflows to preserve the content and provide access in a reliable and contemporary manner (Figure 1).

## Our History

TIB's founding myth roots in a lucky escape from the devastating bombing of Hanover in the Second World War. Virtually at the last minute ox carts rescued the library's stocks to the nearby Harz Mountains. As one of few collections it survived the war undamaged and turned out to be the most extensive in Germany with respect to science and technology. In contrast to most countries the young republic decided on

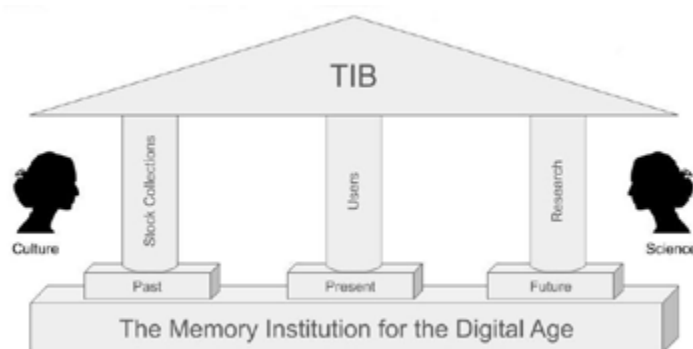


Figure 1. Illustrating TIB's philosophy embedded in society and time: the library researches for user-centred methods to preserve and provide access to its diverse collections by contemporary means

a distributed library system to both appreciate Germany's history as a multinational state and avoid the vulnerability of a centralised library ecosystem. This political framework and the Sputnik crisis led to the foundation of the German National Library of Science and Technology in 1959. Due to many committed colleagues of Soviet origin TIB established a reliable relationship with Soviet libraries. The result was a valuable literature exchange programme rare in those times.

journals, six thousand databases, more than 17 million standards and patents. Additionally, TIB hosts the DOI registry for research data DataCite (<https://datacite.org/>) which has assigned more than 1.5 million data sets altogether with an increasing number of registrations every year. As a final selected feature, TIB is the German liaison of arXiv, contributing the financial share of all German science institutions.

The day-to-day business is reflected in the library's organisation chart (comprehensively illustrated in Figure 2). There are two main pillars: a stock-related

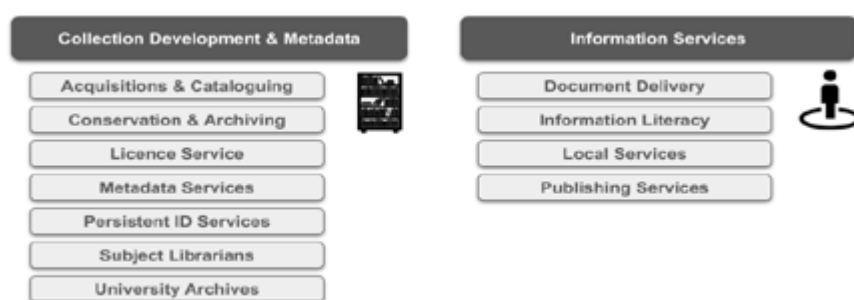


Figure 2. The two library departments concerned with the collections and the users including all organisational units

### Digital Awakening

Since the late 1980-s but at the very latest since the turn of the millennium the digital age challenged four millennia of tradition and experience with handwritten and printed literature in a physical manifestation. Libraries have optimal workflows for textual information kept on media like books, journals, discs, or many other physical containers reflecting the logistical processes prior to the Digital Age. In a globally connected world, the remedy of printing and physically distributing information has become obsolete, so have many library workflows. On the other hand, electronically available information poses challenges regarding storage, reliable archiving, and a new copyright management. Both publishing houses and libraries contend for new roles in the digital information economy. We find ourselves in the infancy of the digital age, or in the Digital Dark Ages, a phrase coined at IFLA 1997. This era demands rethinking and overhauling the library as a memory institution.

