Bachelorthesis

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Digital Publishing in Engineering Research and Development

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Digital Publishing in Engineering Research and Development

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Abstract

Purpose – This bachelor thesis discusses the various publishing concepts in engineering and their development through the age of digitization. In addition, the changes and expansions of science communication are reviewed. In particular, the presentation and visualization of results and the access to science in various digital forms changed significantly.
Methodology – The publication strategies and their aspects in the digital publishing concepts are explained.
Findings – Results provide a large and informative overview of publishing concepts in today's research and development landscape. Students and engineers can learn about different publishing strategies and understand their sustainability.
Practical implications – By applying digital publishing concepts, the way in which knowledge and research results are shared can be significantly influenced and a greater reach can be achieved. In addition to the importance of effective communication and dissemination of results for researchers and scientists, such publication strategies are also conducive for young students and engineers in developing their own careers. Knowledge of publishing concepts and their application can have a positive effect on the individual's integration into a company or research institute.
Social implications – Science communication in digital form is easy to handle. Especially for research and development, it is important that the results are disseminated without obstacles. Advanced knowledge and new developments can be made accessible to almost everyone with the help of digital science communication and Open Access.
Originality – A clear presentation of digital publishing concepts is made available to students and researchers.

Name des Studierenden
Salar Ali

Thema der Bachelorarbeit
Digitales Publizieren in der technischen Forschung und Entwicklung

Stichworte (GND)
Luftfahrt, Ingenieurwesen, Digitalisierung, Forschung, Entwicklung, Wissenschaft, Wissenschaftskommunikation, Veröffentlichung, Open Access

Kurzreferat

Zweck – In dieser Bachelorarbeit werden die verschiedenen digitalen Publishing Konzepte im Ingenieurwesen dargestellt und darauf eingegangen, wie sich diese durch das Zeitalter der Digitalisierung entwickelt haben. Zudem wird veranschaulicht, wie sich Wissenschaftskommunikation durch den Einfluss von digitalen Publishing Konzepten nachhaltig verändert und erweitert hat. Insbesondere die Darstellung von Ergebnissen und der Zugang zu Wissen in verschiedenen digitalen Formen hat sich stark verändert.
Methodik – Die Veröffentlichungsstrategien des Digital Publishing werden erläutert.
Ergebnisse – Das Ergebnis liefert einen großen und informativen Überblick über Publishing Konzepte in der heutigen Landschaft von Forschung und Entwicklung. Studierende und Ingenieure lernen verschiedene Veröffentlichungsstrategien kennen und verstehen deren Nachhaltigkeit.
Bedeutung für die Praxis – Digital Publishing Konzepte verändern die Art und Weise, wie Wissen und Forschungsergebnisse verteilt werden. Es kann eine erheblich größere Reichweite erzielt werden. Das ist wichtig für Forscher und Wissenschaftler. Für Studierende und Ingenieure ist das wichtig für den Aufbau der eigenen Karriere. Das Wissen über Publishing Konzepte und deren Anwendung kann sich positiv auswirken beim Einfügen in ein Unternehmen oder in ein Forschungsinstitut.
Soziale Bedeutung – Wissenschaftskommunikation in digitaler Form kann recht einfach gestaltet werden. Gerade für die Forschung und Entwicklung ist es wichtig, dass Ergebnisse ohne Schranken kommuniziert werden. Mithilfe digitaler Wissenschaftskommunikation können Wissen und neue Entwicklungen für jeden mit Hilfe von Open Access zugänglich gemacht werden.
Originalität – Eine übersichtliche Darstellung von digitalen Publishing Konzepten wird Studierenden und Forschenden zur Verfügung gestellt.

HAW HAMBURG

DEPARTMENT OF AUTOMOTIVE AND AERONAUTICAL ENGINEERING

Digital Publishing in Engineering Research and Development

Task for a *Bachelor Thesis*

Background

As an individual in a company or as part of the international science community the need arises to communicate/disseminate our work results among our peers. Today the communication and/or dissemination will primarily be digital, but in most cases remains traditionally based on writing. Other means of digital communication (voice, graphical, video, data centered) are possible, but not the main focus of this thesis. A company would have (hopefully) defined its product centered communication strategies and standards. Information will primarily be pushed through the organization as need to know requires. Corporate research results are archived and kept secret, protected by patents, or shared with the international science community. In the international science community, the information is rather pulled by researchers in literature reviews. For this reason, researchers make their results publicly available in established databases and/or consider alternative means of dissemination through the Internet.

Task

The thesis presents an overview of the various modern digital publishing concepts and provides young readers with a hands-on experience ranging from scientific writing to publishing strategies for their own career development, be it in industry or academia. As such, the report gives an introduction to all major aspects of "Digital Publishing in Engineering Research and Development". Topics covered in this thesis are:

- Possibilities in Academic Publishing
- Open Science
- Digital Preservation
- Understanding Repositories and Machine Readable Web Pages
- Dissemination with Academic/Professional Social Media
- Hands-On Experience: Publishing on a PrePrint Server

The report has to be written in English based on German or international standards on report writing.

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List of Abbreviations

AI	Artificial Intelligence
ARK	Archival Resource Key
CAD	Computer Aided Design
CC	Creative Commons
COinS	ContextObjets in Span
CSS	Cascading Style Sheets
CV	Curriculum Vitae
DCMI	Dublin Core Metadata Initiative
DDC	Dewey Decimal Classification
DINI	Deutsche Initiative für Netzwerkinformation
DMS	Document Management System
DOI	Digital Object Identifier
GND	Die Gemeinsame Normdatei
HTML	Hypertext Markup Language
ISBN	International Standard Book Number
ISSN	International Standard Serial Number
LCSH	Library of Congress Subject Headings
ML	Machine Learning
NBN	National Bibliography Number
OA	Open Access
OAI	Open Archives Initiative
OAI-PMH	Open Access Initiative Protocol for Metadata Harvesting
OER	Open Educational Resources
OSS	Open Source Software
ORCID	Open Researcher and Contributor Identifier
PDM	Product Data Management
PDF	Portable Document Format
PDF/A	Portable Document Format Archive
PID	Persistent Identifier
PLM	Product Lifecycle Management
RD/R&D	Research and Development
RE	Requirements Engineering
RVK	Regensburger Verbundklassifikation
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
URN	Uniform Resource Name
W3C	World Wide Web Consortium

1 Introduction

1.1 Motivation

Since the beginning of industrialization, technical research and development has advanced rapidly. Automation in industries and computers in general are indispensable for today's technical development. For science, an important task has always been to be able to communicate and pass on newly acquired knowledge. Researchers can thus gain better knowledge and advance research. For centuries, mankind and science have used and continue to use the two core methods for this purpose: Firstly, the oral presentation of information. Secondly, the dissemination of knowledge and results in the written form on paper or in books. The age of industrialization and the subsequent digitalization, science communication gained new and revolutionary possibilities.

Here at the University of Applied Sciences in Hamburg - HAW, as for other colleges and universities, the influence of digital possibilities on university life has been enormous. So-called electronic learning platforms, such as our university-internal EMIL, have become indispensable for successful studying at HAW. This allows lecturers the opportunity to make documents and other information papers, even entire lecture videos, available to students. Students can use the platform to obtain important documents and, if necessary, exchange information with one another or with professors. Communication in the digital world in the form of mail exchange or video conferencing can be much faster than before. For example, one hundred years ago when the means of digital communication was not available.

It must always be kept in mind, that the digital age of the Internet is still fairly new. The World Wide Web as we know it and the digital publishing that goes with it has been around for about thirty years - on the other hand the printed book is over 500 years old.

Researchers especially, can use digital publishing to make their findings available in established databases or consider other alternative ways of disseminating them via the Internet. While this technical progress brings mass amounts of opportunities, it is nevertheless worth mentioning that not all areas of business must be positively affected by it. In the newspaper industry, the ability to publish digitally has caused entire industries to tremble. The downfall of the newspaper industry results from the fact that advertising is increasingly migrating to the Internet and circulation is falling sharply. The mainstay of financing is therefore suffering an enormous setback, and professional journalists are feeling increasingly exposed to pressure from amateur publicists. For many newspapers, moving to the Internet appears to have a financial obstacle. Giving away expensive content for almost nothing is not a sensible way to run a business. Instead, newspapers sell their entire issues separately in several articles, or alternatively offer their bundles of press products at a flat rate.

The digital publishing option has also had a largely disillusioning effect on the book market. So-called “self-publishing” occupies the segment of the market. Instead of traditional intermediaries, such as book publishers, products are offered directly to marketers via online marketers. This results in a negative impact on the many small companies in the publishing industry, as the cost of the technology is almost prohibitive. Instead, large and influential companies such as Amazon or Google are given the opportunity to enter the publishing business and dominate it to a large extent.

Likewise, Encyclopedias such as Brockhaus are losing their value due to the upheaval in the publishing industry. Whereas in earlier times these bundles of knowledge were still regarded as an essential feature of solid information, in present time, they are rather unknown to a large proportion of younger generation.

1.2 Title Terminology

The title of the bachelor thesis is "Digital Publishing in Engineering Research and Development". In the following, each of the terms contained in the title is defined.

Digital Publishing

Publishing in general is the public presentation of information and/or results, for example in books or scripts. Digital publication primarily refers to the publication of an article or information in publishing houses or on online platforms. They therefore include publications that are primarily accessible digitally.

Research and Development

According to the **Gabler Wirtschaftslexikon 2018**, research and development is defined as follows:

> *"Research and development mean the systematic search for new knowledge using scientific methods in a planned form. While research is the general acquisition of new knowledge, development deals with its first concrete application and practical implementation."*
> *(based on GABLER 2018)*

Research describes the general acquisition of results and knowledge. Development means to concretize and apply new knowledge and furthermore to result into practical implementation.

1.3 Aims and Scope

For an individual in a company or anyone within the international knowledge community, the possibility of digital knowledge communication is almost indispensable today. The aim of this thesis is to present the development and influence of digital publishing in today's research and development and to help young students especially in entering the professional world. In doing so, it aims to illustrate the different concepts and thus provide the opportunity to gain practical experience from scientific writing to publishing strategies. This can be very helpful for one's career development and integrity in business or research.

1.4 Structure

This work is divided into the following sections:

Chapter 2 Introduction to general publishing methods and media with regard to the increasing influence of digitization.

Chapter 3 Explanations on academic writing and dissemination of publications. In addition, academic publishing strategies and legal aspects on intellectual property.

Chapter 4 This section deals with open science and its methodologies. Furthermore, the possibilities which continue to be developed due to the digital turnaround.

Chapter 5 This part is devoted to the digital approach to preservation and archiving in electronic resources for various data.

Chapter 6 Notes on the creation and design of machine-readable pages and references. In addition, the influence of metadata is discussed.

Chapter 7 Here, the advanced use of repositories for primarily scholarly purposes is covered in more detail.

Chapter 8 Description of various social media and platforms that have established themselves in research and development and are increasingly shaping career or corporate strategies.

Chapter 9 In this final chapter, the previously described methods and procedures are applied to a practical example and a preprint on wind energy is prepared for publication. The individual steps are shown.

Chapter 10 Summary of the thesis results.

Chapter 11 Recommendations for further investigations.

2 Basics and General Concepts

The following section illustrates basic methods for publishing and distributing literature or articles to be published. The individual subsections also discuss how these concepts have been influenced by increasing digitization.

2.1 Edition

The term edition in publishing comes from the Latin term *editio* and translates as publication. An edition thus describes the preparation of a publication for publication. While editing is more related to the tasks of a journalist, editing aims at a kind of restoration of the original text of an author. Editing is therefore mostly done by publishers. It should be possible to provide the reader with a trustworthy text. For the editor, the task is that they adapt the author's sources according to the usage of the language and the modern times. The goal of the edition or the editor is thus to determine the relationship between the original and the self-edited text. For example, the spelling can be adapted if the original spawns from an old time, in which spelling and grammar deviate from today's norms. Accordingly, the use of language can also be modernized, and vice versa, there is the possibility of faithfully recreating the original text. Thus, the editor must make decisions about how to adapt the templates, whether to adapt them at all, and the extent to which certain parts of the source are of greater importance or which may be less significant (HISTORICUM 2014).

In professional publishing, in addition to the editorial text, editors prepare a so-called editorial note or editorial report. In it, the editorially made decisions are justified. Editorial reports become significantly important when older versions of the source text are available or even when there are several older versions that differ in literary characteristics.

Poorly made editions very often omit such a report or in worst cases fail to note editorially made decisions. Such an editorial note can therefore serve very well as an indication of whether the edition at hand is reliable or not.

2.2 Dissemination

In science, unlike in medicine, the distribution of research results is referred to as dissemination. The term translates as a sowing or scattering and comes from the Latin term *disseminare*, which translates as "to sow." Scientific research results are increasingly becoming more and more comprehensive. To avoid the latter being available in reduced and summarized form to more than just relevant audiences, science uses dissemination to spread results. In this way,

knowledge from science can be disseminated and made known beyond the professional group. In medicine, the term dissemination is used for the description of disease symptoms and their distribution in an organ system. Well-known diseases and diagnoses in which the term is used include multiple sclerosis or infectious diseases such as tuberculosis. For diagnostic criteria and assessments, dissection is considered, among other things, as a guide to the progress of a disease (DORSCH Lexikon).

2.3 Advertising

Most of the people today turn to the Internet to find information for products, read ratings and reviews from other consumers, and make purchases online. Increasing digitization has thus also had an impact on marketing and advertising. In the past, the classic and familiar form of advertising was predominantly related to print media, for example newspapers and brochures, as can be seen in Figure 2.1. It is known from the past that the distribution of these print media was predominantly via direct mail or in the form of flyers. Digitization and the possibility of distributing advertising digitally stand out from print media in one crucial factor: the possibility of making advertising interactive.

Figure 2.1 Prospect of the journal Bild der Wissenschaft (WISSENSCHAFT.DE 2022)

The advantage here is that further relevant aspects can subsequently be drawn from it with the help of web analytics. For example, the next digital advertisement for the consumer can be tailored and adapted to his or her needs. Figure 2.2 illustrates an example of interactive advertising.

Figure 2.2 Display advertising of Pattison (TOBESOCIAL 2013)

According to a **2012 paper by Tugba Ceren Topcu** at Humboldt University in Berlin entitled "The Value of Advertising in the Digital World," digitization is causing the convergence of different media sectors. The power of the Internet in today's world continues to grow, either as a medium or as a space for action. According to a study by ARD and ZDF from 2021, around 67 million people in Germany use the Internet and are therefore online (BEISCH-SCHAEFER 2020). This corresponds to about 80 percent of the total population in Germany and has thus increased by about 20 percent compared to 2006 (2006 about 59.5%). The importance of electronic media has increased enormously and continues to do so day by day. It is therefore hardly surprising that advertising and information procurement for products are also increasingly common for consumers and society in paperless form (TOPCU 2012). Basically, according to an article by **Miriam Schäfer**, author at the dataloft agency, the digital form of advertising can be divided into two types: The so-called display advertising and native ads (SCHAEFER 2010).
Display advertising refers to the classic advertising form of print media in mostly pretty much the same interpretation in digital format, as shown in Figure 2.2. Like the classic advertising brochure or the advertising flyer and their superstructures, a kind of billboard is visualized to the consumer. This usually contains a picture combined with an advertising text – as it is already known from the past. There are different formats of display advertising. Advertising banners and advertising pop-ups are not foreign to most people. While advertising banners are usually found or seen in rectangular form in the upper area on websites, advertising pop-ups make themselves visible by suddenly appearing in dynamically selected places. Thus, in comparison to advertising banners, the actual action on the Internet is interrupted. Certain security tools and settings in the browser can help to disable advertising pop-ups. In addition to these two very familiar forms of display advertising, there are also so-called interstitials. The term may sound strange and meaningless to some, but most people are familiar with this form of display advertising. It is advertising that appears, for example, on loading websites or even better known as an interruption of videos that you watch on YouTube. Most people know it, they want to watch a video or are already watching a video and first an advertisement is played. Before the advertisement can be skipped, the user must endure the latter for a certain time. In this case, we are talking about display advertising as interstitials, see Figure 2.4.

Figure 2.3 Interstitial Advertising (ADVIDERA 2022)

Another type of display advertising is a so-called rich media ad. The interactive functionality is to be emphasized here, emphasizes Schäfer. The user can interact with this dynamic form of advertising, for example, by scrolling or clicking on additional fields. Interstitials can also be a kind of mixture of rich media ads themselves. If we stick to the example of YouTube, the interstitial ads may also appear with, for example, the possibility to scroll or click more buttons in the ad display.

Compared to display advertising, native ads can be considered as a kind of natural ads. Natural in the sense that such advertisements fit practically seamlessly into the environment in the digital field. The term, which comes from the Latin language, means something like *innate* or *natural*. For the digital field, this means that this type of advertising appears visually more as a fixed component of the content called up and is therefore not usually perceived or considered as advertising. To get a better idea of this, let us look at everyday situations where we encounter native advertising. For example, the user searches for products via search engines such as Google. In almost all search engines, advertisements can be found in native form. If you look at the search results, you will often see ads to the left or right of the title of the link, such as **Advertisement** or **Sponsored**, next to the relevant links. And this is even though the ad often has little or nothing to do with the actual search or deviates strongly from the product searched for. In this case, we are talking about digital advertising in native form, because the user notices these ads from time to time, but they do not interfere in the environment or are simply skipped or scrolled away. Businesses pay search engine operators accordingly to be able to use this type of advertising. So-called “product placements” are also a form of native advertising. In this case, products appear in the content of a video format, for which a provider advertises

accordingly. However, these products are not directly related to the actual content of the video itself. Advertising by influencers and ads within social media networks in general are also native. In the case of influencers, products from partnerships with marketers are presented in return for payment and posted on their far-reaching channels with corresponding advertising messages. Ads on social media platforms appear in the news feed or between story posts, the same way as in search engines (SCHAEFER 2010).

In addition to these two major categories of digital advertising, there are also formats such as advergaming advertising or e-mail advertising from, for example, newsletter subscriptions or spam. Most people are familiar with the latter; advergaming advertising refers to advertising games that serve advertising in an entertaining form. Unlike other forms of advertising, which are usually perceived passively, advergames give users the opportunity to engage with the advertising message actively and voluntarily. Unexpectedly, this circumstance brought great satisfaction and sympathy from most users. **In 2002, the Bochum Institute for Applied Communication Research** came to the following conclusion in a study: "While almost 90% of all test persons judge TV commercials as annoying, advertising in advertising games meets with sympathy from more than half of them. Companies use advertising games to try to obtain address data of potential customers for further marketing purposes and measures, among other things. It is not uncommon for the full use of a game to usually require registration by the user in order to participate in sweepstakes or use the game to its full extent, according to the Bochum Institute in their study (BIFAK 2002).

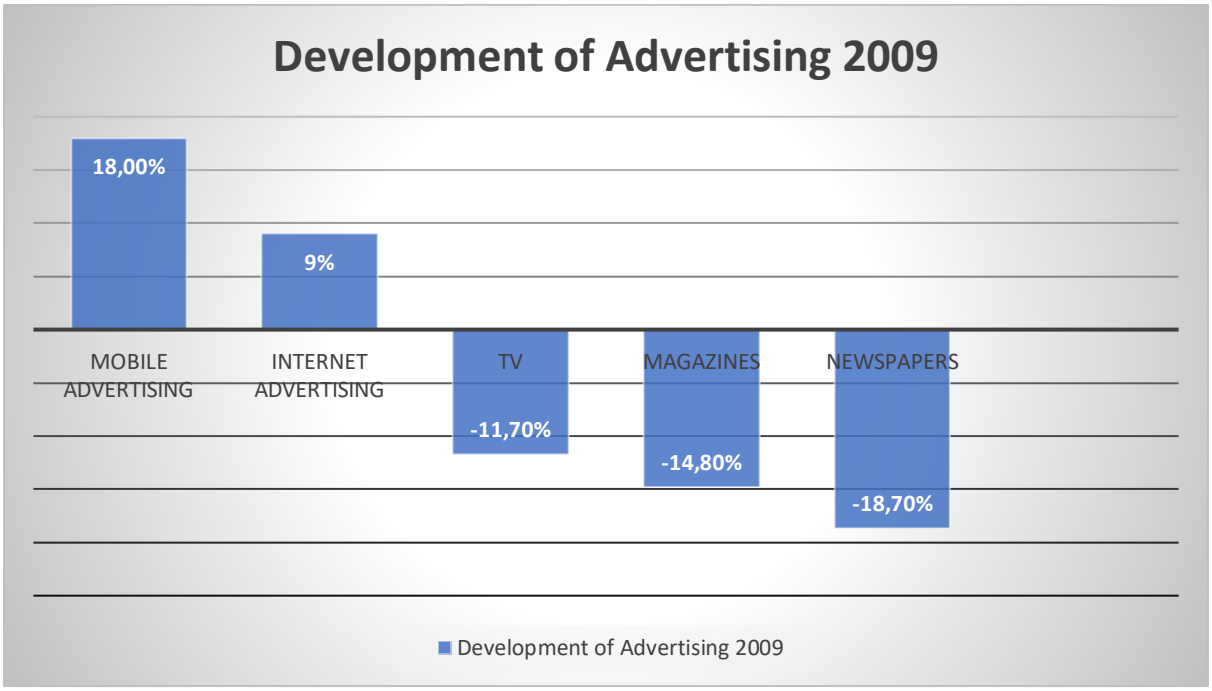

Figure 2.4 Statistics of the increase and decrease of advertising in media 2009 (SPOTLIGHT 2014)

2.4 Academic Publishing

Academic publishing is undergoing major changes because of increasing digitization and is in a state of transition from printed to electronic format. The focus is on the dissemination of academic research and science. The form of publications primarily includes books, scientific journals, or dissertations. Based on the form of peer review or editorial review, articles are prepared and qualified for publication. Peer review describes the form of evaluation by so-called "peers", i.e., by independent reviewers or scientists from the same subject area. Figure 2.5 shows how a peer review can proceed.

Figure 2.5 Steps of a Peer-Review-Process (WILEY 2022)

For the evaluation, there are various standards set by the publishers themselves that must be adhered to. Mostly, the academic journals work with their own methods for this or have their own publication facilities. However, it is not uncommon to find academic journals that act in an interdisciplinary way and publish articles from different fields or sub-fields. It is not only in peer review and quality assurance that there are different procedures in individual publishers and journals. The form of the publications themselves can also differ enormously.

Academic publishing in today's digital world is usually based on open access publications. Here, articles are made available by publishers on the Internet free of charge to everyone at the time of publication. In order to be able to finance themselves fees may be demanded from the author for the processing of their article. Often these fees are shifted from the reader to the researcher or the researcher's source of funding. The Internet has made it easier for open access self-archiving to take place. Authors can thus make copies of their articles themselves available

on the Internet free of charge. However, it should also be mentioned here that the degree to which the publisher is known can have a major influence on the reach and broad publicity of the article. Thus, it can sometimes be more advantageous for an author to publish with a well-known publisher with a wide reach and to incur possible costs, rather than to publish it himself/herself for free in a "place" that may have less name recognition or spread less quickly. The fact that the business models in the electronic form are different than before has meant that since the 1990s electronic resources, especially their licensing, have become very widespread. Especially for scientific and non-scientific journals, access to the Internet is thus of great importance and significance.

To boost one's own scientific reputation, the author's goal is to have his results disseminated as widely as possible and cited as often as possible. On the one hand, this can raise one's own profile and, on the other hand, ideally earn good money. Scientific publications that receive a lot of attention often play a major role in the allocation of research funds. As already mentioned, the basic principle for the author is to publish the article in an internationally recognized journal rather than in two or three smaller and less prestigious ones (ACADEMICS 2021).

2.5 Research and Development

The following section describes how digitization is impacting and has impacted research and development, also known as R&D or RD for short, particularly in the engineering world.

Basically, according to the **Gabler Wirtschaftslexikon 2018**, research and development can be divided into four categories or functions in terms of their application reference. Basic research forms the basis, while the other functions include technological development, pre-development, and process and product development. The last two categories play a role for the economic and market-oriented area. In their functions, the goals are primarily to make the already finished product marketable and to introduce it to the market after technical implementation. Before this can happen, it first requires basic research and subsequent technology development. In basic research, the focus is primarily on gaining new knowledge and experience, with research taking place primarily in universities or in institutions. Resulting findings can thus be used as a basis for application-oriented knowledge. Based on this and on practical experience or application-oriented knowledge, results obtained can be used in technology development to solve practical problems with the help of technology. In this way, existing methods and technologies can also be further improved (GABLER 2018).

Digitalization and the associated dynamics can influence the competitiveness of research and development as well as the overall success of a company. As part of a research project, Groningen University of Applied Sciences, with the support of **EARLY BRANDS** as an innovation and technology consultancy, has prepared a study that shows which topics are strategically

relevant regarding digitization in the context of R&D (EARLY BRANDS 2022). In an online survey, more than 600 selected top decision-makers and experts from research and development were questioned throughout Germany. According to their statements, the dynamics of digitization bring challenges with them that present companies with strategic and operational upheavals. The experts identified four top challenges. More than 83% of those surveyed believe that digitization will lead to increased efficiency requirements for research and development activities within the company. In second place, at around 80%, is the expert view that customer demands regarding new products and services are also increasing significantly. Furthermore, research and development in companies are under increased pressure to ensure that technologies and future-oriented topics that are decisive for competition are used earlier. This view is shared by around 76% of the experts. The fourth place of the top challenges is occupied by the increase in the demand for speed in processes of research and development as well as networking within and outside companies. The latter leads to the next part of the study or its findings, namely how digital solutions and tools can help address these challenges in the future. Organizational, coordination and analysis activities should be made more efficient and powerful. As with the top challenges, the four top opportunities through digital solutions were compiled for this purpose. Around three-quarters of the experts think it is important that virtual collaboration is significantly supported, and that facilitation is required regarding the management of R&D activities, technologies, and future topics. Around 65% also support the finding that it is important for R&D projects to analyze and present the economic viability and that coordinated research and development can be carried out regardless of location. This leads us to the consideration of the importance of stationary and mobile applicability in the approach to the solution. Both stationary and mobile work play an important role in the successful practical use of digital solutions. Especially the mobile or location-independent application finds more importance than before due to the influence and the increasing use of mobile devices, such as tablets or smartphones. The possibility of, for example, cloud-based data access for research and development teams is becoming increasingly important. For a correspondingly high level of data security, people also want stationary solutions with local data storage. About half of the experts are of the opinion that both types, i.e. both stationary and mobile applicability, are significant for successful practical use in the company and for the requirement of data security. Approximately 30%, and thus slightly more than half of the other half, consider stationary applicability to be more important, while 20% of the experts consider mobile applicability to be more important in today's environment. For the use of digital solutions and tools, the study concluded by identifying the four top performance requirements for digital tools and solutions in research and development. With 80% participation, the experts believe that accelerating activities in R&D is the most important performance requirement for strategic support in the company and at the same time for successful collaboration. More than 70% also think that facilitated planning of activities must be available for this. Slightly more than 60% of the experts consider it important that existing technology portfolios are further developed and aligned. And another 60% feel that it is important to be able to identify and tap into key technologies earlier (EARLY BRANDS 2022).

To summarize, the study shows that R&D experts see innovative software offerings and digital tools as the key for enabling companies to meet the increasing demands for efficiency and performance regarding the influence of digitization. Especially the effective networking of employees and partners as well as the support of strategic alignments of R&D topics and the acceleration of their activities are in the foreground. The ability to work both, stationary and mobile, is indispensable for successful use. In addition, high security standards and optimal integration into the existing IT structure are important requirements. About research and development, digital solutions thus offer decisive competitive opportunities and advantages in terms of strategic alignment of the R&D portfolio, accelerated processes and facilitated collaboration.

2.6 Engineering in the Digital Turnaround

For a long time, engineering was considered an applied natural science. The focus is on research and development, design, production and testing of scientifically technical products. In contrast to the history of technology or the philosophy of technology, engineering sciences deal with already existing technology and its possible future implementation or improvement and expansion. Nowadays, engineers work increasingly interdisciplinary. In addition to the findings of the natural sciences, economic, intellectual and socio-scientific aspects are also integrated. But the question now arises: How has the rapidly increasing digitization affected the world of engineering and its technology?

In the following, an overview is provided. **In an advertisement from 2019, verlag moderne industrie GmbH** puts forward the thesis that classical engineering is increasingly developing in the direction of digital engineering or has already done so within the last years (ITEM 2019).

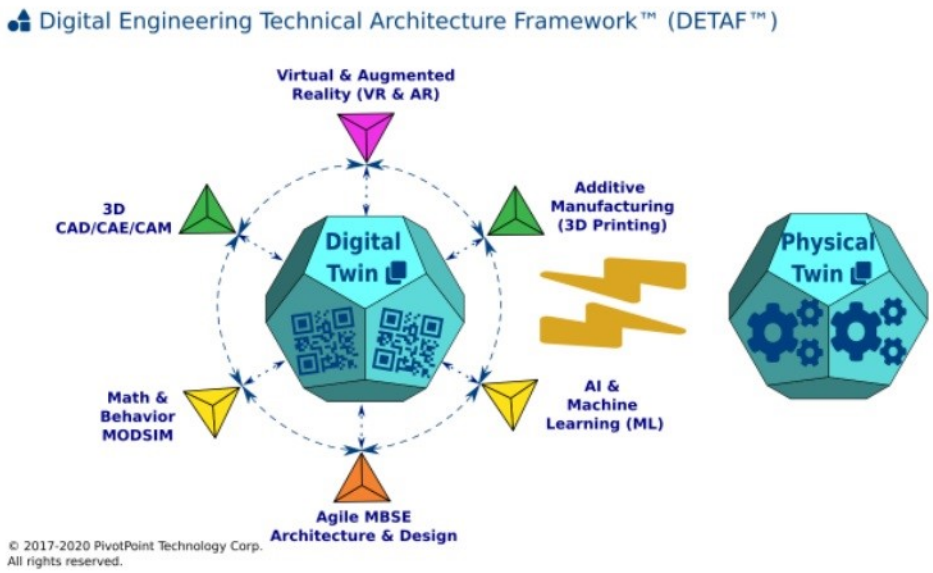

Figure 2.6 Digital Engineering Technical Architecture Framework (DEG 2022)

Digital engineering refers to the design work of the engineer considering new types of digital tools. In this context, not only conventional CAD programs play an important role. Because beyond that, the networking of the design engineers is far in the foreground. For example, with so-called "item engineeringtools", designs can be shared and edited with colleagues all over the world, thanks to globally unique project numbers. As we learned earlier in the section 2.5 Research and Development, the demands and expectations in engineering science are increasing significantly with the influence of dynamic digitalization. Both from customers and from companies themselves for marketability and competitiveness. Lead times in projects are becoming increasingly shorter, so new possibilities for process optimization can be crucial for decisive success in competition.

Mechanical engineering and innovations, especially digital ones, belong together, which is why many companies want to identify and set technical trends and innovations as early as possible. The focus here is on the gradual integration of smart and digital technology in various business areas. Comparatively small investments and innovations can already significantly increase efficiency and optimization processes. In order to be able to profit from the advantages of the digital transformation, the focus is being placed on ensuring that more and more digital elements find their way into the tactical-operational business processes of companies. Conscious and strategic corporate decisions are therefore required, which should primarily place value on successively digitizing various areas of operations rather than entire production facilities. Examples of this include the use of driverless and smart transport systems and the monitoring of machine data via tablets or other mobile devices. It is often the comparatively small interventions and changes in existing systems that can bring major competitive advantages. The rapidly increasing digital support of design and development processes is also being increasingly. With the help of digital engineering, which is being increasingly used in working practice, already existing digitized elements can be linked and expanded. And in the best case, even networked worldwide. The option of accessing project information online, without having to use special CAD readers, is bringing a lot of promising benefits. Through digital engineering, mechanical engineering can benefit from the digital transformation in a wide variety of areas and functions. It cannot be ruled out that in the future, in addition to the mere design, production and sale of products, revenues will increasingly be generated with services. These can be both maintenance and optimization.

As already mentioned, digital engineering extends far beyond the use of pure CAD programs and 3D data; the networking of engineers and their projects plays a greater role. Interlinked standard processes ensure that the designer does not have to deal with recurring tasks individually each time and this can thus be avoided. One example is the mentioned item engineeringtool, whose automatic functions can be used to streamline many steps in 3D design. Manual re-entry can also be automated, and input errors thus avoided. Further added value is provided by online archives with complete project histories and customer reconciliations (ITEM 2019).

2.7 Document Management

Document management or a document management system (abbreviated to DMS) is indispensable for successful work in a company. While in times before the digital turnaround, documents were stored in files and folders, and in some cases are still stored in this form today, it is now almost indispensable in modern companies to use electronic or digital software for this purpose. The possibilities and opportunities are manifold and can be used or integrated in many ways. The goal is no longer just to digitize documents, the DMS software also helps companies to organize and coordinate the development, revision, control and distribution of documents. It is therefore important that attention is paid to the appropriate solution already during the integration of the DMS software. To achieve this in a successful manner, a wide variety of technologies are available with, for example, artificial intelligence or cloud software. In order to bring this closer and to be able to demonstrate it, it should be explained how and for what the DMS software functions in general.

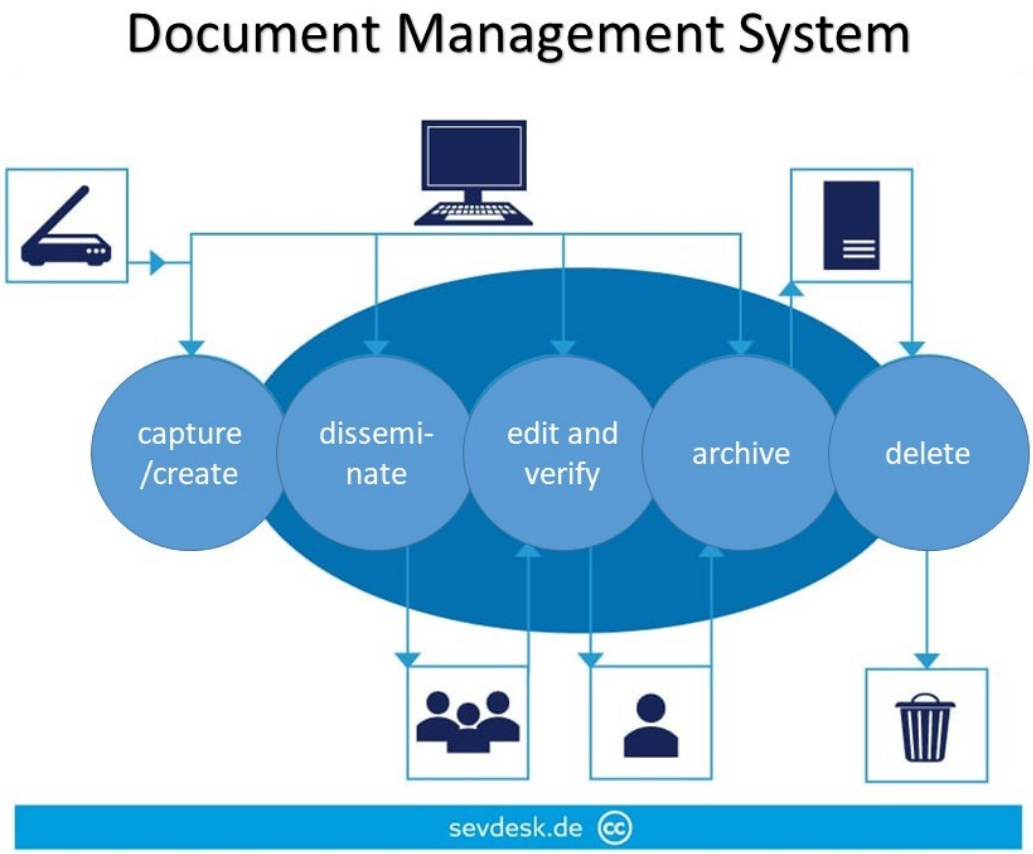

Figure 2.7 Structure and functions of a DMS (based on SEVDESK 2019)

The integration of artificial intelligence - AI and machine learning - ML in modern software makes management and archiving much easier. Archiving steps, for example, can be automated or shortened with their help; furthermore, the retrieval of documents is facilitated by speech or text recognition. Regarding the important data protection guidelines of documents, the DMS software can regulate the storage period. Documents that require to be destroyed or deleted after

a certain time would experience this step automatically and save the employees the effort for this. It is therefore also essential that employees understand the advantages and functions of the system in detail to use its full potential (EAS-MAG 2021).

2.8 Requirements Engineering

Section 2.6 Engineering in the Digital Turnaround examined and explained the influence of digitalization in engineering. The use of digital engineering and its functions has become established in most parts of the engineering world over the last few years. How has the digital turnaround affected requirements engineering - RE in this context?

Rene Schröder from Hanover, specialist and Head of Business Alignment at PwC Germany, the leading auditing and consulting firm in the Federal Republic of Germany, addressed this in an article published in **February 2021** and took a closer look at the new trends in requirements engineering in the digital age. Requirements engineering offers valuable solutions for service providers and customers. Yet, it requires time and resources from both sides. Construction projects, manufacturing IT, automation of entire process chains and documentation all require certain requirements. Here, a configuration software can provide opportunities to find the right choice. Without RE, there would be no digital communication between AI, machine and human in almost all industries. The requirements engineer visualizes a kind of interdisciplinary interface in different areas where requirements are important, for example between the company and the customer or between the industry and the raw material supplier.

RE brings success whenever there are various communication difficulties between the contracting parties and a business deal can be made through the specialized application of RE. The requirements are primarily based on expectations and the associated goals or customer requirements. To successfully integrate technical systems and softwares, all requirements must always be specified unambiguously, without contradictions, or completely. The task of the requirements engineer is to find a digital software solution for the existing task, adapted to the defined requirements. Creating a so-called “moving target” is the future trend here. Projects in the new digital transformation are based on requirements analyses and drive innovation processes. Like a flexible bracket, they can be laid over the entire project and supported adaptably with the help of digital skills and analog competence profiles (SCHROEDER 2021). Another soft skill, so-called “generalist thinking”, provides added value. This means that a basic understanding of the context must always be present to solve tasks.

In this way, RE is more of a continuous task, because being able to communicate good ideas is necessary for the requirements engineer to be a reliable architect for the customer in digitization issues and in requirements management. Continuously in the sense that his or her work is always based on the specific wishes and requirements and that the requirements engineer thereby

also forms a kind of basis for the digital further development of software, products and systems. In this way, processes or work steps can be shortened in a smart way or components of projects can be adapted to specific wishes. For example, standard software can be turned into a customized tool with a specific interface design, or a configurator can be turned into the lightweight counterpart for the perfect equipment of a bicycle. Requirements management thus forms a central fixed point for corporate success and combines digital craftsmanship with tools from all possible areas, such as analysis, big data, control or production. After prior consideration, the requirements engineer scales necessary standards in a process and adapts the solution accordingly for each project (SCHROEDER 2021).

2.9 Configuration Management

Like Document Management or Requirements Engineering, Configuration Management has adapted to the influence of the digital turnaround. In general, configuration management manages units of work results that describe the product or software, according to the **dormakaba Group**, global service provider for access and security technology, in a **2019** article by its editorial team. This can roughly be considered as a package in which all related work results, i.e., the individual units or configurations, are included, as indicated in Figure 2.7. Examples of such units are use case documents, test specifications and test data, meta and configuration data, or user documentation. In today's time one sets oneself increasingly apart from standardized products, customers require desires, which adapt to their specific needs and requirements. To enable customized product design, incrementally more companies are therefore using configurators.

With the help of these tools, it is possible to digitally represent product knowledge and business models and thus streamline digital planning and configuration management processes. First and foremost, therefore, it is a matter of process optimization and the integration of artificial intelligence, like in the other management areas. For a new customer, not everything has to be set up and generated from scratch; instead, configuration tools help to respond interactively to the customer's wishes. Various product combinations and options are given a digital presence at the customer's site, from which options can then be selected or adapted according to the customer's own wishes. Among other things, this saves the need for time-consuming consultations and follow-ups, as well as time-consuming processes for quotation generation and order creation. Furthermore, configurators help to avoid errors and increase security.