### Information and Science Institution: Two Sides of the Same Coin

#### The Library

The author John Naisbitt coined the phrase «We are drowning in information but starved for knowledge» [1]. As the largest library for science and technology in the world TIB can illustrate that proverb impressively. As of 2018, the stock comprises about six million printed books, nearly 1.5 million e-books, twelve thousand printed and 45 thousand electronic

and a service-/user-related department. The stock-related department combines established library processes with modern workflows regarding digital collections. The acquisitions and cataloguing teams succeed in discovering and obtaining rare literature like conference proceedings or research reports from all over the world. In a next step, indexing the literature, especially language transcription, poses challenges. The traditional role of subject librarians is extended to community liaisons who convey methods and tools for open research adapted to their individual subjects. Furthermore, TIB keeps a licencing department to both negotiate products like e-book packages and arbitrate fair contracts. For example, the library argues in support for text mining privileges, transparent contracts, archiving rights on library servers, or a delayed open access clause.

The user-related department distinguishes between local and transregional customers and develops its services accordingly. Selected teams are the publishing services who advocate open access and open science but also counsel primarily researchers where and how to publish their work, be it as a traditional textual publication or research data of any kind. Additionally, there is the transregional document delivery service arranging the logistics to supply scientific and industrial customers in Germany<sup>1</sup>.

<sup>1</sup> There are special circumstances allowing for international document delivery, but this service extends beyond the library's primordial mission.

TIB is caught in the tide of a digital transformation which states the question which processes need to be transformed. Albeit most workflows could be optimised by automation already there are two three factors to be reconsidered: Social factors linked with changes of this magnitude, guaranteeing the data quality in an ever faster publishing and globally connected environment, and the nationally imposed archiving warranty of the library's collections. The research department tackles many of the challenges and paves the way towards a memory institution of the Digital Age.

### **The Research Institution**

#### *Organisational Structure*

Apart from research administration, science is often characterised by the absence of long-term day-to-day business but by innovation-driven short-term project work. Accordingly, TIB's research department thrives on a quickened pulse. Figure 3 shows its organisational chart comprising of five topical sections and two substantiating cross-sectional units for infrastructural support, i. e. administrative and technical services.

#### *Data Science and Digital Libraries*

The Data Science and Digital Libraries Research Group envisions a convergence of human-readable and machine-readable research literature. If computers could interpret and contextualise proliferating information, it would simplify searching, connecting and analysing scientific results systematically. Furthermore, it could help optimise peer-review, reproducibility analysis, or comparison studies. The project Open Research Knowledge Graph (<https://projects.tib.eu/orkg/>), funded by the European Research Council, attempts to create a semantic web of research literature to approach the vision of an intelligent web of human- and machine-readable scholarly communication [2]. Further notable projects include the platform SlideWiki [3] to openly share and transparently develop educational content or big data best practices and infrastructure for Industry 4.0 as dealt with in the Horizon 2020 project BOOST 4.0 (<https://boost40.eu/>).

#### *Lab Non-textual Materials*

The Lab Non-textual Materials extends the library's natural collecting mission from traditional textual formats like books or journals to non-textual materials like software, podcasts, raw or integrated research data, e. g. 3D objects or simulations, but with a main focus on films. To incorporate these materials to a library stock new technical and operative infrastructure, i. e. servers, media management software, or curation workflows have to be introduced. One of the main goals is to make non-textual materials as natural in teaching and research as traditional textual containers that are rooted in logistical shortcomings like printing and analogue distributing prior to the Digital Age. That includes, of course, also teaching to create and disseminate new media for scholarly communication.

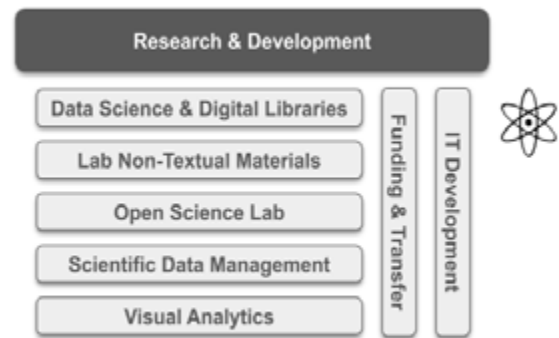


Figure 3. Organisational structure of the TIB's research department

The main task of the Lab Non-textual Materials is the maintenance and advancement of the web-based TIB AV portal (<https://av.tib.eu/>) for quality-tested scientific videos, laxly described as a YouTube® for scientific films. The portal hosts and indefinitely digitally preserves films of secured provenance with trusted licence given by the creators. Thus, films entrusted to the AV portal are curated and provided with exceptionally high standards with regard to trustworthiness. On the level of information retrieval, a film's metadata are automatically enriched by text, speech, scene, image recognition as well as a matching with a German and an English controlled vocabulary extending a search to synonyms or alternative spellings, to allow for a comprehensible search within the content. Also, a film is assigned a DOI for unambiguous reference and the Media Fragment Identifier allows for exact referencing and citing to the second [4]. As of 2019, five years after its launch, the AV portal contains more than 22.000 films, mostly conference recordings, lectures, experiments, and video abstracts which are provided to about 1.500 users per day.