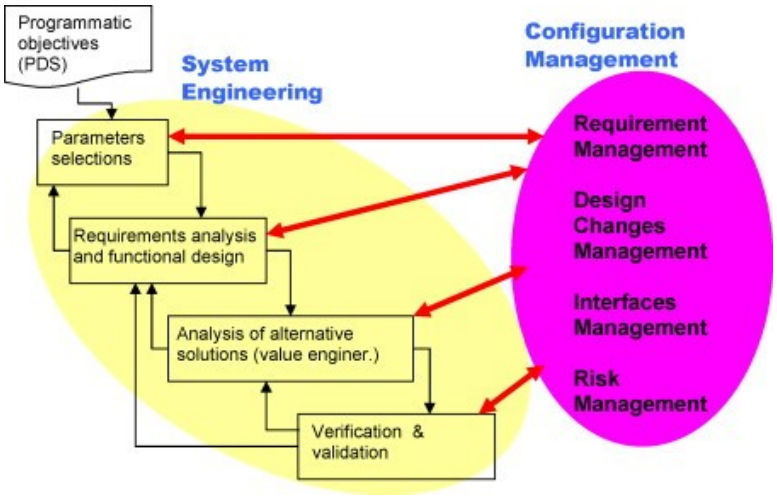

Figure 2.8 Systems Engineering and Configuration Management (SCIENCEDIRECT 2007)

Predefined rules for reliable configurations and binding prices make it possible to ensure safety during planning, reduce the risk of human error, and avoid costs for any rework that may be required. Automatic processes, which previously had to be carried out at great expense by employees with the appropriate knowledge, significantly optimize configuration usage. For example, when an order is received, it is entered into the digital planning tool and converted into a production order in the system without interference. Configurators as a digital tool increase efficiency in the company in many areas. For example, marketing and sales teams can focus on new customer acquisition, customer relationship management and maintenance instead of order processing. Development and product teams devote their time to planning innovations rather than preparing cost estimates. When purchasing configurators, it is important to remember that there are no universal standard solutions. Companies should always make sure that the system can act in a modular way and that this also provides expansion options for future requirements (DORMAKABA 2019).

2.10 Product Data Management and STEP

Product data management - PDM is closely related to configuration management. Its task includes the management and storage of product-defining, representing and presenting data because of product development. This data can be made available to the product life cycle in downstream phases. The basis for this is provided by an integrated product model. PDM systems implement the rules and methods of product data management in a company; they are thus part of the company's information and coordination system. As the core of a PDM solution, they deliver results that are intended to ensure the seamless reproducibility of work steps or configurations of a product. Information in PDM systems includes CAD data, models, part information, manufacturing instructions, requirements, notes and documents. Essentially, a PDM system provides solutions for secure data management, process implementation and optimization, and configuration management. Security and management functions are used to protect intellectual property. This includes, for example, role management or project-based access

rights. Both internal product teams and external partners are offered participation in the product lifecycle with the help of integrated workflow and process functions. The influence of digitization has had a particular impact here, as with the other management systems, on the optimization and automation of processes. Of course, a PDM is also used for existing products, for example, when data contained in them needs to be updated or new data added. PDM systems are therefore the hub for all related information during product development or updating. The CATIA program from Dassault Systems used at our university is also one of the PDM systems. The central tasks of PDM systems thus include, as we also know from CATIA for example, product structure management, variant and configuration management, the classification of products, material management or the product version history. PDM systems are primarily concerned with the process steps of product conception, specification, design and realization of the product (XPLM 2021).

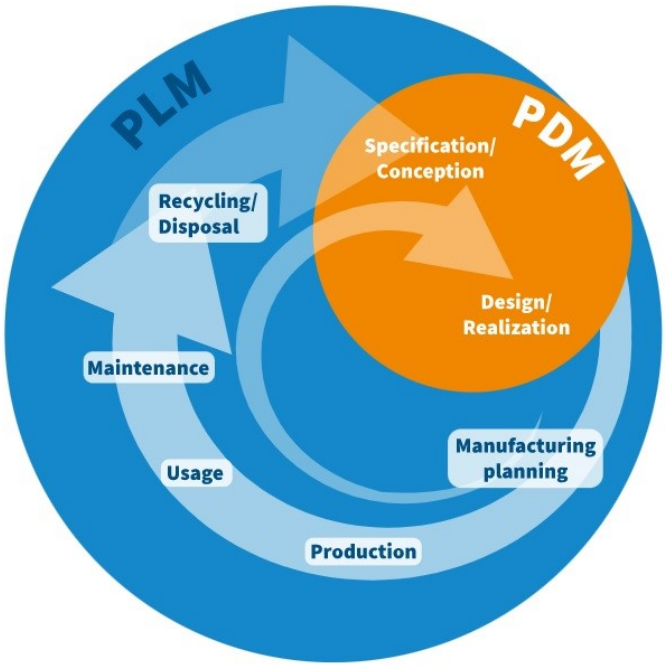

Figure 2.9 Product life cycle and product data management (XPLM 2021)

Since not all methods or rules of PDM are available in a PDM application system, the possibility of data exchange between the different system classes is required. For this exchange of data and the description of product models, the ISO 10303 series of standards, also known as STEP (Standard for the exchange of product model data), has become widely accepted. STEP is thus a standard for the description of product data, in which the functional aspects of a product are present in addition to the physical aspects. STEP can thus map product data information of the entire life cycle. Various application protocols are provided, which form a kind of package in which interfaces and data types are designed for a specific application. AP 203, for example, is particularly tailored to aviation and to the controlled configuration design management it contains (STEP 2000).

2.11 Corporate Communication and Press Releases

Corporate Communication is closely related to the concepts of data management from the previous two subchapters. Its possibilities are manifold. Communication and marketing can be used to manage the perception of the company both internally and externally. The goal is to maintain the reputation of the company (VOGT 2016). In addition, information is provided about important developments in the company. The essential difference to the concepts of data management is that, in addition to the company and the customers, public relations are also included. Important players in corporate communications thus include the press, associations, and other multipliers from the corporate environment. In this way, attention can be drawn to the company in a targeted and strategic manner through internal and external communication.

The influence of media reports can have both a positive and a negative impact on perception. It is therefore also important to be able to respond accordingly in a professional manner. During digitalization, the division between marketing and communication has narrowed considerably around corporate communications, especially due to the influence of social media. Whereas previously the product was usually marketed first, and only later coverage was achieved through a press article, for example, these two processes often run in parallel. Customer expectations have also changed due to the location-independent availability of information about companies, products, and services as well as the possibility of direct and sometimes public exchange. If these expectations are not met, customers have the option of switching providers or submitting a review with just a few clicks. Corporate blogs or e-mail marketing are also among the newer trends in corporate communications in the digital turnaround, as is the use of intranet platforms for internal corporate communications between employees. The important thing here is that the content is tailored in each case to the media channels, as well as the target groups operating there. Corporate communication is thus developing more and more toward empathetic communication focused on customer concerns (VOGT 2016).

Companies use press releases to inform the public about news on their own behalf. Here, too, the trend is moving in the direction of digitization; many newspapers and magazines can now be read online. It is important for the company that press releases are designed and formulated as well as possible. The two target groups that need to be addressed or convinced are the journalists, who decide whether to publish the article, and the reader.

3 Academic/Technical Dissemination and Publishing

3.1 Scientific Conference, Workshop and Lecture

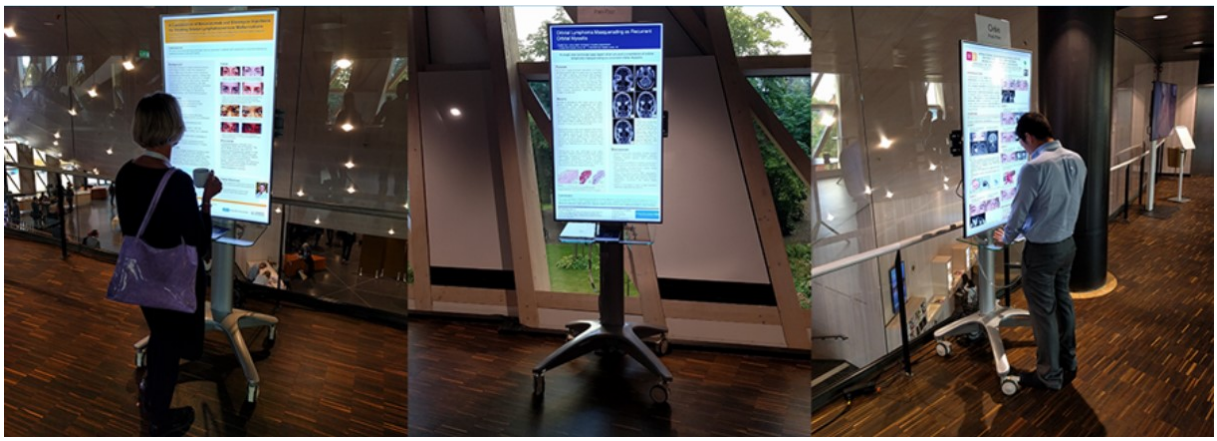

Figure 3.1 Digital poster session (GAP 2018)

Scientific conferences give researchers the opportunity to present their findings and work and to discuss them with each other. During such a conference, presentations are given in the form of short and factual papers, usually 10-30 minutes in length. Afterwards, the audience can discuss and exchange ideas for a few minutes. Poster sessions are also an alternative to oral presentations. They are in general more compact than oral presentations.

Due to the digitization, the use of electronic poster sessions has proven to be smart and helpful, as shown in Figure 3.1. On the one hand, space can be saved because the audience can also see several posters on one monitor. On the other hand, the ability to use moving images through electronic posters also plays a major role.

Larger conferences and their presentations are sometimes held in several parallel sessions. If a scientific conference takes place on a smaller scale, it is referred to as a workshop. They usually offer more room for discussion. Furthermore, scientific conferences can also be a combination of lectures and interactive formats.

In a so-called “conference volume”, the publications of contributions from scientific conferences and meetings are made available, usually in book form. But also, with the conference proceedings the trend has developed partly in the direction of the publication in electronic form (NEUHOFF 1989).

3.2 Scientific Journal, Peer Review and Metrics

Scientific journals are considered the most important medium for publishing new findings and methods from science and research. They include world-renowned journals such as *Nature* and *Science.*

Figure 3.2 Different Science journals (SLATE 2019)

It is often of great importance for the reputation and standing of a scientist to be able to publish in such journals. Before a paper is published, it is usually peer-reviewed by experts or other scientists in the field. If a scientist is considered to have a high level of expertise, he or she is invited by a scientific journal to participate in the peer review process. Such scientific journals are usually not aimed at the general public, but more at the experts. Access to such journals is therefore usually available in university or institutional libraries. Here, too, the trend of online access is developing during digitization, in addition to traditional access in printed form (HBI 2006).

The point of a peer review is to ideally fill scholarly journals only with articles that add value to the readers. The main advantage of peer review is the significantly increased quality of articles. For the procedure, there are usually two different ways regarding the anonymity of the reviewer and the reviewed. If the author is known to the reviewer, but the reviewer does not know the author, it is called the single-blind procedure. If both parties are anonymous, it is called the double-blind procedure, as shown in Figure 3.3.

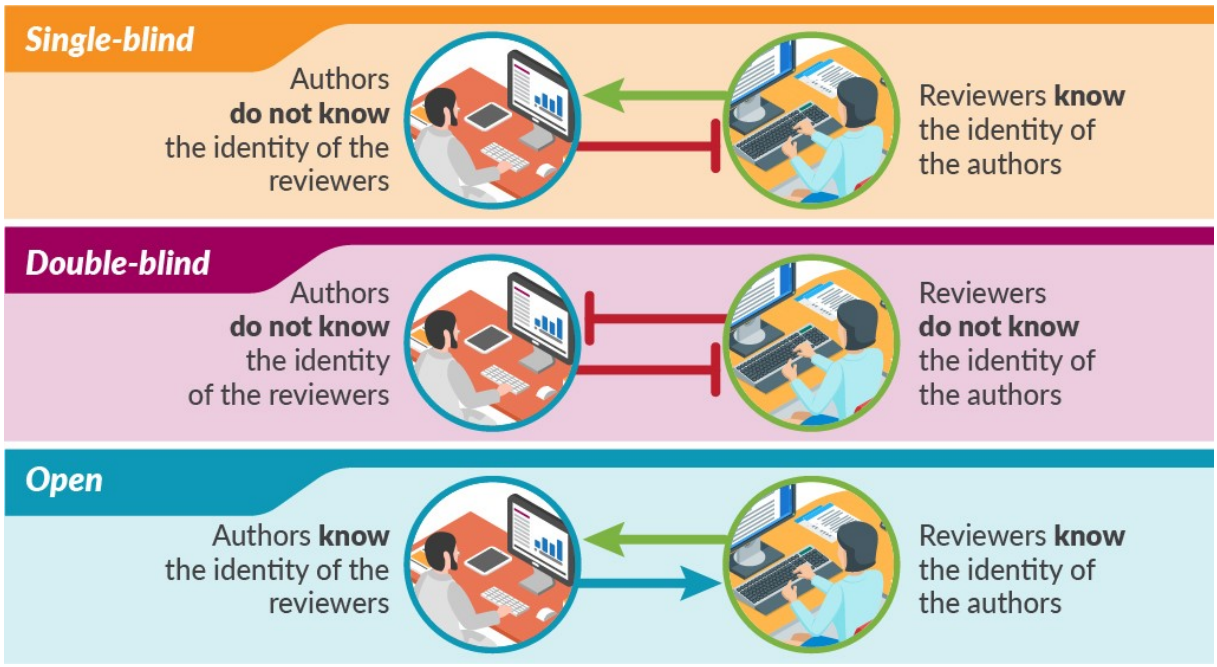

Figure 3.3 The types of peer review procedures (MPIP 2018)

The anonymity is intended to ensure a thorough and unbiased review without regard to the person of the author and may ultimately contribute to a higher scientific level. Once the review has taken place, the author receives the result of the review via the publisher. In doing so, the reviewer informs the author whether he/she considers the article suitable for publication or whether it requires revision. Furthermore, the result could be that the reviewer rejects the article completely. For many years, the mostly restricted access to scientific journals has been under increasing criticism. It is also criticized that the objectivity of the peers is often not ensured, and that one can therefore never know exactly whether the reviewing expert leaves his or her subjective views and/or goals so far aside that the only thing that is really evaluated is whether the article offers added value and is based on methodologically correct research. Because of digitization, platforms and online libraries such as Sci-Hub have been developed in which unrestricted access to such scientific publications is sought. Access to several scientific journals is also possible in Germany via the national licensing system (WELLER 2001).

In order to keep the reputation and standing of the journal as high as possible, the influence of metrics plays a role in addition to the peer review of articles. The influence and perception of a journal can be characterized via bibliometric metrics such as the so-called h-index and the impact factor. Therefore, it is often common for scientific publishers to publish article-based metrics as additional information with their published articles.

3.3 Trade Journals

Scientific journals are a subfield or a large subset of trade journals in general. Basically, a scientific journal is a periodical that is published regularly and deals predominantly with a clear

subject area. As a rule, it is much smaller in terms of the publisher and the editorial staff than a general-interest journal, and it also has significantly fewer employees. First and foremost, trade journals impart specialist knowledge and serve to provide professional and technical information and further training. Articles in trade journals are usually up-to-date and not all-encompassing. The best-known and largest trade journals in Germany include the Deutsches Ärzteblatt and Computerwoche (HBI 2006).

3.4 E-books and the Future of the Book

Due to the turnaround of digitization, it is difficult to predict whether the future of the book in classic printed form will be threatened by the introduction of electronically readable books. Media such as radio, the Internet and television are often perceived as a threat to the preservation of the classic book. Meanwhile, many reference works, such as encyclopedias, are increasingly available on the Internet rather than in book form. In addition, leisure reading is increasingly being published in the form of e-books. Amazon released the first generation of its concept for accessing e-books, the so-called Kindle, in 2007 and landed an enormous success with it over the years. In 2010, Jeff Bezos' company managed to sell more electronic books than printed or bound books. It is obvious that the trend is continuing, and readers like to read their books in electronic form, especially among young people. Books with an enormous amount of text are very popular on e-book readers, tablets, or the smartphone, as hundreds of them can be stored quite easily. Many people see this as an important reason for turning to books in electronic form, because hardly anyone wants to have to carry a lot of weight around with them. Digital books are more accessible and easier to buy, plus they tend to be less expensive than the ones in physical form. The ongoing diversification of e-books is an important aspect of their increasing popularity. This is because, in addition to reading, such readers nowadays also enable e-mail and other simple functions. Consequently, since e-books are dependent on their electronic media or readers, one drawback is that the devices rely on a power source to recharge the battery every few days if used regularly. Especially when traveling and not always having a power source available, this can become problematic. Still, there are many readers whose battery can last longer than a week in some cases due to their display characteristics. Another minor drawback is that it is difficult or even impossible to rent or sell digital books. Books in printed form can be lent and sold by users at will, but electronic books are usually copy-protected and linked to a user account on the reading tool. On Amazon in particular, the trend declined again somewhat after 2010, and in 2015 there was hardly any increase in the sale of e-book readers for the company. The book in classic printed form remains fundamental and more important than the electronic form, especially for reading enthusiasts. They continue to be popular standard gifts for birthdays or Christmas. Opening the book and turning pages offers a haptic pleasure, which is why many would not want to do without it. In addition, there are often beautifully designed aspects in and on books, such as a beautiful spine, color illustrations and different font variations. In the scientific field, the digital book has already completely asserted

itself in many parts. Many publishers no longer produce books but offer universities and students their works only electronically for reading on a computer or laptop. But the scholarly segment, unlike fiction, is a small one for bookstores. While they have come to terms with the loss in the scientific segment, they are struggling for sales of fiction. Both the printed book and the digital e-book are therefore far from finished. The trend due to the influence of digitization is developing more in the direction of both forms of reading creating new foundations for new book media that expand normal books with numerous multimedia and interactive contents. Especially through the combination with music, animations or sound effects, e-books can be united with movies or audio books. Interactive activities also offer playful elements and motivate people to read. Today's apps such as *iPoe* or *Conundrum* provide readers with such interactive options, such as cinematic shock effects when turning the pages or dramaturgically cleverly used music. The future of the book is therefore still very much open and it remains to be seen how it will develop further (SCHLEICHER 2016).

3.5 Self-Publishing and Book-on-Demand

In addition to the classic publication of readings via publishing houses, there is the possibility for authors to publish their reproducible works themselves and thus act as self-publishers. This can be a publication in the classic form of the book or also works on sound carriers can be published by self-publishers. For the authors, independent publishing means that they must take care of everything that a publisher would otherwise take care of: This includes editing, cover design and book typesetting, as well as comprehensive marketing strategies. Consequently, this requires a lot of work and a reasonable familiarization with the subject matter of publishing. In addition, there is nowadays the possibility that service providers can be used for certain tasks. Authors must always keep in mind that they must bear all the costs of publishing themselves, which are otherwise usually borne by the latter when publishing through publishers. The public image of self-publishers often plays a major role in their success. It is not uncommon for self-publishers to be viewed critically, as many think that self-publishing is only done because no publisher has been found who is interested in the work. In addition, commercial failures are often not a result of poor quality, but rather fail because of overwhelming media competition that makes it difficult to generate public attention for a book these days. Nevertheless, it is important for self-publishers to always act confidently and be convinced of their own works. Because the best representative of one's own interests is oneself and the best way to realize one's own wishes is self-publishing (XLIBRI 2022a). So-called books-on-demand and the Internet have significantly increased the earnings opportunities of self-publishers in the present day. Compared to traditional offset printing, which is used for works that should have a large print run or number of copies and require much more budget due to warehousing and fixed costs, publications based on book-on-demand are much cheaper. They are based on digital printing technology. The templates are created as a digital data set and can be kept in stock by the manufacturers in perpetuity. Self-publishers like to resort to this method when the print run

of works is difficult to calculate or will be predictably small. In recent years, numerous committed small and self-publishers have discovered market gaps and successfully exploited them for their published manuscripts. Today, there are also many service providers in the book-on-demand sector that can significantly increase the professionalism of self-publishers. Examples of such market gaps are readings such as alternative travel guides or business and law compendia. From a scientific point of view, self-published works have a comparatively low status, especially without the usual peer-review process (XLIBRI 2022b).

3.6 Patents and Defensive Publications

A patent is an industrial property right for technical inventions. It makes it possible to prohibit others from commercially using a new invention or to decide on this. In return for the exclusive right of use, the basic technical ideas or the invention are published. In Germany, according to the Patent Act, the term of protection can be up to 20 years. Both products and processes can be patented. If a valid patent right exists, the owner can decide who may manufacture, sell, or import the invention, for example. For inventions to be patented at all, the prerequisite is that the innovation solves a problem in a new, non-obvious and technical way. The first claim, also known as the claim, is important in patents because all further claims are derived from it. Thus, if the content is the subject of previous publications and thus reproducible, the patent is considered meaningless and does not grant an industrial property right. Patent law is handled differently in many countries. In Switzerland, for example, it is not examined during the granting procedure whether the innovation is new and inventive. In addition, it can be challenged by third parties or is granted without warranty. Moreover, the protection and enforcement of the patent usually rests with the owner himself. Neither the state nor any institutions and bodies watch over whether patents are infringed or not. As soon as the term of protection has expired, the invention is regarded as common property and may be freely used by all. Likewise, during the valid industrial property right, there is the possibility to license the use of the inventions or to trade or sell patent rights (IGE 2022).

In order to protect innovations in the long term, there are nowadays numerous strategies in so-called intellectual property management (IPM for short), i.e., operational and strategic activities for dealing with intellectual property. In return for publication, a patent application gives the inventor exclusive marketing rights for a limited period of time. For products and inventions that are expected to have low market shares or do not serve a main business field of the company or the inventor, the strategy with defensive publications is used very often. The difference with the patent is that new inventions are disclosed, and the protective cover is removed, as from then on they are automatically prior art from a legal point of view, and it prevents third parties from patenting the invention themselves. Finally, the novelty value of the invention is thus no longer given. Since this strategy is cheaper, because the costs of the patent application and the patent attorneys are omitted, this possibility is gladly considered, to protect own inventions and

above all to be able to bring the innovations faster on the market. In markets where products have very short life cycles, the time saved can be a great advantage. Patent applications usually involve a great deal of effort and correspondingly high costs; defensive publications, on the other hand, offer the advantage of disclosing an invention with relatively little expenditure of resources. The cost-benefit ratio and the difficulty of filing a patent application are thus important factors in the decision to resort to defensive publication. The strategy is thus applied, for example, in the case of small further developments or when it is difficult to prove an infringement of property rights. Users such as research institutions, public institutions or the open-source movement like to use the strategy of defensive publications, as they usually do not aim to patent their invention, but rather to make it freely available to the general public on a permanent basis. In addition, so-called patent trolls can be curbed. This refers to companies or individuals who purchase patent rights, for example in the case of insolvencies, and whose intention is usually exclusively to fight against infringements of these patent rights and to profit without themselves having the corresponding product on the market (FIZ 2022).

3.7 Reverse Engineering

Reverse engineering means reverse development or reconstruction. The structures or the development or production processes of a completed product or system are examined and a plan is created backwards with a kind of initial reconstruction. The aim of reverse engineering is to reproduce the object as accurately as possible and to examine it in terms of uncovering sources of error, carrying out quality controls and further developing the product. Often, competing products are also of great interest. Concerning the investigation and documentation of products, reverse engineering facilitates aspects such as the specification, mechanisms, or manufacturability of the product, among others. In this context, it is important that the product is properly understood in terms of its composition or interaction, its function, and the functions of the individual parts (CHEEMA 2019).

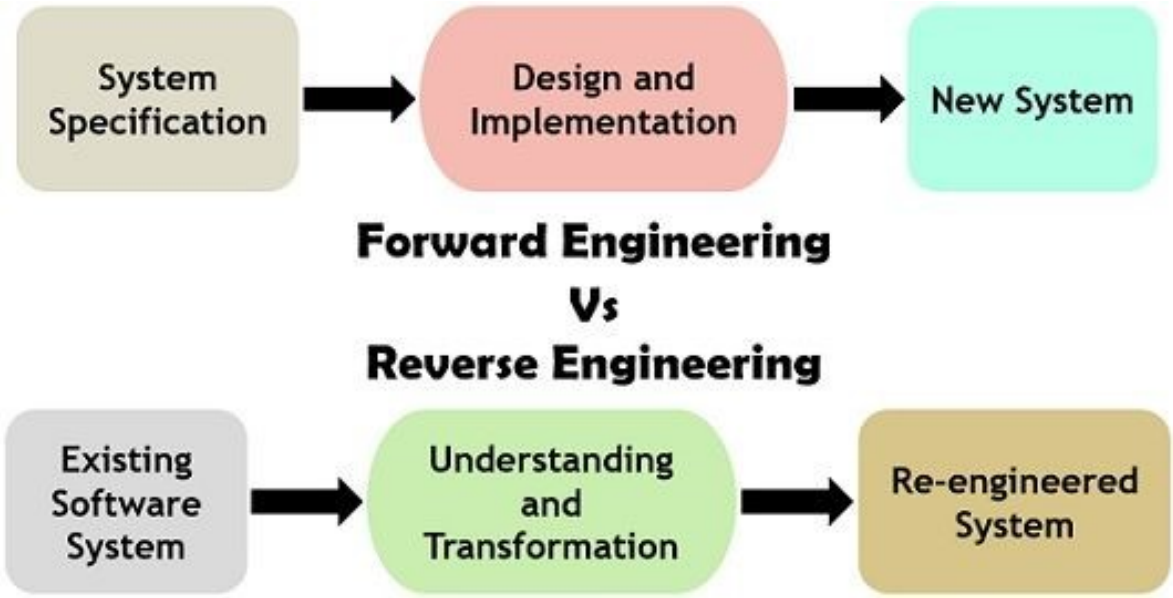

Figure 3.4 Forward Engineering vs. Reverse Engineering (TECHDIFFERENCES 2022)

3.8 Lecture/Presentation

A lecture is a usually pre-considered and generally oral communication from a speaker to one or more people. They are given in a specific, typically short, period of time. Oral contributions, technical presentations at conferences or short speeches at seminars are among the most common forms of it.

3.9 Memorandum

A memorandum is a statement, a calendrical notebook or simply a note with something worth thinking about. The term originates from Latin and is often abbreviated to memo. Literally translated it means "that what is to be remembered".

3.10 Report

In a report, the journalist or the publisher describes a fact or an action based on a news item. Thereby no evaluations of the author are included and besides the actual news also the context will be presented. Thus, reports contain accurate information and go into the background and antecedents. Reports can also contain lengthy quotes and are one of the most common forms of

informational messages. There are also different forms of reports, such as action reports, factual reports, or live reports.

3.11 Specification

Specifications are used to define and quantify the requirements for a product, material, or service as precisely as possible. They thus constitute the precise determination of the requirements and are an explicit set of them. Technical specifications can be developed privately. This is usually the responsibility of companies, regulatory agencies, or military organizations. Often, standardization bodies also develop technical specifications, which usually include more voluntary standards. With a successfully developed specification, the buyer can test and accept the product or service at the time of the transaction.

3.12 Scientific Writing

Scientific debates are predominantly conducted in written form. Scientific writing is to be distinguished in principle from journalistic or narrative writing. They also require an objective language that conveys knowledge so that topics can be made understandable to various sectors of society (TRAEGER 2018).

Scientific writing involves a compositional process. It involves formulating research questions, hypothesizing, investigating hypotheses, and publicizing results of research in scientific publications.

There are various guidelines for the correct use of numbers and characters, for example, and even DIN standards have been created for this purpose. Due to new information technology changes, new scientific genres for writing and publishing have emerged in recent years.

Open science brings writing and publishing more and more together. The relationship between researchers and scholarly publishers is increasingly influenced by the Internet, which provides opportunities to self-publish research and scholarship. In the field of teaching or didactics and the increasing interest in career advancement, scholarly writing and publishing is becoming more relevant, leading to increased information and debate about practical aspects (CAMPUSJAMES 2021).

3.13 IMRAD

The Technical University of Dresden gave the following definition for IMRAD:

> *"IMRAD is an internationally common document format used to conceptualize the organization and structure of scientific papers. For presenting empirical research results in scientific articles, IMRAD is the norm. In the university context, the format, supplemented by a theory section after the introduction, is a good outline basis for e.g. bachelor or master theses."* *(based on TUD 2019)*

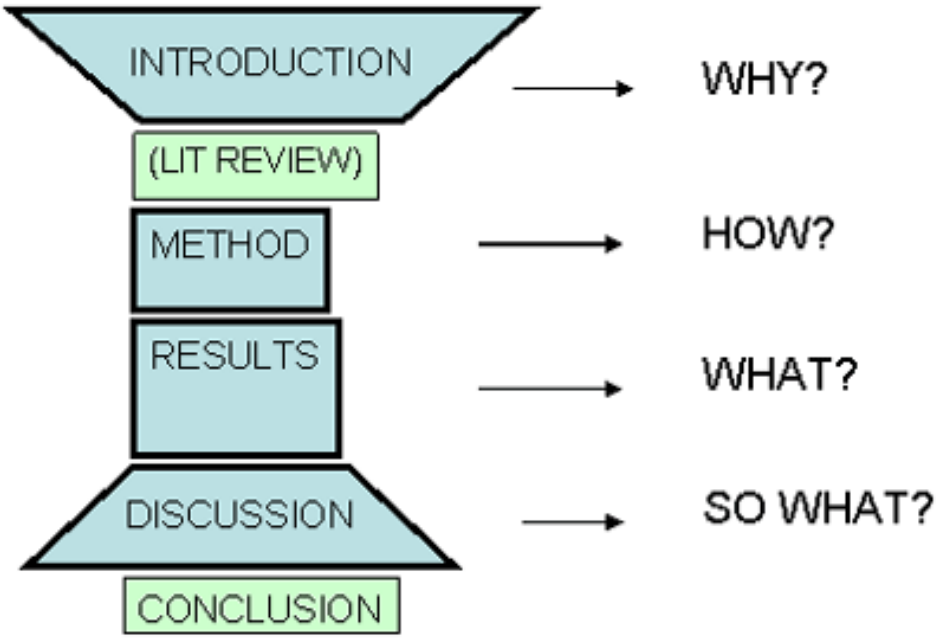

Figure 3.5 IMRAD formation (SWALES 2000)

3.14 References

The indication of a source of information used in a publication, for example a book, is called a source citation or a reference. For the indication one usually uses either the direct form at the object itself, as for example a photo or a quotation, or indicates the sources in an index, which is usually at the beginning or at the end of the publication. For movies or sound-based publications, the sources may be displayed or announced in the credits. The well-known aerospace engineering journal AAST, abbreviated for Advances in Aerospace Science and Technology, make references in articles for publication based on ISO 690 (International Standard Organization 690).

3.15 Perma.cc

Due to increasing digitization and frequent use of web-based source citations, there are now ways to create permanent records of cited sources using platforms such as Perma.cc. It is not uncommon for sources from the Internet or the websites to be altered or deleted. The Perma.cc service helps avoid this and create references that are of lasting value. A perma-link leads the user to an unchangeable record of a site that he or she used or has used as a source reference.

3.16 Technical Communication and Technical Writing

Compared to corporate communication, which is largely strategic and commercial in nature, technical communication serves to convey technical, scientific, or other information. Companies often have employees who act as technical communicators or technical editors. They use various methods for researching technical processes or products, documenting them, and presenting them. They may share this information in different ways, such as paper documents, web pages, or computer-based training. Overarchingly, the goal is to create easily accessible information for a specific audience and publish it to them. The writing and drafting of technical communication are referred to as technical writing and also encompasses the largest subset of technical communication. An example of this might be instructions or providing directions on how to do something, regardless of how technical the task is (JOHNSON-SHEEHAN 2005).

4 Open Science

4.1 Open Science and Open Access

Open Science refers to transparent and freely accessible knowledge and scientific practice that can be shared and further developed through collaborative networks. By publicly disclosing the processes of science, citizens are given the opportunity to view research processes and to participate or contribute to them. In open science, research data such as laboratory results or other interim research findings are shared with the public. Interested members of the public, which may include other scientists or students, for example, are thus provided with freely accessible knowledge and research data that they themselves are allowed to reuse, disseminate, or reproduce. Especially in citizen science projects and participatory research, i.e. research that involves the participation of citizens, this science practice is much used. Open Science is a good way to ensure or increase the quality of research and to allow interested parties outside one's own institutions to participate and contribute to progress. The practice of scientific publishing, or rather the practicing of publishing scientific literature, is consequently referred to as Open Access. The goal is to make scientific literature freely accessible to all and as well to be able to implement this as far as possible without technical or legal barriers (SAEZ-FUENTES 2018). The Budapest Open Access Initiative gave the following definition of Open Access in its 2002 statement:

> *"By open access to this literature, we mean its free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. The only constraint on reproduction and distribution, and the only role for copyright in this domain, should be to give authors control over the integrity of their work and the right to be properly acknowledged and cited." (BOAI 2002)*

Nowadays, open access is predominantly opened under two different strategies. At the Budapest Conference in 2002, these two strategies were outlined; they include, on the one hand, access via the so-called "golden road" and, on the other hand, via the "green road". The golden road refers to primary publication in an OA medium that follows the appropriate guidelines. This primarily refers to scientific OA journals that have a high reputation due to the peer-review process. Scientific literature that is published secondarily and the self-archiving are referred to as publications via the green road. These usually take place on websites of institutes or private individuals, thus making copies of literatures already submitted to publishers freely available. Both preprints and postprints can be documents published through the green route. The difference in both is that with preprints, publication has already taken place, but a peer review has not yet occurred. The situation is different for postprints, where the process has already been carried out (BOAI 2002).

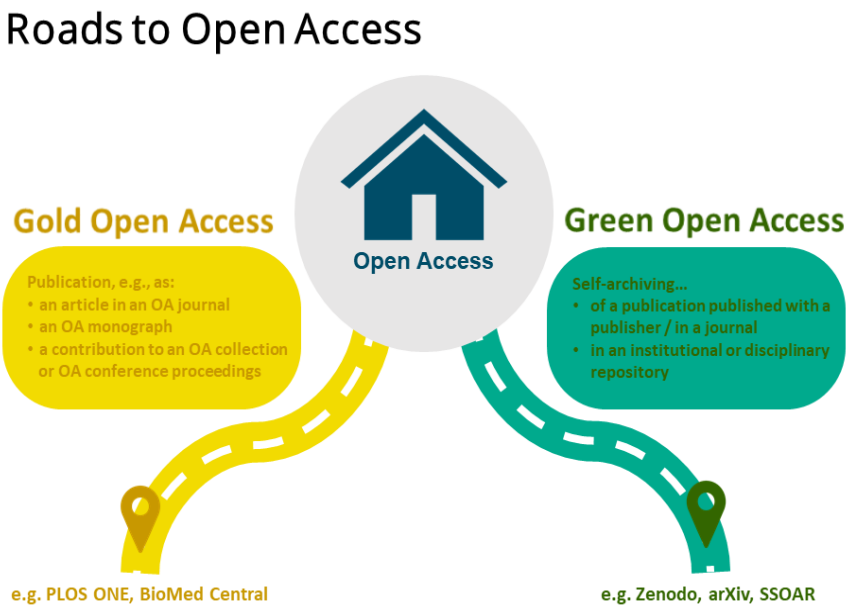

Figure 4.1 Golden and green road to Open Access (OAN 2022a)

In addition to the two most common paths, there is also the gray path and the so-called hybrid path. The gray route involves the publication of gray literature, which includes, for example, theses or conference reports. These literatures are not available in the book trade. The hybrid path refers to publication via open access media with the addition that a printed version of the literature is made available for a fee (OAN 2022a).

4.2 The Open Archives Initiative and the Protocol for Metadata Harvesting

Publications such as preprints and postprints via the green route are very often stored on document servers or institutional repositories. In the past, it was often difficult to find these publications on the servers of institutes and universities.

With the introduction of the OAI, the Open Archives Initiative, an initiative was created to make it much easier to find such publications. Operators of preprint and document servers are founders of this initiative and thus provide simple techniques to make access as easy and user-friendly as possible. One of these techniques is the well-known Protocol for Metadata Harvesting, or OAI-PMH for short, which allows metadata to be collected and processed easily and has become widely established in the scientific community (OAI 2002).

4.3 Open Education and Open Educational Resources

In terms of content, open education refers to an educational policy and social demand that education be made freely accessible to all. More precisely, it can be understood as a type of knowledge transfer in which learning content can be made available and used primarily via the Internet on freely accessible learning platforms. The idea behind it is also to promote access to technology, to support collaborative learning, and to provide opportunities to examine, test, and prove the knowledge acquired. It thus describes the vision to promote, understand and realize freely accessible education. Among the most important initiatives for freely accessible education and teaching content is the OpenCourseWare program launched by MIT, the Massachusetts Institute of Technology, in 2002, which today counts more than 200 universities and organizations worldwide in its list of participants. The principles of the Open Education movement are set out in the Cape Town Open Education Declaration, which advocate realizing the potential of Open Educational Resources - OER, i.e. any teaching platforms or the access to them.

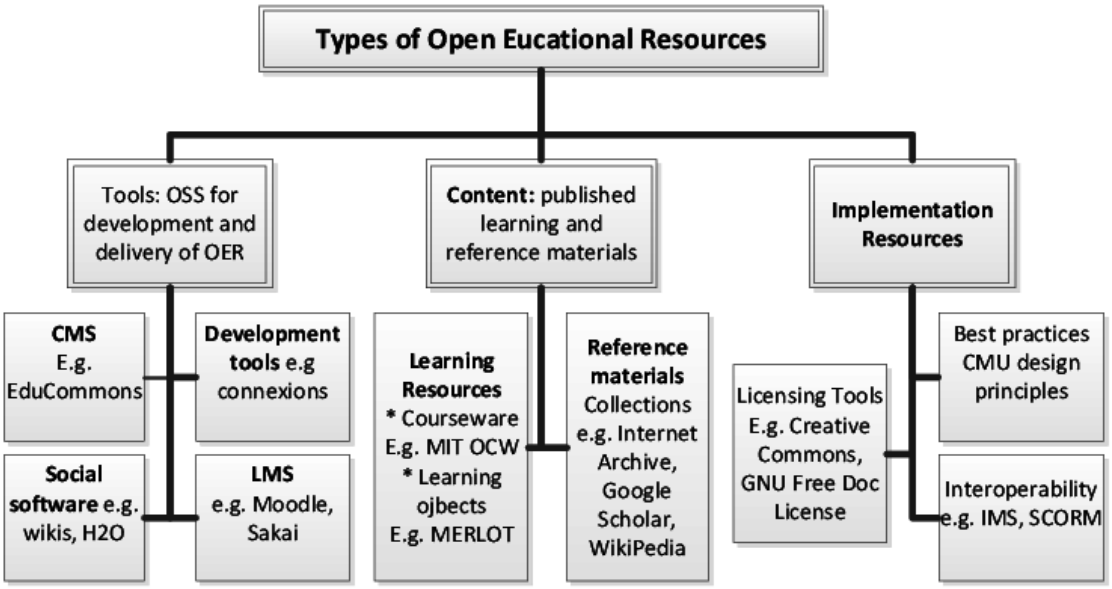

Figure 4.2 Types of Open Education Resources (RESEARCHGATE 2022)

OER are accessible via free licenses. Especially distance and higher education institutions work a lot with the concept of OER and as well social media contributes a big part to the spreading perception. The desire is that education and OER content should be available all over the world and especially that global societal differences and barriers should not influence whether someone has access to education and digital media or not. Thus, it is hoped that especially less developed countries will benefit from the funding and be able to participate in education. Also, an accompanying rising reputation and the taming of the monopolistic book market receive motivating significance for the proponents of OER through the digital turnaround in the world (OPENALL 2022).

4.4 Open Data

Open data refers to any information and publications that are freely accessible to everyone and may be used, processed, or redistributed under free licenses. Data that is personal or subject to data protection must be excluded. Scientific publications or OER teaching content and platforms, for example, are types of Open Data. In addition to data from government agencies, this can also include data from companies or universities operating in the private sector.

4.5 Open Catalogue

So-called open catalogs provide access to stored content in standardized formats. Among other things, they can contain structured databases with information on products with the purpose of categorizing and classifying items in question and, furthermore, normalizing databases for increased user-friendliness. This makes it easier to find, search and compare items within categories.

4.6 Open Source Software

To promote Open Science and collaborative work, it is possible for computer software to be used and made available in the form of Open Source Software - OSS. This includes software that is accessible under the use of licenses, allowing the software and its source code to be freely used, studied, or redistributed. Capable end users can thus participate online in the development and adapt the software to their personal needs.

4.7 Creative Commons Licenses

The non-profit organization Creative Commons - CC, which was founded in the USA in 2001, offers various license agreements via the Internet. Authors of works or media can thus grant the public various rights of use. With the help of the organization, many rights of use and possible uses can be covered. The spectrum or the poles are the classically known copyright and the public domain. Copyright means that a work may only be used with consent and in return for remuneration, whereas public domains or so-called public freedoms do not require consent or remuneration. Figure 4.3 shows forms of Creative Commons Licenses and their terms. Initially designed only for United States copyright, there are now also agreements tailored to

international legal systems. The status of adaptation to German law is documented at Creative Commons International: Germany.