Further activities of the Lab Non-textual Materials include a conference recording service, that provides the technical and legal infrastructure in addition to the media expertise, transforming the AV portal into an open source platform, archiving and access methods for the various data that chronicle cultural heritage (e. g. Europeana Media (<https://pro.europeana.eu/project/europeana-media>)), and facilitating new ways to transparently and sustainably preserve, curate, and provide access to software that is involved in scientific findings.

#### *Open Science Lab*

In the Digital Age the scholarly work offers opportunities to be as transparent and democratic as never before. The Open Science Lab (OSL) strives for inventing and establishing free, fair, and open instruments and methods for every step in the research lifecycle. The projects are not limited to actual

products or services but to consider the ethical bigger picture of fair conduct in research. This includes not only scientists' behaviour but also stockholders in the vicinity of research like publishing houses or funding institutions among others.

The three main themes are FAIR research information, nurturing communities that concern themselves with common digital cultural heritage, and exploiting new ways of knowledge transfer in academia and beyond.

FAIR is an acronym advocating for findable, accessible, interoperable, and reusable research data - i. e. fair data. The focus is to understand and assess research products beyond proprietary, non-reproducible indicators which often carry a corporate bias. The German research ministry funds the research group to develop and implement open, reproducible views and indicators. As a service the OSL advocates the administration and adoption of the VIVO (<https://duraspace.org/vivo/>) research intelligence platform in Germany and Europe.

Projects on digitisation, mining and collaborative use of mostly non-textual material include the organisation of hackathons like Coding Da Vinci (<https://codingdavinci.de/>). The event brings together computer science, information science experts and scholars from the humanities to work on cultural data.

The third focus is to openly share knowledge. The Generation R platform (<https://genr.eu/wp/>) provides knowledge about open science on a meta level. Furthermore, the OSL organises book sprints on diverse topics where experts come together during a short but intense period of time, mostly for a week, to write a digital book on a specific subject. Finally, the OSL fosters collaborations in the research environment including Wikimedia Germany, Volkswagen Foundation and Stifterverband.

#### *Scientific Data Management*

The Research Group Scientific Data Management tries to find answers on how to collect, analyse, and preserve big data in science and industrial research. When TIB conducted a survey a key finding was that scholars consider the library a trustworthy institution to extend its services to the important category of mass data collections. That not only led to implementing an infrastructure to archive and provide big data but also to define ethical and scientifically sound best practices to (re-)use it. Projects include the Horizon 2020 project IASIS (<http://project-iasis.eu/>) or BigMedilytics which comprehensively tackles challenges of big data in the medical sciences, or the Horizon 2020 funded PLATOON (<https://www.tib.eu/en/research-development/project-overview/project-summary/platoon/>), a digital platform and analytics tools for energy.

#### *Visual Analytics*

The Visual Analytics Research Group studies the new library collections of films and images. Until

recently, in interpreting visual content humans were superior to computers, but of late neural nets outmatch us increasingly often. An award-winning task is the intelligent geolocation tool which ingests a photo and assigns it a point on the world map. So far this might appear a recreational magic trick. The vision is to extract context information from all sorts of images or to detect discrepancies between spoken text and linked images. The VIVA (<https://projects.tib.eu/en/viva/projekt/>) project aims at automatic analysis of visual concepts as well as person recognition in large video collections; in this case, the baseline is video footage from the late GDR. Another endeavour is iArt (<https://projects.tib.eu/en/iart/about/>), an exploratory interactive image retrieval system, which allows users to search and explore large image databases of art history.

This illustrates the various approaches to maintaining new data collections and making them accessible for open research. Of course, the research groups do not work in isolation but collaborate with each other and the operational side of the library as can be exemplarily shown by FID move – an information research project creating a specialised information service for transportation science.