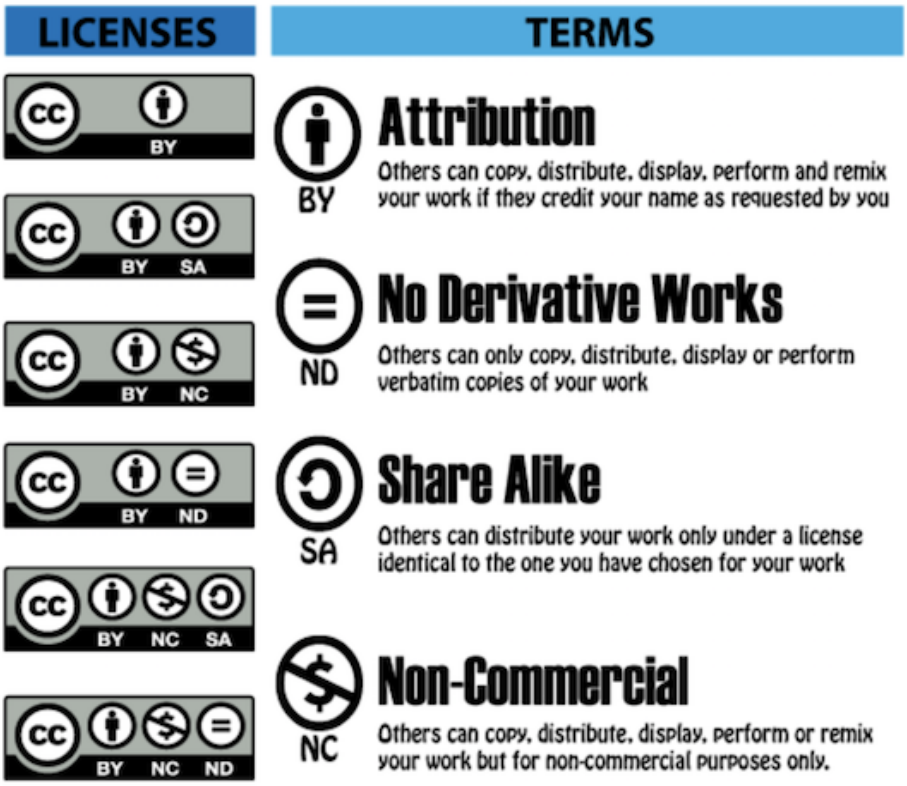

Figure 4.3 Terms of different CC licenses (RESEARCHGATE 2022b)

4.8 Current Research Information System

Research information systems allow research activities, for example projects and patents, to be made available and managed by research institutions in a database. Conceptually, they are analogous to previous Open Science methods with the difference that, in addition to the research activities, they also provide information about the institution and about the employees or their activities and affiliations. Depending on the type, this may include technical papers or other research publications. For example, supervision of doctoral dissertations may also be listed. All these publications can enhance the portfolio and reputation of scientists, and as well, give them the opportunity to develop and better manage their activities through, for example, evaluations. Research information systems are continuously updated and contain comprehensive directories of researchers and their institutions.

5 Digital Preservation and Archiving

5.1 The Digital Dark Age

New developments in research and technology usually also require certain technological access points in which to obtain the desired information. Especially in an age in which work is predominantly digital. The dark age of digitalization refers to the loss of such information that can no longer be accessed, or can only be accessed in part, due to outdated technologies. This can affect various technical areas, whether hardware or software. Consequently, access to information for future generations would become more difficult should new technology make it difficult that the representation of older data may no longer be technically supported. In principle, data or data sets can be preserved in modern times by means of technical information transfer, such as the classic copying of data, and transferred to contemporary technologies. The origin of the literal term lies in archaeology and history. The term dark centuries or dark ages is used to describe time periods that have hardly been researched, if at all, because there is too little archaeological and literary information and finds that could, for example, provide more accurate social and cultural impressions of the time (YOUNG 2017).

5.2 Digital/Electronic Preservation

Information retention of electronic data in today's world is done by means of electronic archiving. By its definition, it is a long-term, secure, database-supported, and unchangeable way of storing data records that can be reproduced electronically at any time. To ensure and control this preservation of data, special archiving systems are used, which must be adapted over time to the latest technology as far as it is possible. There are also legal requirements and guidelines for the electronic archiving of information. As a rule, immutability and long-term availability are of great importance and significance for audit-proof archiving. Many companies and the information society are still struggling with increasing technological progress and changing techniques to enable good long-term archiving. Modern software techniques and the ever-increasing demand for information in electronic form bring new challenges for companies and require appropriate professionalism and implementation. Many documents, contractual or administrative records, as well as other data and even signatures, are becoming digitalized over time, and very little is kept in the traditional paper format, among other reasons simply to save costs and resources. The workflow of a digital archiving procedure is shown in Figure 5.1. Many banks, for example, nowadays almost exclusively use electronic signatures and storage of documents, both for their own archives and for customers' mailboxes (LEXWARE 2022).

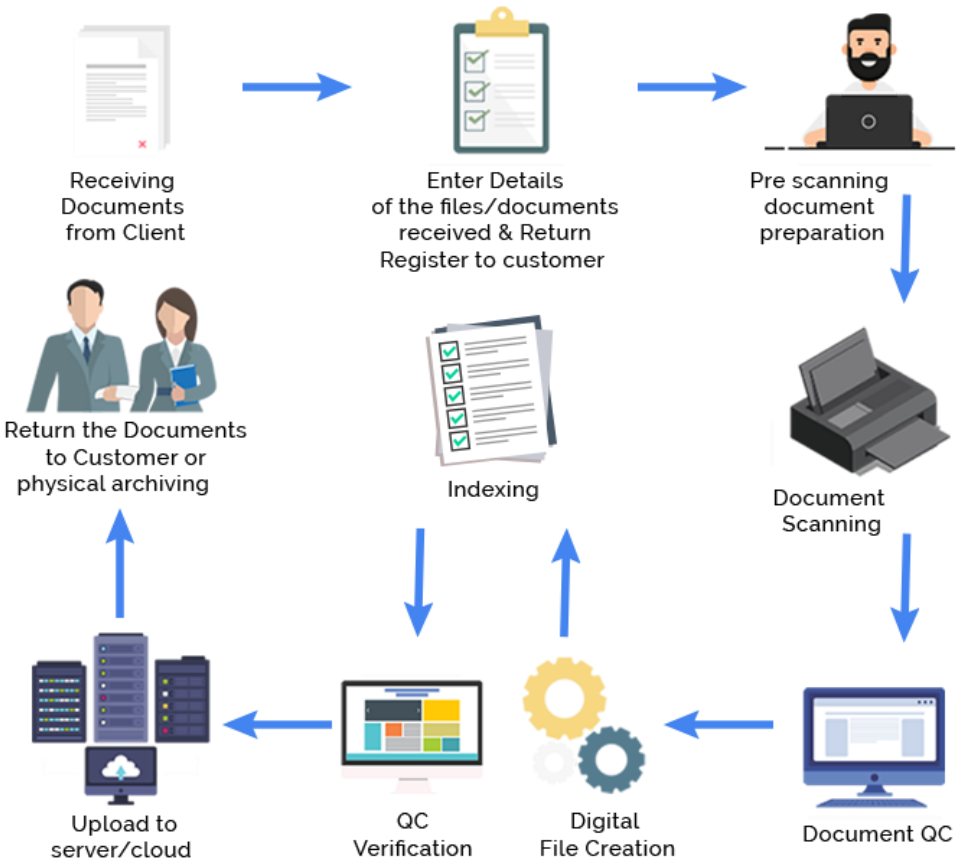

Figure 5.1 Workflow of a digital archiving procedure (DOK 2021)

5.3 FAIR principles

In 2016, the journal Scientific Data, with the help of a consortium of scientists and organizations, defined principles for data preservation using the FAIR principles. The term reflects the following requirements in the individual letters:

F – Findability
A – Accessibility
I – Interoperability
R – Reusability

Data that meet these principles are referred to as FAIR data. In particular, the machine-readable capability of data is given great importance in this. This is because, as technology increases and advances, the handling of data becomes correspondingly more complex and voluminous for humans as users. The dependence on computer support plays an increasingly important role. Machine capability in this context is a kind of guideline that reflects the ability of computers to enable humans to access, find, interact with, and reuse data with as little and uncomplicated effort as possible. Another abbreviation in the context is the designation of so-called FAIR/O

data. In addition to fulfilling the FAIR principles, this also shows that the data carries an explicit data-enabled and open license (SCI DATA 2016).

5.4 Archive

An archive, whether electronic or classic physical, is a storage medium for keeping important information and data for an unlimited period of time and for making it continuously usable or maintaining it. Archives are used worldwide today and can be found in almost all areas of life. First and foremost, they serve to secure important information, such as contract data or property rights. They can be in public form as well as in private ownership. With increasing digitization, electronic archiving is becoming more and more important and has become indispensable in many areas today. Archives have the peculiarity that the information stored usually originates from primary sources and that the transmission of this information therefore usually took place only once.

5.5 Repository

A directory that serves to store and describe digital objects for archiving is called a repository. Objects such as programs, publications, data models or business processes are managed in it. The use of repositories is particularly popular in the scientific field to make scientific work transparent and thus traceable. A repository can be accessible to the public as well as to a restricted group of users. The subtle difference to the classic archive is that the latter is mostly used to store primarily historical documents and lore that are usually no longer used but must nevertheless be preserved for legal and historical reasons. In addition, the data and documents in archives are primarily from primary sources, as mentioned earlier. In the case of repositories, this does not necessarily have to be the case, but it still cannot be ruled out. System information that is required for possible changes and management of the digital documents and objects can also be included in repositories.

5.6 Institutional Repository

An institutional repository is used by primarily research institutions to collect, manage, and store intellectual output of the institution. In universities or research institutions, it can contain all kinds of materials, such as monographs, preprints and postprints, but also gray literature such as dissertations or theses. Basically, the intention is to make research and its results accessible and to create a global visibility of research institutions and their work. **Clifford Lynch**

from the USA, Executive Director of the Coalition for Networked Information, defines the institutional repository in a **report from 2003** as follows:

> *"In my view, a university-based institutional repository is a set of services that a university offers to the members of its community for the management and dissemination of digital materials created by the institution and its members. It is most essentially an organizational commitment to the stewardship of these digital materials, including long-term preservation where appropriate, as well as organization and access or distribution."*
> *(LYNCH 2003, page 2)*

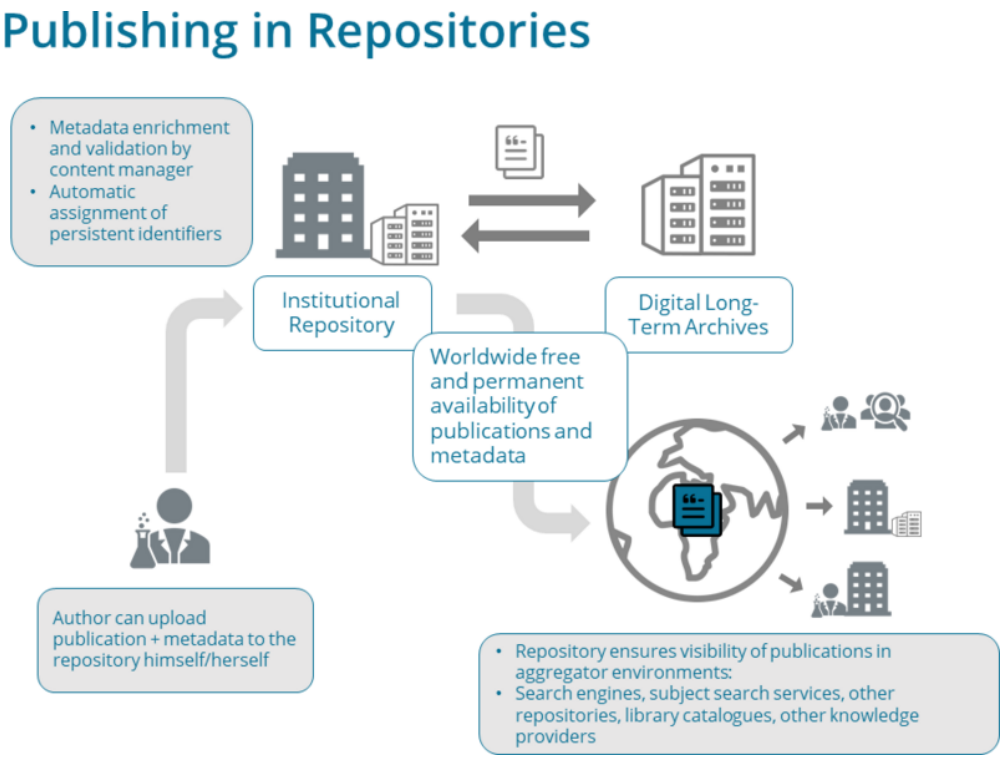

Figure 5.2 Publishing procedure in Repositories (OAN 2022b)

5.7 Internet Archive and Web Archiving

The Internet Archive was founded in 1996 in San Francisco and initially functioned purely as an archive for the preservation of websites. Over the years, it has expanded to include other archives, and in 2007 it was officially granted digital library status. Founded by Brewster Kahle, the non-profit project specializes in long-term archiving and free access to all kinds of public domain works. In addition, emphasis is placed on making access easier and more user-friendly for limited users, such as people with physical disabilities. It is now the largest international facility for web archiving.

Web archiving differs in definition from classical archiving in which it refers to the preservation and collection of net publications. These are publications that were not usually published in physical form, for example as a book, but exclusively via the Internet (ARCHIVE 2021).

5.8 Zenodo

Figure 5.3 Zenodo logo (ZENODO 2022)

Zenodo is an online storage service for storing and accessing scientific datasets. In addition to pure data, it can also contain science-related software, reports, videos, and other publications. Funded by the European Commission, the service integrates the repository service of GitHub, Inc, the Microsoft subsidiary used for version management of software development programs. It is managed by the consortium of the Open AIRE pan-European research information system and CERN, the European Organization for Nuclear Research. With the help of Zenodo, stored source codes can be preserved in a citable form and publications can always be accessed. To ensure this, digital identifiers and source codes are used for the publications, for example Digital Object Identifiers - DOI. Furthermore, various licensing options or user statistics are integrated (ZENODO 2022).

5.9 Deutsche Initiative für Netzwerkinformation/German Initiative for Network Information

In addition to the numerous organizational units for web-based storage and archiving, some of which have already been mentioned, there is DINI, the Deutsche Initiative für Netzwerkinformation. In English, the German Initiative for Network Information. It was founded in Göttingen in 2002 and promotes electronic publishing in open access, in learning software and in media literacy at universities.

As with other organizations and initiatives, DINI aims to set international standards to make the networking of science or repositories and their users better and more manageable. For this purpose, compatible interfaces for repositories are used and the visibility and findability of the

data is improved. The initiative awards so-called DINI certificates to document servers, among others, if the repository meets the minimum requirements for this (DINI 2022).

5.10 Persistent Identifier

A persistent identifier - PID is a code that is used to ensure that digital resources and objects can be permanently located and identified. This includes both abstract objects and concrete resources, such as journal articles or scientific publications. The aim is to give the data a permanent recognition value and thus make them permanently findable. In addition, PID codes prevent dead links that can result from server errors or human influence. In plain language, this means that the preservation of data and objects is always maintained if, for example, companies renew their websites and do not want to take over articles from the old pages. In order to ensure that these objects can be accessed, PID codes provide a remedy and thus ensure that these objects and data can always be uniquely identified for searches. In addition, they are always linked to their data producers or to the resources based on them. Examples of PID codes are Digital Object Identifiers - DOI, as used by Zenodo, or Uniform Resource Names - URN. The great advantage of PID codes is that even if metadata, for example, changes, the code always remains the same and the objects can therefore be called up permanently. Accordingly, this also requires regular maintenance and updating of the information. The infrastructure of a persistent identifier is shown in Figure 5.4. The organization responsible for the object itself takes care of it and as well handles the integrity and durability in general (BERG-CROSS, RITZ and WITTENBURG 2015).

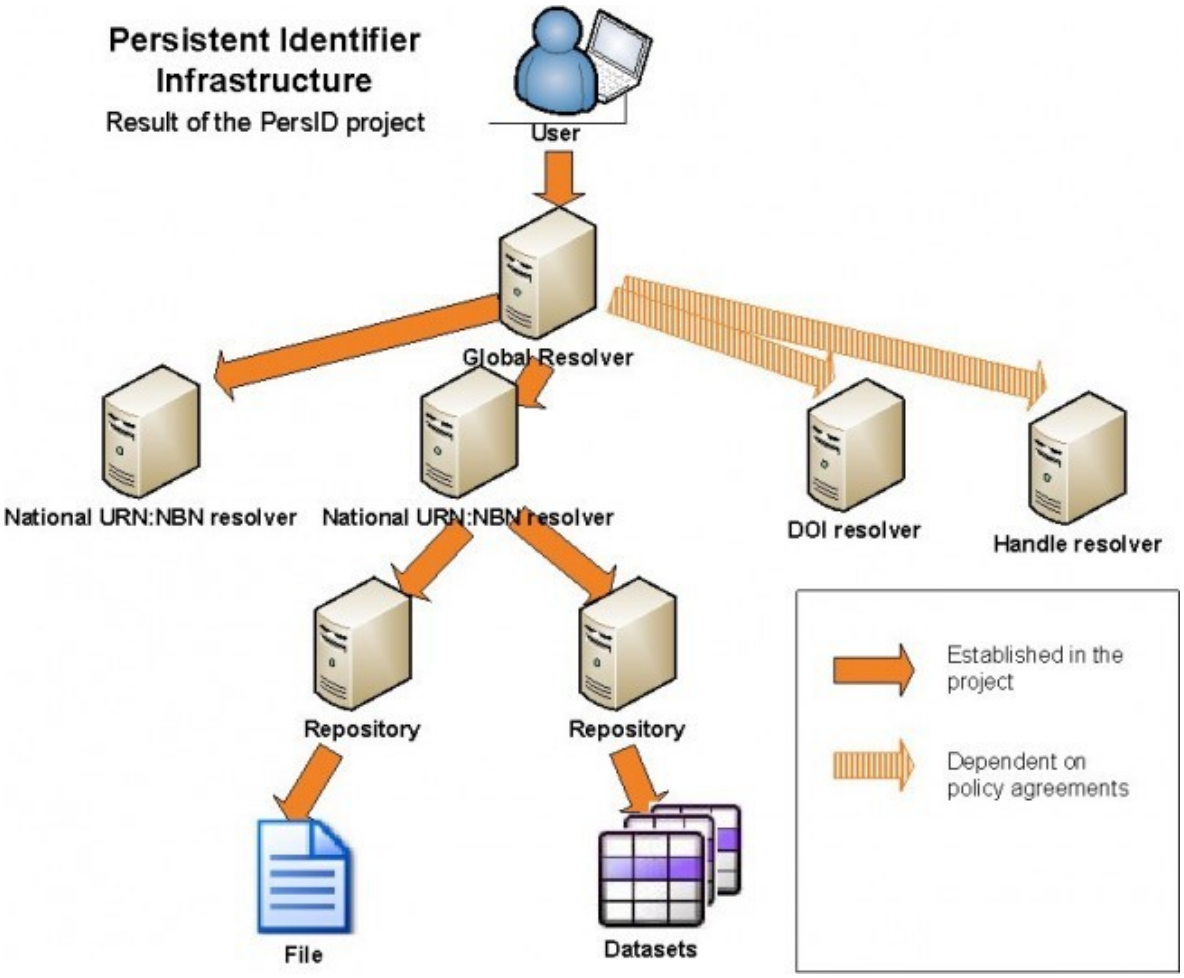

Figure 5.4 Infrastructure of a Persistent Identifier (KE 2011)

National Bibliography Numbers - NBN can be described as publication identifier systems used by national libraries. They mostly have a country-specific format. NBNs are typically used for documents which do not have a publisher-assigned identifier such as an ISBN. They can be used to identify persistently media that are archived in national libraries, for instance master or doctoral theses.

5.10.1 Digital Object Identifier (DOI) and Uniform Resource Name (URN)

DOI codes are handled according to ISO 26324 and are roughly comparable to the international standard book number - ISBN and the international standard serial number - ISSN, the classic physical forms of identifying literary works (DOI 2019).

URNs are used to uniquely identify objects or digital content by name. Characterized by its urn scheme and namespace, a URN is unique compared to a Uniform Resource Identifier - URI, which consists of a string of characters. They are location-independent and serve the purpose of giving resources unique and permanently valid names. A URN can either be a completely

new identifier or an identifier already assigned by other mechanisms, such as an ISBN (DNB 2022).

5.10.2 Archival Resource Key

Uniform Resource Locators - URLs are used to identify and locate resources, such as a web page. They are a kind of subcategory of URIs, but due to their frequent use they are often equated with them. An Archival Resource Key - ARK is a kind of multifunctional URL and counts as a URI since 2019. It is characterized by the marking ark: after the hostname of the URL and the ARK scheme is underpinned by three link-based requirements:

- From the object to a promise for stewardship
- From the object to metadata which describes it
- To the object itself (or appropriate substitute)

Thus, three facets of a provider's ability to provide persistence are made accessible. ARKs are readily used by a wide variety of entities, such as publishers or government agencies, to provide reliable references to scientific and cultural objects (ARKS 2021).

5.11 PDF/A

With the introduction of the Portable Document Format - PDF by Adobe Inc. in 1993, the company revolutionized a platform-independent file format for the exchange and storage of electronic documents. PDF is nowadays used worldwide. The format is not based on any standard and since 2018 the PDF Association has been taking care of its constant further development. The file format has the advantage that documents can be reproduced faithfully, regardless of the original application program, operating system, or hardware platform of the document.

Through the implementation of the PDF Archive - PDF/A, which was published in 2005 and operates according to the ISO 19005 standard, a global standard for the long-term archiving of PDF documents was released. With its help, documents can be made readable and usable even after decades. The standards specify how the elements must be used for long-term archiving.

PDF/A can be roughly categorized into two levels of conformance. Under Level A, both pure visual reproducibility and the content and structure of the document are considered. This means, for example, that structural elements of the document, such as page breaks, are included. In Level B, on the other hand, only the visual reproducibility of the document is regulated. This is

the decisive format when scanning documents, for example, since in most cases only the visible representation is to be achieved here.

PDF/A has a lot of advantages compared to other traditional archiving formats such as TIFF. The standard has been revised several times since 2005, since it was initially based only on the outdated PDF 1.4 version.

Figure 5.5 roughly shows the advantages of PDF/A over TIFF and general PDF. Figure 5.6 shows the evolution of PDF/A enhancements over the years, considering the level names and document types.

It is also important to note that output to PDF/A should be done directly at the scan client and not afterwards. Converting documents to PDF/A afterwards usually proves to be very complex and correspondingly time-consuming or computationally expensive. In addition, not all documents can be converted to PDF/A without problems. There is a whole range of software tools for validating conformity that provide clarity and help (DOCUBYTE 2018).

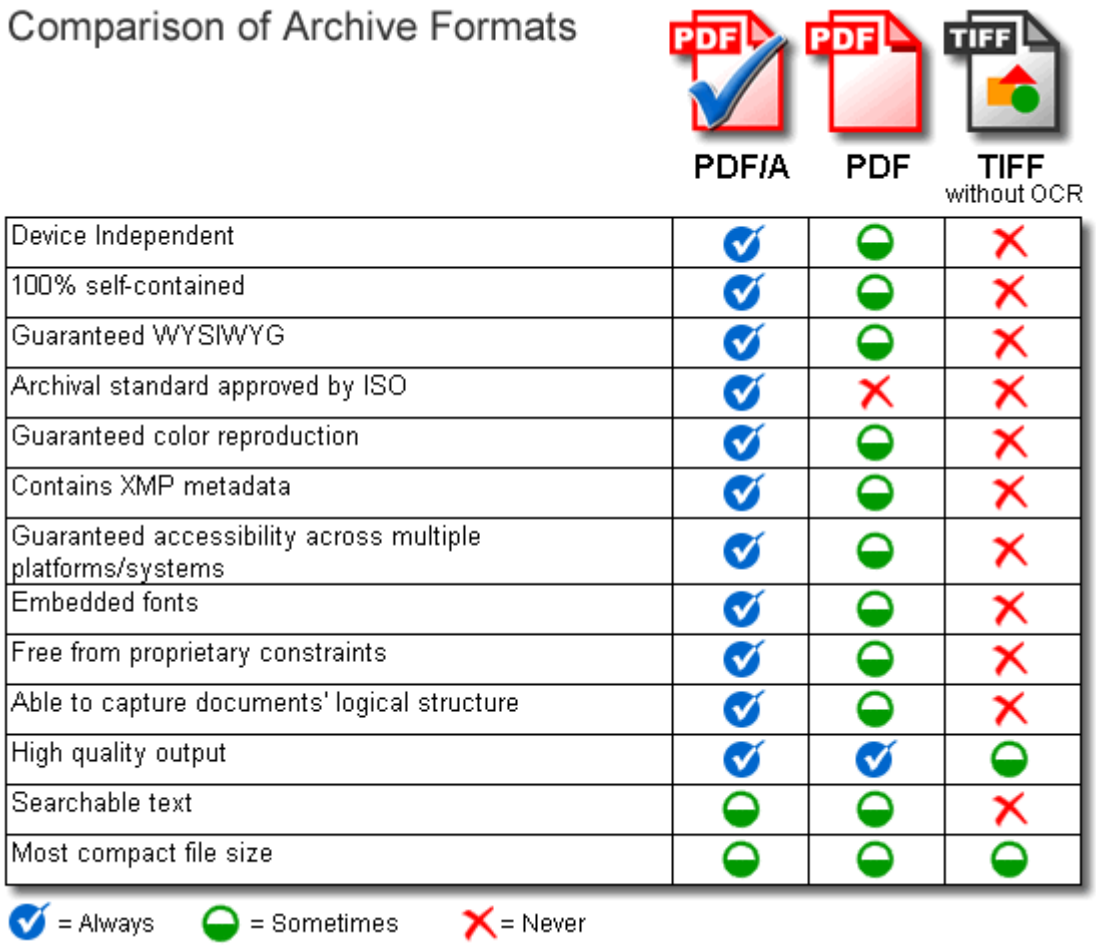

Figure 5.5 Comparison of PDF/A, PDF and TIFF (SOLIDDOCUMENTS 2022)

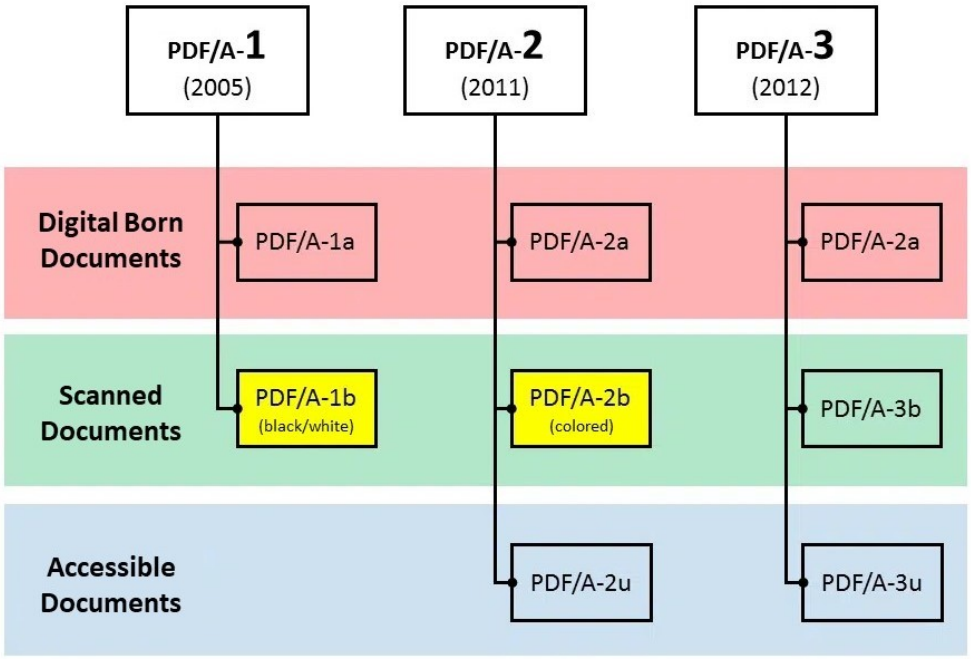

Figure 5.6 Evolution of the PDF/A configurations (based on DOCUBYTE 2018)

6 Building a Machine Readable Web Page

6.1 Hypertext Markup Language – HTML

A markup language is a machine-readable language for structuring and formatting texts and other documents. With the use of so-called tags, properties, affiliations, and presentation forms of sections of a text are described, i.e., elements such as words, characters and paragraphs. The best-known format of the markup language is Hypertext Markup Language, or HTML for short. It is the core language of the World Wide Web and was first introduced by the World Wide Web Consortium - W3C in 1992. Roughly speaking, it is the format in which web pages are written. Outdated, the principle is simple. The creator of the web page writes a text in the HTML file and can then use the file to format and structure elements such as font size or type. In addition, HTML links are linked to include other web pages or to include images, videos, and background sounds. Modern Internet browsers read these files and it then takes only fractions of a second to display the web page. To get a closer look at the principle of HTML, you can, for example, open any web page and click the right mouse button in a free area. If "Save page as" is then clicked, the blank code of the HTML file can be displayed in the editor. A visual example or a comparison of the normal view of the web page and the display of the HTML file in the editor is shown in screenshot figures 6.1 and 6.2, respectively, using Professor Scholz's digital library as an example (ASCHERMANN 2018).

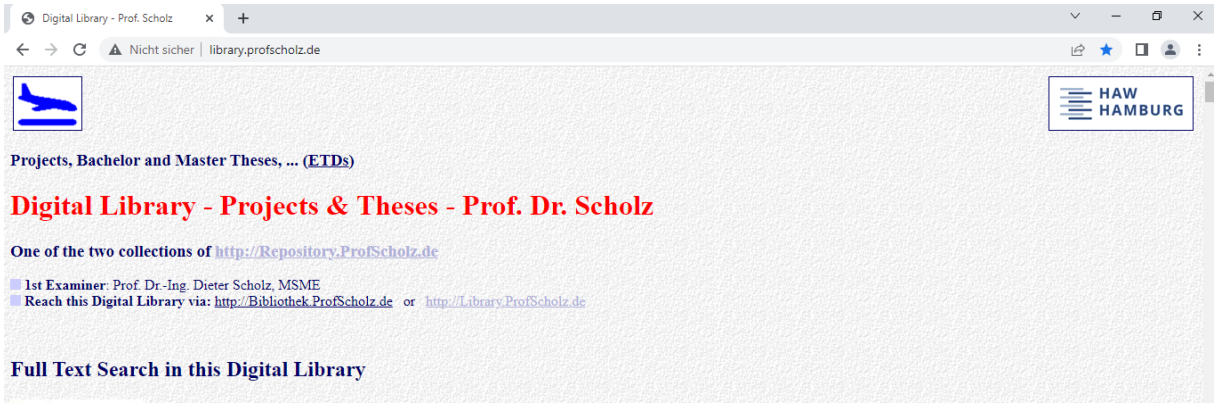

Figure 6.1 Digital library of Prof. Dr. Scholz, normal view

Figure 6.2 Digital library of Prof. Dr. Scholz, editor view

Nowadays, there are content management systems, such as WordPress or Typo3, which take the outdated writing of the website from the creator and write HTML files by means of graphical interfaces. For separating presentation specifications from content to a large extent, the W3C introduced Cascading Style Sheets - CSS in the course of time. CSS describes a so-called style sheet language, making it able to create design instructions. In earlier times, web pages were created using only HTML, but today it is primarily used only to structure the page. CSS regulates in modern web design the format of this text structure and how it should be displayed in terms of, for example, layout, colors, and typography. Furthermore, there is the worldwide known scripting language JavaScript, which with its introduction has made it possible that HTML files can not only be displayed in the web browser, but also dynamically changed. These interactive documents are also referred to as dynamic HTML (ASCHERMANN 2018).

6.2 Dublin Core

The Dublin Core or Dublin Core Dataset expresses a standardized vocabulary that is used to generate and describe metadata. To make documents or sources easier to find with the help of metadata, the Dublin Core dataset has 15 so-called *core elements* with which the resources can be described. This standard is defined by the Dublin Core Metadata Initiative (DCMI), an organization that acts to standardize metadata and its vocabularies. The core fields are thus a collection of simple and standardized conventions that can be used to describe content from the Internet and thus make it easier to find. The elements can be used several times and optionally. In addition, there is the "simple" variant and the "qualified" variant, which contains three further elements (audience, provenance and rightsholder) in addition to the 15 core fields in the simple variant. The so-called "qualifiers" serve to refine and extend the semantics of the simple elements and can thus allow a description tailored to more specific needs (HILLMANN 2005).

6.3 SelfHTML

SelfHTML is a kind of encyclopedia that deals with the various aspects of web design. Especially in German-speaking countries, this format is popular and is used by beginners as a good approach to creating web pages. Also, for advanced users SelfHTML is a good reference book. In addition to pure documentation, there is also a forum and a blog with a wide variety of technical articles on web design topics. It also promotes topics such as accessibility and the semantic web, the latter meaning the extension of the web to promote easy exchange of data between computers.

With the help of SelfHTML, German-language documentation on HTML and related technologies is made available. The motto is the **energy of understanding**. SelfHTML is thus not only to provide knowledge and solutions, but also to promote understanding and to support readers with tools for self-help (SELFHTML 2022).

6.4 ContextObjets in Spans (COinS)

To enable bibliographic metadata to be embedded in HTML in a machine-readable way, there is the method of ContextObjets in Spans, COinS for short. The data in the browser is often not directly visible and to make this possible one uses COinS among other things. Usually, the use of a so-called plugin is necessary for this, i.e., the extension of an existing software by a software component. COinS uses the Open URL standard, i.e., the standard for specifying metadata in a URL, to link to documents regardless of their current location. Browser plug-ins, such as Zotero in Firefox, use COinS to create such OpenURLs or can read the metadata for other purposes. Technically, a so-called span element with the attribute class="Z3988" is added to the HTML source code. Its title attribute then contains references to OpenURLs. This is shown once in Figure 6.3; the line breaks only serve to improve readability (GBV 2017).

```
<span class="Z3988"
title="ctx_ver=Z39.88-2004
&rft_val_fmt=info:ofi/fmt:kev:mtx:journal
&rft.title=Ariadne
&rft.aulast=Chudnov
&rft.atitle=Opening+up+OpenURLs+with+Autodiscovery
&rft.issue=43
&rft.issn=1361-3200
&rft.date=2005-04
&rft_id=http://www.ariadne.ac.uk/issue43/chudnov/"></span>
```

Figure 6.3 HTML source code with span element (GBV 2017)

6.5 Metadata for Social Media

With its "**Tweetmap**" project, the software company **Inosoft** has produced an interesting study about metadata and its transparency. It shows how metadata analyses and the combination of information from two independent online services can be used to find out a lot of details about a user in social networks such as Facebook and Twitter. It is the metadata that makes this transparency possible. In addition to the actual content of a phone call or WhatsApp message, additional information is always transmitted that the user usually has no idea about or does not notice or consider. The National Security Agency refers to this data as information about data, but not the actual data itself. The sender and the receiver transmit this data of the data in the background to a communication, including locations and, for example, the duration of a

telephone call. The result of the project includes an interactive map that combines geospatial data from Twitter with Google Maps, Earth, and Street View, and was created without the assistance of the companies. Nowadays, the iOS and Android apps of Twitter or Instagram, for example, can determine the user's position to within a few meters as soon as the apps are in use, and you locate yourself or post something. The combination of metadata, such as the location and time of a post, with Google Maps, for example, can therefore provide information about where the user lives or which places he or she likes to visit. For example, if a user posts that he or she is looking forward to dinner at grandma's house and additionally posts something about or on the way there, it can be inferred what grandma's house looks like without even sharing a photo or similar of it. If these tweets are then compared or combined with those of other users, a lot of personal details about the user's network and private life can be extracted. Metadata is very interesting for companies like Facebook, Google, or Twitter to make a user digitally recognizable. Although WhatsApp describes itself as a savior of privacy by encrypting messages, metadata is still transmitted there as well. They are easy to collect and analyze, and they are also standardized and sent automatically. In some cases, the user cannot legally avoid sharing and disclosing this data. Who communicates with whom, when, for how long, from where and how often is often more meaningful than what is actually said. Let us take the example of a woman who first calls her gynecologist, then her mother, and then a man with whom she has also spoken more often recently. She then turns to a counseling center for families, which also deals with abortions, and just from all this information and without knowing the exact content of the conversations, it is clear what is at stake. According to Edward Folten, an IT professor at Princeton, metadata is a "proxy for content". Often, he said, it is not about knowing a fact exactly, but much more about its very likely confirmation based on context. "You can find out so much with metadata. For example, a person's network, their religion, political views, daily routine. Metadata can be collected and analyzed in the millions", Folten said. According to Inosoft, the transmission of metadata is not necessary for pure communication. Telephone numbers or e-mail addresses would be completely sufficient. Nevertheless, the transfer of metadata can be attractive for companies in that money can be made from the information generated. The effort involved is not as great as it seems. Inosoft, for example, needed a weekend for their Tweetmap project. And it did so without any financial interest, but with the intention of showing what can be discovered with publicly disclosed information and what traces users can leave behind without really being aware of it (INTERNETWORLD 2016).

6.6 Metadata for Search Engines (Computing)

The content of each individual URL can be described with the help of meta tags and meta descriptions. Search engines display the meta title and meta description of a web page in their search results. In addition, the title tag, or rather the page title, serves as a ranking factor for search engines and can thus significantly increase the number of clicks or the popularity of the website. Search engines, other websites, and social media platforms display the given

information that should summarize the content in the best possible way. Search engines such as Google or Bing can additionally display alternative metadata if the page content matches the search query. Thus, the use of matching keywords in the metadata is important (DOMAINFACTORY 2019).

To create a website that allows it to be found by various search engines, it is necessary to comply with each specific regulation regarding metadata. Thus, it is important to ensure that correct metadata is used in the creation process, which can then be recognized by the individual search engines and subsequently produce the correct and desired results. The creation of websites, especially if they are to be versatile and findable for many search engines, requires appropriate know-how and the specific knowledge of the correct structure and writing of a website. To illustrate this visually in a simple form, the landing page of Daan Hurtecant's master thesis was chosen from Professor Scholz's Digital Library. The following illustrations show in abstract form which individual criteria specific to the search engines must be considered to deliver the correct results when searching for the work.

When we talk about metadata, we are talking about implicit data. This data is not seen directly but is integrated into the HTML code of a web page. This allows other websites and bots to use the data and, if necessary, provide relevant results during the search. The three most important meta tags are usually the meta description, the meta title and the meta keywords. There are subtle differences in the processing of metadata, because not all search engines or websites always understand and use all meta tags that exist. The meta title is one of the most important ranking factors for Google and the most important of the meta tags that a website owner should optimize. The meta description, on the other hand, does not have a direct effect on the ranking, but is still an important factor in increasing the click-through rate.

As shown in Figure 6.4, the content of the page starts with the HTML tag and the introductory tag for the head <head>. The entire content of a page is enclosed in the <html> and </html> tags. In between them come all the general details about the HTML file. After the tag for the head follows the tag for the title of the page and is enclosed by the two tags <title> and </title>. After the title, it is on to the content metadata. Lines 4 to 14 show the general important metadata that is necessary for a page to be found by search engines like Google. Each piece of content in a single metadata is first preceded by the type of metadata, for example line 6 with <meta name= "description". After that, the content is entered after "content=". Care must be taken that the entire content is written in the one associated line.