### **A Specialised Information Service for Transportation Science**

#### *A Brief Introduction to the Specialised Information Services*

Since 2014 the paradigm of a distributed national library with a main focus on collection management has been transformed into a community-oriented e-infrastructure that aims at time- and space-independent information supply and research services. The programme of the specialised information services has supported a shift from printed to electronic literature especially in the Humanities, but has also created opportunities to optimise library collections and services for upcoming multidisciplinary or niche fields.

#### *The Specialised Information Service for Mobility and Transport Research*

In recent years the multidisciplinary subject of transportation science which incorporates engineering, social sciences, and the sciences have become of political interest because it is the scientific foundation to lead the society through the "Verkehrswende". The term describes the shift from individual mobility of fossil fuels to intelligent and ecologically and socially sustainable mobility. TIB and the Saxon State and University Library Dresden (SLUB) implement a digital research environment for traffic science, the Specialised Information Service for Mobility and Transport Research (<https://www.fid-move.de/>) called FID move<sup>2</sup>. It focuses on four key areas:

<sup>2</sup> In German Fachinformationsdienst Mobilitäts-und Verkehrsforschung, abbreviated FID move.

The first is a web portal aggregating all relevant services and products, the second is a consulting service with emphasis on Open Access publications, the third focuses on research data including advice in research data management and the development of a subject-specific research data repository, and the third is the community navigation service Research Compass where topics, scientists, and research groups can be explored. Among the challenges of the first area, the web portal, there is the development of a subject-specific, multilingual thesaurus complying with semantic web standards. This ambitious task illustrates the need for library experts who are experienced with authority data and knowledge engineering experts to join forces.

*A Subject-specific Thesaurus for Transportation Science*  
Building a thesaurus is an ungrateful task at best because it is an invisible support for users and an academic indulgence for scientists. In library catalogues, a thesaurus may extend a keyword search to synonyms, alternative spellings, or search for the same term in another language. The underlying semantic structure allows for topical browsing. Latest research shows that literature indexed with a (subject-specific) thesaurus can document the whole evolution of a subject and the taxonomy therein (<https://www.tib.eu/en/research-development/project-overview/project-summary/texttransfer/>).

In transportation science the negotiation of a common vocabulary between the different research areas involved is a frequent requirement. In expert interviews researchers reported they create a new Excel sheet dictionary for each new project or collaborator. The term *roundabout* serves as an example: Only considering English it has at least six more commonly used names like *island*, *rotunda*, or *circular junction*. Even among scientists there is not one unique term that everyone can agree on or that is not absolutely prone to misconception.

There are subject-specific or general controlled vocabularies already but no one-fits-all solution so far. Either they are only in German or in English, or they exist as a basic collection of words, or the semantic structure is not compatible with existing

standards. TIB has started the effort to transform relevant controlled vocabularies to meet the SKOS standard (<https://www.w3.org/2004/02/skos/>) and then align them.

The vision is not to build another vocabulary but connect them, enable intermatching and contribute new concepts where needed. Figure 4 indicates a network of general and subject-specific controlled vocabularies established in information and transportation science. One of the main challenges will be to make different conceptualisations transparent.

## Conclusion

The German National Library of Science and Technology is a dedicated memory institution for the Digital Age that does not neglect its experience from the past but enhances it by a philosophy of user-centred services and by improving on the basis of its own research. Information and research expertise are both needed to successfully implement a specialised information service for the politically and socially meaningful transportation science. Eventually, zooming in a little further, the example of building a subject-specific thesaurus emphasises the challenges and opportunities for an optimal infrastructure in research.

FIDvoc and its sources

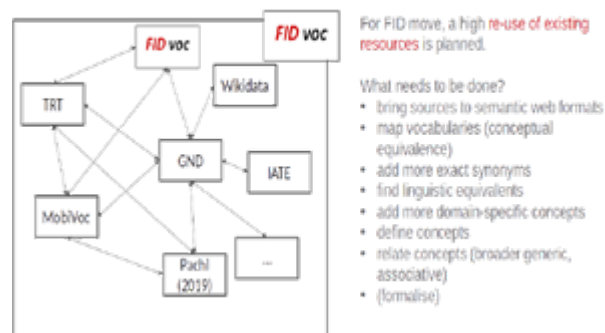


Figure 4. A schematic illustration of a virtual thesaurus network for transportation science

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