Note that due to the page size, image 6.4 is cut and therefore lines 5, 6, 8 and 9 are not completely shown. However, for the description of the metadata it is quite sufficient here and if you want to see the entire content of the lines, you can open the web page once and right-click on "Show page source" to display the source text. This also applies to the following illustrations, which are also cut.

```
<html>
<head>
<title>Launch of an Ecolabel for Passenger Aircraft</title>
<meta http-equiv="content-type" content="text/html;CHARSET=iso-8859-1">
<meta name="keywords" content="abstract, landing page, AERO, HAW Hamburg, pro
<meta name="description" content="Purpose - Introducing an ecolabel for aircr
">
<!-- <meta name="author" content="Scholz, Dieter"> Causes confusion with Open
<meta name="abstract" content="Landing page with metadata and abstract for a
<meta name="distribution" content="global">
<meta name="generator" content="Word Mail Merge">
<meta name="date" content="2021/05/26">
<meta name="language" content="eng">
<meta name="robots" content="index,follow">

```

Figure 6.4 Generally necessary metadata of a web page for search engines (based on HURTECANT 2021)

Figure 6.5 shows information regarding COinS and Mendeley. With the help of COinS bibliographic metadata can be retrieved with bibliographic software. Mendeley gives priority to CoinS over other metadata specified. Information in the source code that does not appear on the page is highlighted in green by comment commands and can be viewed in the source code.

```
CoinS (ContextObjects in Spans) a method to embed bibliographic metadata.
This allows bibliographic software to retrieve bibliographic metadata.
https://de.wikipedia.org/wiki/COinS#Technik
https://en.wikipedia.org/wiki/COinS#Client_tools
Specifically for Mendeley:
https://www.mendeley.com/guides/information-for-publishers (https://perma.cc/AS9E-8
In this directory: KEV_Guidelines-2004-12-09.pdf
In this directory: KEV-Format-Book.html
Used here: By-Value Book Metadata => &rft_val_fmt=info:ofi/fmt:kev:mtx:book
<span class="Z3988" title="...&rft.name=data..."></span> must be in one line!
Generally, data must be URL-Encoded (Umlaute!).
For Mendeley not necessary to replace " " by "+" in title as given in examples.
Apparently, Mendeley gives priority to CoinS over other metadata specified (DC or H
-->
```

Figure 6.5 Information for Mendeley and COinS (based on HURTECANT 2021)

Figures 6.6 and 6.7 show the part in the HTML structure that is necessary for the page to be found by Google Scholar. Google Scholar uses automated software, known as "parsers", to identify bibliographic data of your papers, as well as references between the papers. If you are using repository or journal management software, such as Eprints, DSpace or Digital Commons, please configure it to export bibliographic data in HTML "<meta>" tags. Google Scholar supports Highwire Press tags (e.g., citation_title) as you can see in our example. Dublin Core tags (e.g., DC.title) should only be used as a last resort. For journal papers they work poorly because Dublin Core does not have unambiguous fields for journal title, volume, issue, and page numbers. To check that these tags are present, visit several abstracts and view their HTML source. Figure 6.6 shows the minimum required metadata for Google Scholar Highwire Press and for Google Scholar Dublin Core. In Figure 6.7 and 6.8 you can see what additional metadata was used for the Highwire Press and Dublin Core variants.

```
<!-- Minimum Metadata for Google Scholar: Highwire Press -->
<meta name="citation_title" content="Launch of an Ecolabel for Passenger Aircra
<meta name="citation_author" content="Hurtecant, Daan">
<meta name="citation_publication_date" content="2021/05/26">
<meta name="citation_pdf_url" content="https://www.fzt.haw-hamburg.de/pers/Scho

<!-- Minimum Metadata for Google Scholar: Dublin Core -->
<meta name="DC.title" content="Launch of an Ecolabel for Passenger Aircraft" xm
<meta name="DC.creator" content="Hurtecant, Daan">
<meta name="DC.issued" content="2021">
<meta name="DC.identifier" content="https://www.fzt.haw-hamburg.de/pers/Scholz/

```

Figure 6.6 Minimum Metadata for Google Scholar (based on HURTECANT 2021)

```
<!-- Additional Metadata for Google Scholar: Highwire Press -->
<meta name="citation_publisher" content="Aircraft Design and Systems Group (
<meta name="citation_online_date" content="2021/05/26">
<meta name="citation_keywords" content="Luftfahrt">
<meta name="citation_keywords" content="Passagierflugzeug">
<meta name="citation_keywords" content="Ökolabel">
<meta name="citation_keywords" content="Umweltzeichen">
<meta name="citation_keywords" content="Aeronautics">
<meta name="citation_keywords" content="Airplanes">
<meta name="citation_keywords" content="Eco-labeling">
<meta name="citation_keywords" content="Energy labeling">
<meta name="citation_keywords" content="Kraftstoffverbrauch, Luftverschmutzu
<meta name="citation_language" content="eng">
<meta name="citation_urn" content="urn:nbn:de:gbv:18302-aero2021-05-26.013">
<meta name="citation_doi" content="10.15488/11558">

```

Figure 6.7 Additional Metadata for Highwire Press (based on HURTECANT 2021)

```
<!-- Additional Metadata for Google Scholar (and others): Dublin Core -->
<meta name="DC.contributor.advisor" content="Scholz, Dieter">
<meta name="DC.identifier" content="https://doi.org/10.15488/11558" scheme="DCTE
<meta name="DC.identifier" content="https://nbn-resolving.org/urn:nbn:de:gbv:183
<meta name="DC.identifier" content="https://archive.org/details/TextHurtecant.pd
<meta name="DC.identifier" content="https://n2t.net/ark:/13960/s2cs4b0h8cj" sche

<meta name="DC.language" content="eng" scheme="DCTERMS.RFC1766">
<meta name="DC.publisher" content="Aircraft Design and Systems Group (AERO), Dep
<meta name="DC.type" content="Master Thesis">
<meta name="DC.type" content="text">
<meta name="DC.type" content="book">
<meta name="DC.relation.ispartof" content="Digital Library - Projects & Theses -
<meta name="DC.relation.ispartof" content="http://library.ProfScholz.de" scheme=
<meta name="DC.rights" content="Copyright by author">
<meta name="DC.rights" content="CC BY-NC-SA">
<meta name="DC.rights" content="https://creativecommons.org/licenses/by-nc-sa/4.

```

Figure 6.8 Additional Metadata for Dublin Core (based on HURTECANT 2021)

As digitization increases, social media are playing bigger roles. That is why people like to include metadata to help them search for the pages or articles as well. Figure 6.9 shows some of this metadata.

```
<!-- Metadata for Social Media -->
   <!-- Twitter (https://bit.ly/2BhcnRQ) uses also data under GENERAL -->
<meta name="twitter:site" content="@AERO_at_HAW">
<meta name="twitter:creator" content="@Prof_Scholz">
<meta name="twitter:card" content="summary_large_image">
   <!-- Alternatively for Twitter: (small) Summary Card with HAW Logo -->
   <!--
   <meta name="twitter:card" content="summary">
   <meta name="twitter:image" content="logoHAWforTwitter.jpg">
   <meta name="twitter:image:alt" content="Logo HAW Hamburg">
   -->
   <!-- Facebook (https://bit.ly/2Bg3qs0, https://perma.cc/DE2T-KE9A and https://ogp.me
<meta property="fb:app_id" content="350123748915603">
<meta property="og:type" content="book">
<meta property="book:release_date" content="2021-05-26"> <!-- Is converted at FB in sec
<meta property="book:tag" content="Master Thesis">
   <!-- GENERAL - used by Twitter, Facebook, LinkedIn (https://bit.ly/2RzvUCm, https://
<meta property="og:site_name" content="http://Library.ProfScholz.de"> <!-- Only display
<meta property="og:title" content="Launch of an Ecolabel for Passenger Aircraft">
<meta property="og:url" content="https://nbn-resolving.org/urn:nbn:de:gbv:18302-aero202
<meta property="og:description" content="Author: Daan Hurtecant, Abstract: Purpose - In
">
<meta property="og:image" content="https://www.fzt.haw-hamburg.de/pers/Scholz/arbeiten/
<meta property="og:image:type" content="image/png">
<meta property="og:image:alt" content="Major results from the work of Daan Hurtecant">
<meta property="og:image:width" content="1200"> <!-- Helps loading page -->
<meta property="og:image:height" content="628"> <!-- Helps loading page -->
```

Figure 6.9 Metadata for Social Media (based on HURTECANT 2021)

Finally, it should be mentioned that the figures 6.5 to 6.9 only show insights into a possible structure of HTML-based web pages. In this section it has been important to show which data are relevant for which intentions and which additional possibilities there are to include metadata. Thereby only some examples of many things were shown, if you want to learn more about how to build and write a page correctly, there is enough literature and sources that can support you.

7 Advanced Use of a Repository

7.1 Classification

Classification is a cognitive activity. It involves dividing objects or data into classes based on different and common characteristics. Only this analysis and classification into uniform group structures divides the data of a company into categories with certain attributes. The aim here is to be able to identify products more easily and compare them with one another. Advanced computer technology also provides the opportunity to considerably simplify the transfer of product data, for example between manufacturers and retailers. Nowadays, useful standards and norm guidelines are used to support classifications or to better classify data. An example of this is ECLASS, a globally used data standard for goods and services, or ETIM. Relevant characteristics and specifications listed in these standards are used for targeted simplification. Other standards such as BMEcat, a standardized exchange format, are helpful and useful for the exchange of data (NEXOMA 2022).

7.2 Dewey Decimal Classification

The most widely used international system for organizing knowledge in library collections in the form of classifications is the Dewey Decimal Classification, or DDC for short. In principle, all kinds of data and works can be classified in it, whether texts, images, or other resources. A DDC notation identifies the corresponding classification. As a rule, it consists of hierarchically structured sequences of numbers from zero to nine. All classifications with three-digit notations form the first levels, including, for example, Class 500 for science and mathematics. These three-digit notations or levels are shown in Figure 7.1, with an indication of which question each category answers. DDC notations range from very broad categories to very specific topics. In a numerical sequence of more than three digits, a period precedes the next digit. The subdivisions in the main categories and the subcategories below them are called main or auxiliary tables. DDC is now used in over 135 countries in over 200,000 libraries worldwide. Several national bibliographies structure their order according to DDC. The German National Library has been using the DDC system since 2004. The extensions of the hierarchy levels in the DDC reach into the unlimited (ALEX 2018).

Dewey Numbers	Dewey Main Category	Books in this Category Answer this Question
000 - 099	General Information	How do we organize information?
100 - 199	Philosophy & Psychology	Who am I?
200 - 299	Religion	How did we get here?
300 - 399	Social Sciences	Who are the people around me?
400 - 499	Language	How can I communicate with others?
500 - 599	Science	How can I explain the world around me?
600 - 699	Technology	How can I control the world around me?
700 - 799	Arts & Recreation	How can I enjoy my free time?
800 - 899	Literature	What are the stories of our lives?
900 - 999	History & Geography	What was the world like in the past? What is it like now?

Figure 7.1 An overview of the three-digit DDC levels (SNICKET 2022)

7.3 Regensburger Verbundklassifikation

In Germany and to some extent also abroad, the system of the so-called Regensburger Verbundklassifikation, RVK for short, has become widely established in academic libraries. It was founded in 1964 at the University of Regensburg and still offers a wide-ranging classification system for recording holdings in libraries today. As of 2017, the RVK has been standardized to meet standards and has since functioned as an Open Data resource. It is licensed under the Creative Commons CC0 license.

7.4 Controlled Vocabulary

A collection of controlled terms or keywords used to describe the content of a document is referred to as a controlled vocabulary. The collection is usually based on a so-called thesaurus, i.e., a kind of term system or, more simply put, defined word lists. The keywords, also called descriptors, and the system are used for standardization and identification for the description of the contents. Controlled vocabulary is used in many areas of life to reduce the ambiguities of natural language and to provide consistent indexing in information practices. For example, in controlled vocabularies for reference works, it must be decided whether an article about a passenger car should be called "car," "wagon," or "passenger car." Thus, with the controlled vocabulary system, precise and complete search results can be obtained (WIKI 2022).

7.4.1 Die Gemeinsame Normdatei (GND)

In Germany, there is the so-called Gemeinsame Normdatei - GND, a service founded by the German National Library to use and manage standards data cooperatively. It is an example of controlled vocabulary and includes standards data for the representation of persons, corporations, congresses, geographies, subject terms and works related to cultural and scientific collections. All entities in the system have a unique designation with the GND abbreviation in front. This allows data to be linked both internally to each other and externally to other web resources, for example. The result is a machine-interpretable and cross-organizational data network. In addition to the German National Library, all German-language library networks and numerous other institutions are cooperating in the operation of the GND (DNB 2021).

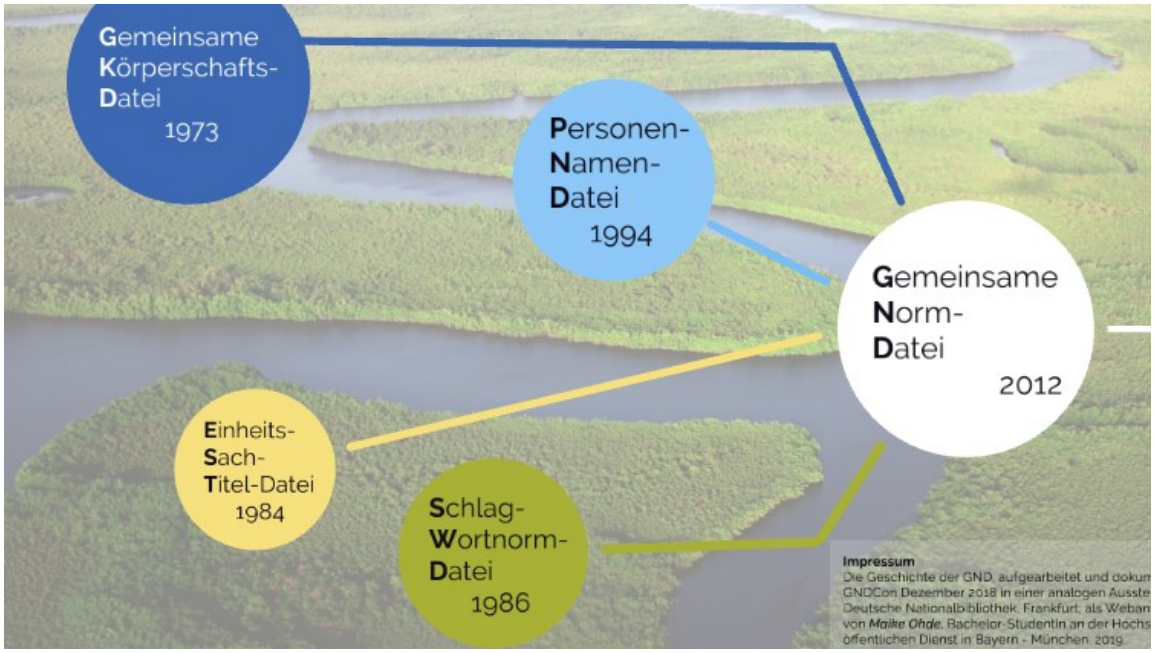

Figure 7.2 Historical development of the GND (DNB 2021)

7.4.2 Library of Congress Subject Headings (LCSH)

The Library of Congress Subject Headings - LCSH is the system used by the Library of Congress in the United States for the management and organization of controlled vocabulary. It is, in this sense, the counterpart of the GND in Germany and is maintained in Washington. LCSHs are assigned to each item in the library collection and make it easier for users to find other relevant literature on their topic. They are published in book form and are divided into five red volumes. Access to the LCSHs is also available on the Library of Congress Web, but for a fee (LOC 2022).

7.5 Altmetrics

Due to digitization, the use of metrics in publishing has modernized. Metrics are used to measure the attention of publications, for example, how often an article is cited or published. Bibliometric metrics are used, such as the h-index, a key figure that describes the reputation and perception of a scientist in specialist circles. Altmetrics, conceptually composed of the words alternative and metric, are alternative metrics and primarily web based. They capture both positive and negative mentions and reactions to scientific publications from online sources such as news portals or social media. For example, they measure how often an article has been accessed, linked to, or discussed. Reviews and likes, i.e., indications of liking, are also included. In addition to quantitative statistics, researchers can also find out who is talking about their publications and on which channels, for example in online journals or in blogs or forums (BRANDT-BOHNE 2018).

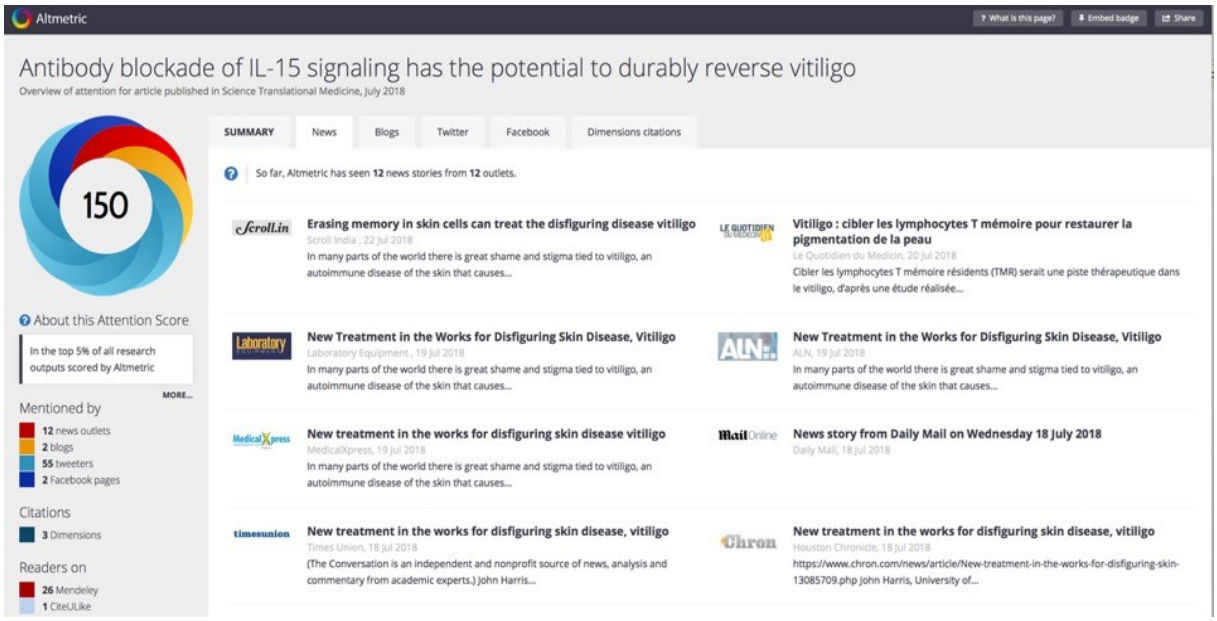

Figure 7.3 Illustration of the Altmetric "Attention Score" with color-coded "donut" for an exemplary selected scientific article (BRANDT-BOHNE 2018)

7.6 Catalogization with WorldCat

Figure 7.4 Logo of the WorldCat library (OCLC 2022)

WorldCat is now the world's most comprehensive database of library holdings. WorldCat can be used to catalog and make available nearly all the knowledge in libraries around the world. The service is managed by the Online Computer Library Center, the global library network that provides shared technology services and research and community programs to members and the library community at large, and thousands of librarians worldwide. The database includes the catalogs of member libraries, and the records are continually expanded and maintained. In addition to increased data quality, this results in significant savings in cataloging time and provides extensive access to hundreds of millions of data records (OCLC 2022).

7.7 Research Tools with Costs

The use of search tools such as WorldCat or the German National Library are to a large extent free of charge. In addition, there are also databases that require a fee, such as the Web of Science or the SCOPUS database, which include search interfaces where users can search for relevant scientific literature in various literature and citation databases. SCOPUS is considered the largest database of peer-reviewed literature in many fields.

8 Dissemination with Academic/Professional Social Media

8.1 Social Media

Social media refers to websites or platforms on the Internet where users can link up and exchange information with each other. The use of social media is interactive. Registered users can share their knowledge and experiences with other users, and it is also possible to react or respond to the posts. In corporate strategies, the use of social media has become significant for customer acquisition and satisfaction in recent years. Social media exist in many forms on the Internet. The best-known examples are social networks, forums, and blogs. Social networks trivially give everyone the opportunity to publish a post themselves or to react to other posts. This includes platforms such as Facebook and Twitter. In a forum, people usually write about and discuss a specific topic. Blogs are usually designed in such a way that there is only one user who publishes posts and other users have the opportunity to react and respond to them.

8.2 Social Media for Scientists

Platforms such as Facebook, Instagram, YouTube, or Twitter have manifested themselves in society predominantly for people's private use. In addition to these networks, there are purely professional or scientific social media platforms that have become very popular among researchers and their institutes in recent years. There are several platforms on the market where academics can create their profile and present their work. Basically, there are two types of social media platforms in terms of networking. On the one hand, there are the pure profile platforms and, on the other, so-called research networks (CITAVI 2020).

Science communication is being enriched by many new players because of digitization, the medialization of the science system and the expansion of formats such as blogs and science slams. In addition to the three central players - scientists, science journalists, and media and public relations professionals - others are emerging and expanding the field of science communication. Social media are significantly changing science communication.

According to KÖNNEKER 2017, this circumstance is generated by individual mass media effects, as well as by new attention and traffic streams for science journalistic portals with repercussions on editorial strategies and organizational structures. (KÖNNEKER 2017). In accordance with Könneker, the following wisdom emerges in his literary work Science Communication in Networked Publics:

"Research institutions, science-promoting institutions and other organizations are also active in social media with their own information and opinion offerings on science topics - as are actors with anti-enlightenment agendas and proponents of conspiracy myths. This provokes the question of whether content skeptical of science can flourish in a special way in social networks, beyond the filter and moderation by traditional gatekeepers of the media system. This is because discussions on science topics in social media are also often emotional, and communities mobilize and radicalize. Several psychological effects are cited as explanations for such polarization phenomena, which are also virulent in offline contexts, but can have greater effects under the conditions of social networks. As a result, existing (science-skeptical) attitudes can become more strongly entrenched and radicalized in social media discourses. Various technological effects and the (factual or supposed) anonymity in online discussions play a forcing role here. "
(based on KÖNNEKER 2017, chapter 1)

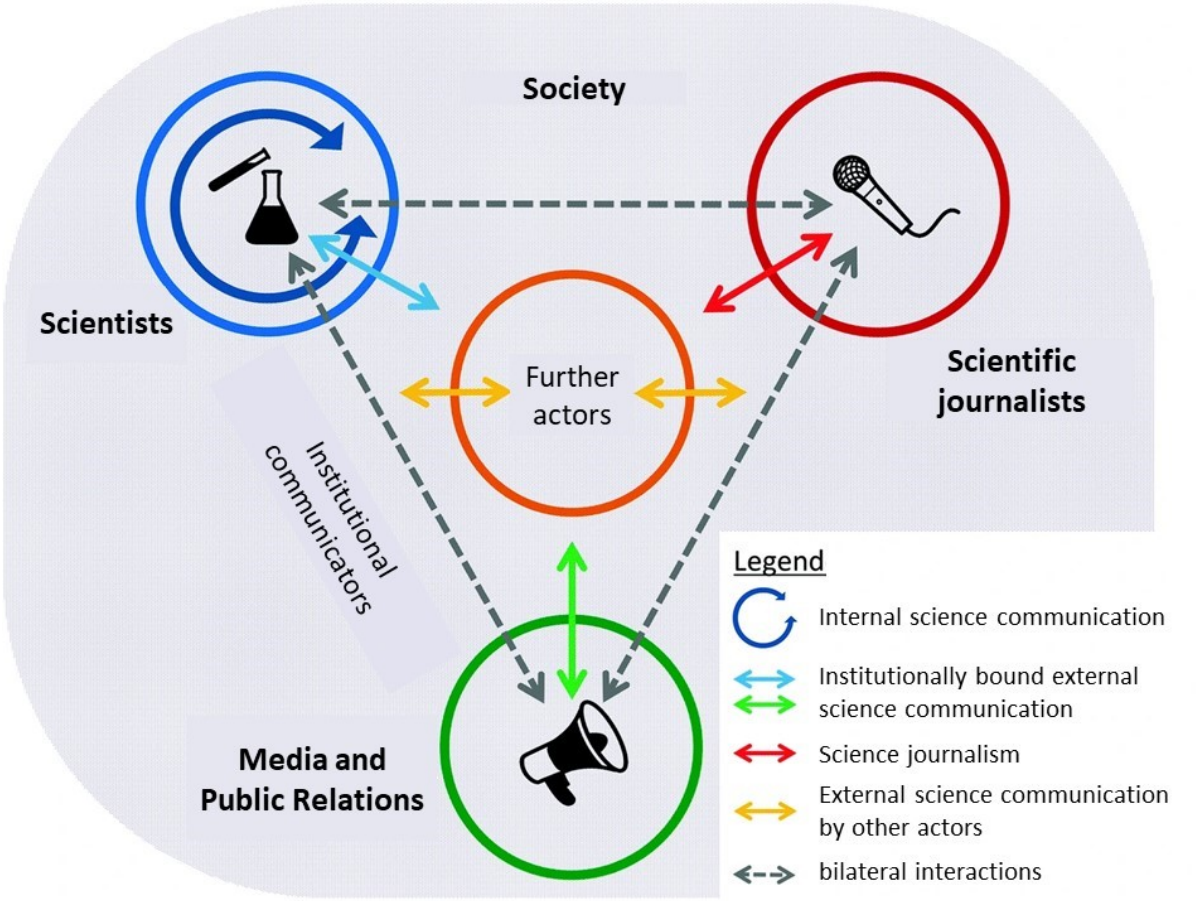

Figure 8.1 Science communication by actors (based on KÖNNEKER 2017)

8.3 Profile Platforms

On profile platforms, users create a profile with which they can be clearly identified. This allows the impact of the author or their work to be measured and activities, such as publications or peer reviews, to be tracked. It is thus similar to privately used social media such as Facebook or Twitter, but with the difference that it is usually not possible to respond directly to posts, as is the case with a Facebook post, for example. Among the best-known profile platforms are ORCID and Google Scholar Citations. The former involves a non-profit organization where scholars with so-called ORCID IDs can list and publish their work and results. The workflow

procedure of an ORCID is shown in Figure 8.2. As you can see, the figure shows all the steps from registration to ORCID publication.

The profile in Google Scholar, one of the world's largest search engines for literature searches of scientific documents, gives authors the opportunity to track how often their work is or has been cited, which they have made available on Google Scholar (CITAVI 2020).

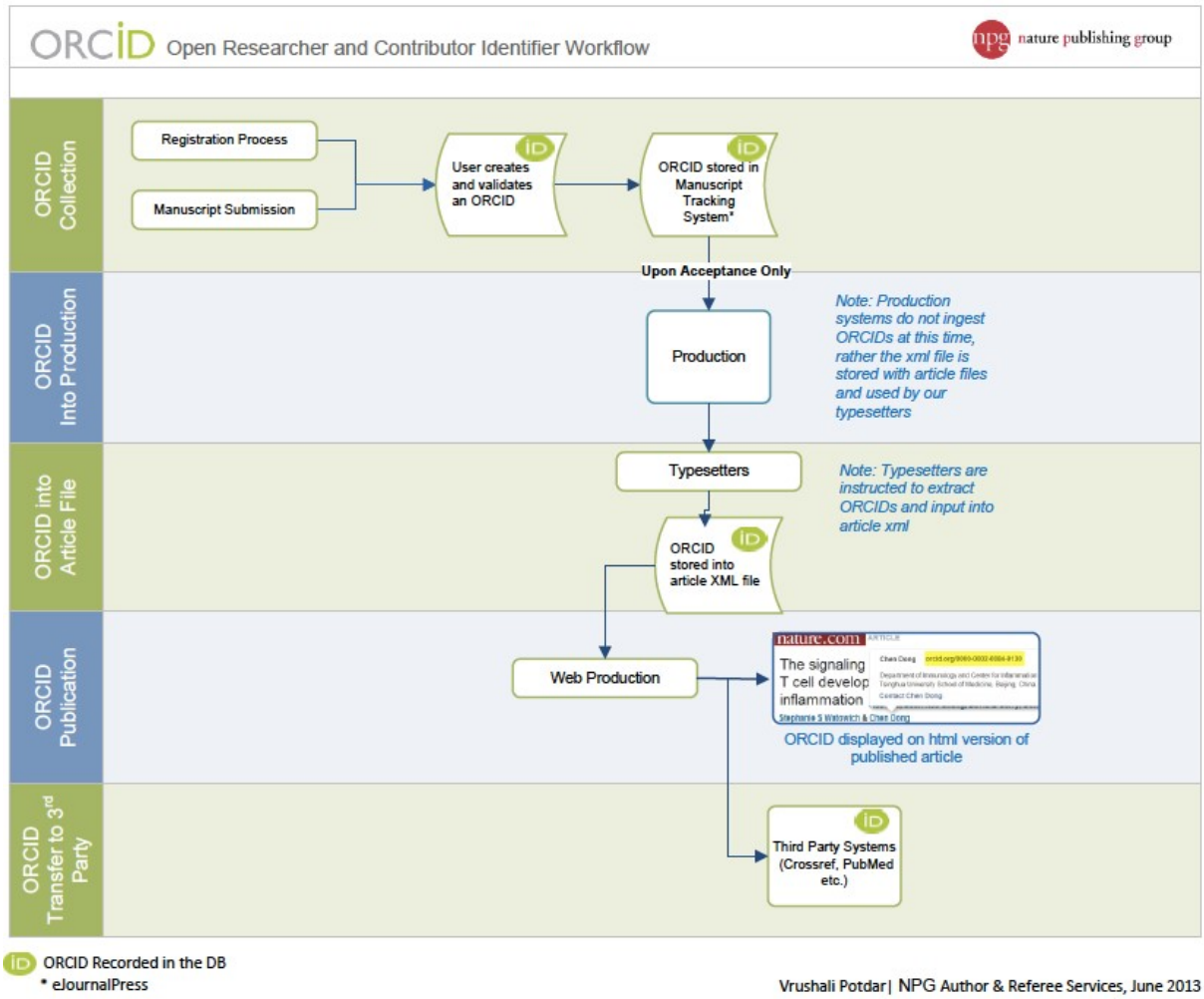

Figure 8.2 Workflow of an Open Researcher and Contributor Identifier - ORCID (ORCID 2013)

8.4 Research Networks

Compared to pure profile platforms, research networks offer the possibility for authors to network and exchange with other users in addition to presenting their work. What takes place internally among colleagues in institutions can be extended with the use of research networks and, additionally, open the doors to other companies and institutions.

Unlike networks such as Facebook and Twitter, where there is usually a mix of both, research networks separate personal and professional use. They are therefore more likely to compete with scientific publishers than with social networks, which are mostly used privately.

Two networks dominate the market among research networks: ResearchGate and Academia.edu (CITAVI 2020). In the following subchapters, an insight is given into these two networks and, in addition, into the well-known platforms LinkedIn and Xing.

8.5 ResearchGate

ResearchGate was founded in 2008 by ResearchGate GmbH in Berlin and serves as a commercial social network and database for researchers from all scientific fields. Today, the platform has more than 16 million members. In addition to their own profile information, users can upload scientific work and network with other users. To use or create a profile on ResearchGate, an e-mail address from a known research institution or proof of a scientific publication is required. Authors can determine whether their articles are publicly accessible or only for their own followers. The so-called ImpactFactor again plays an important role here. Researchers can see how often, for example, their articles or profile has been accessed. The activity score, or better said the ResearchGate Score as shown in Figure 8.3, can be decisive for a good reputation. It is measured, for example, whether people ask or answer questions. The number of readers and citations is also listed in the profile, so that a quick overview can be obtained of how successful a member is in their field. Without distracting with too many details, the platform is graphically appealing and clearly structured. In addition to the possibility of exchanging ideas with other scientists about their work, ResearchGate is a good place to go for job offers, which are specifically played to each member's profile (BLINDERT 2015).

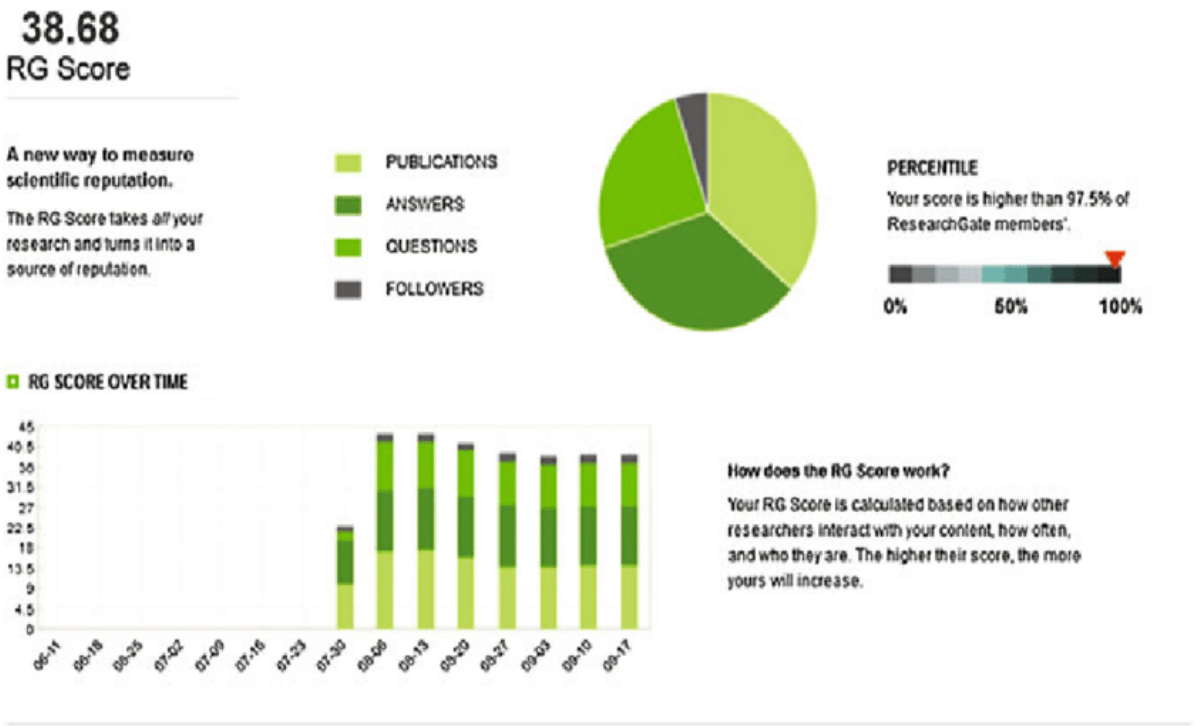

Figure 8.3 Excerpt of a Research Gate Score (RESEARCHGATE 2022c)

8.6 Academia.edu

Academia.edu is a privately held company founded in San Francisco in 2008 that operates a commercial document server. It acts like a kind of distribution station for Open Access papers from academics and researchers in various fields. The use of the platform is particularly high in the humanities and social sciences, and the company now counts more than 100 million members of the network. Like the other research networks, authors can upload and manage their papers, and they can also follow the activities of other users. Ultimately, Academia.edu works similarly to ResearchGate, but with the difference that non-university or non-institutional members can create a profile to use the platform as well. If one wants to register with Academia.edu, all that is needed is a Google or Facebook account. Hence explains the very high and constantly increasing members, from an institutional point of view there is no restriction on who can or cannot register. Figure 8.4 illustrates this steady increase in member registrations between 2010 and 2020. Academia.edu appears to be very appealing, especially for the search for scholarships and jobs (ACADEMIA 2022).

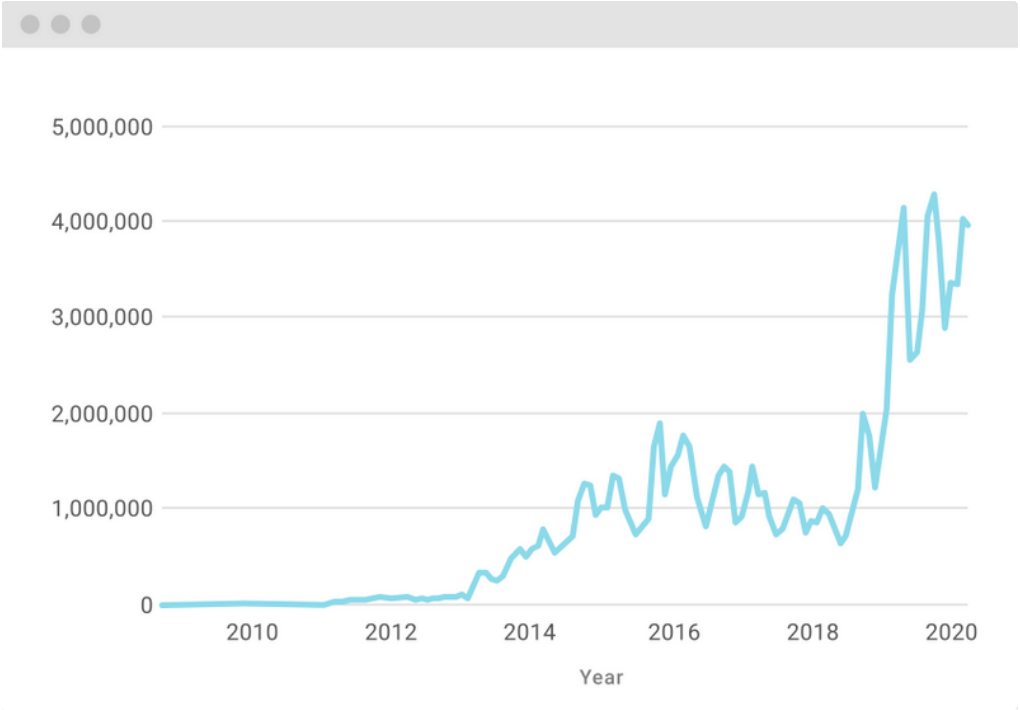

Figure 8.4 Monthly signups to Academia.edu over time (ACADEMIA 2022)

8.7 LinkedIn

LinkedIn is a web-based social career network that was founded in California in 2002 and has over 600 million users worldwide in almost 200 countries and regions. The platform is used to maintain existing business contacts and make new business connections. The site has been part of Microsoft since the end of 2016. Similar to other social networks, LinkedIn offers the option of creating a profile with a resume in various languages, networking with other members, or creating a company profile. LinkedIn is a network with a quiet and respectful exchange regarding scientific topics is possible, and the circle is mostly limited to specific target groups. In Germany, it is primarily used and referred to as a business network. Many use the platform to find out about an organization and its topics. The advantage here is that company profiles or LinkedIn profiles are generally also searched by search engines, which can be very helpful for research. One of the platform's promotional videos says, "**Focus on relationships!**". Because that is what it is all about there. Those users can network with each other and represent each other well through reviews and recommendations. The LinkedIn algorithm determines which content is displayed to users in their feeds. This is influenced by, among other things, interaction rates and content of high quality for the user. Even though links to websites are important for good website traffic, care should be taken to publish the most important information directly in the post. Often it happens that links do not receive much attention and as a communicator you naturally want the important content to reach the target group. Especially in the beginning, it should be kept in mind that the actual social media work usually takes place after the publications themselves. This includes monitoring comments, providing additional information if necessary, or activating other members through tagging, i.e., links (DELESKI 2020).

Figure 8.5 Icon of the LinkedIn platform (LINKEDIN 2022)

8.8 Xing

Xing is a direct competitor to its US counterpart LinkedIn. The platform was founded in 2003 by New Work SE in Hamburg, a service provider for services and products in the world of work. In line with its own motto "**for a better working life**," the company aims to create a working world in which everyone can realize his or her potential. Xing works in a similar way to LinkedIn. After successful registration, members can create profiles and enter their CVs and a wide range of interests, among other things. This can be both professional and private data. References also support the entries here. The basic membership is free, the paid premium membership offers extended functions, such as the complete and finer search function. As with LinkedIn, Xing can be used in multiple languages, and the search function also considers members with common languages. The platform now has around 19 million members in Germany, Austria, and Switzerland. Xing primarily offers a platform for business networks predominantly in German-speaking countries (NWSE 2022).

8.9 Social Bookmarking

Bookmarking is used to create tag collections of web pages or links for reuse. In modern Internet browsers such as Chrome, Firefox, or Safari there is an option to save Internet links as bookmarks or favorites and thus make them accessible for later use. With social bookmarks, users "collect" the links from websites, blogs or landing pages that they liked and that offer them informative value. Compared to the classic saving of favorites for oneself in the browser, with social bookmarking the bookmark is set at an Internet service provider or on a cloud. In this way, the web pages can be accessible to everyone, and the users ensure that the Internet pages with this content are indexed collectively. So-called social bookmarks icons with instructions such as "**Share this post**" are commonly found in everyday life and almost everyone is familiar with them (CUSTOMER GROWTH 2022). An example of this can be seen in Figure 8.6.

Figure 8.6 Social bookmarking links can be found at the bottom of all story pages (BBC 2022)

9 Hands on Experience in Digital Publishing

In this last chapter, a practical example is presented, showing how the previous concepts and methods are used for publications. Among other things, it will be displayed how a previously created preprint by Professor Scholz is published via a designated Internet service, regarding what role metadata plays in this. I started with an initial draft of the manuscript based on LINDEMANN 1985. For the preprint, a narrow topic from the field of wind turbines was chosen. The aim of this chapter is to show how a scientific preprint for a paper can be written, published, and disseminated. In the written preprint, the calculation of the tip-speed ratio λ on the blade element is presented and explained. The result and the preprint can be found as Appendix A in this thesis.

9.1 Writing the Paper

On www.preprint.org any style is allowed for submitted papers. However, all publisher and journal logos and names should be removed. The first page of the manuscript must contain: the title, author list, abstract, keywords, corresponding author contact details, and affiliations for all authors. The preprint concerns the calculation of the tip-speed ratio λ at the wing element.

With the help of the diploma thesis (LINDEMANN 1988) and the seminar lecture (LINDEMANN 1985) according to Scholz, the necessary calculations were carried out and the individual steps were shown.

The preprint contains a general abstract of the listed topic. Subsequently an introduction to wind energy was described, showing what specializes Horizontal Axis Wind Turbines – HAWT and what roles the cone and axis angle play for the power and the design of the wind turbine. This was followed by the calculation and the presentation of the individual calculation steps.

The preprint shows, how cone and axis angle can be considered in the calculation of power output of wind turbines and how this can be done based on an extended calculation of λ. Additionally, it displays where the angle of attack and the cone angle are to be found on the rotor. Subsequently, this is followed by information about the special feature of the Wagner Rotor. Moreover, Scholz goes into detail about The Blade Element Momentum Theory (BEMT) and The Unsteady Blade Element Momentum Theory (UBEMT) before he completes the preprint with the calculation of Lambda and the Conclusion.

9.2 Publishing and Disseminating the Paper

Before the preprint will be uploaded, it is necessary to check that everything is correctly specified and the formalities are correct. The paper will be published on www.preprints.org. Submitted papers should be in Word or LaTeX format, and in addition to the textual abstract, there should be a graphical abstract to ensure readability and clarity. As can be seen in Figure 9.1, the important metadata for uploading the article must be specified. This includes the title, the article type, the abstract and the keywords.

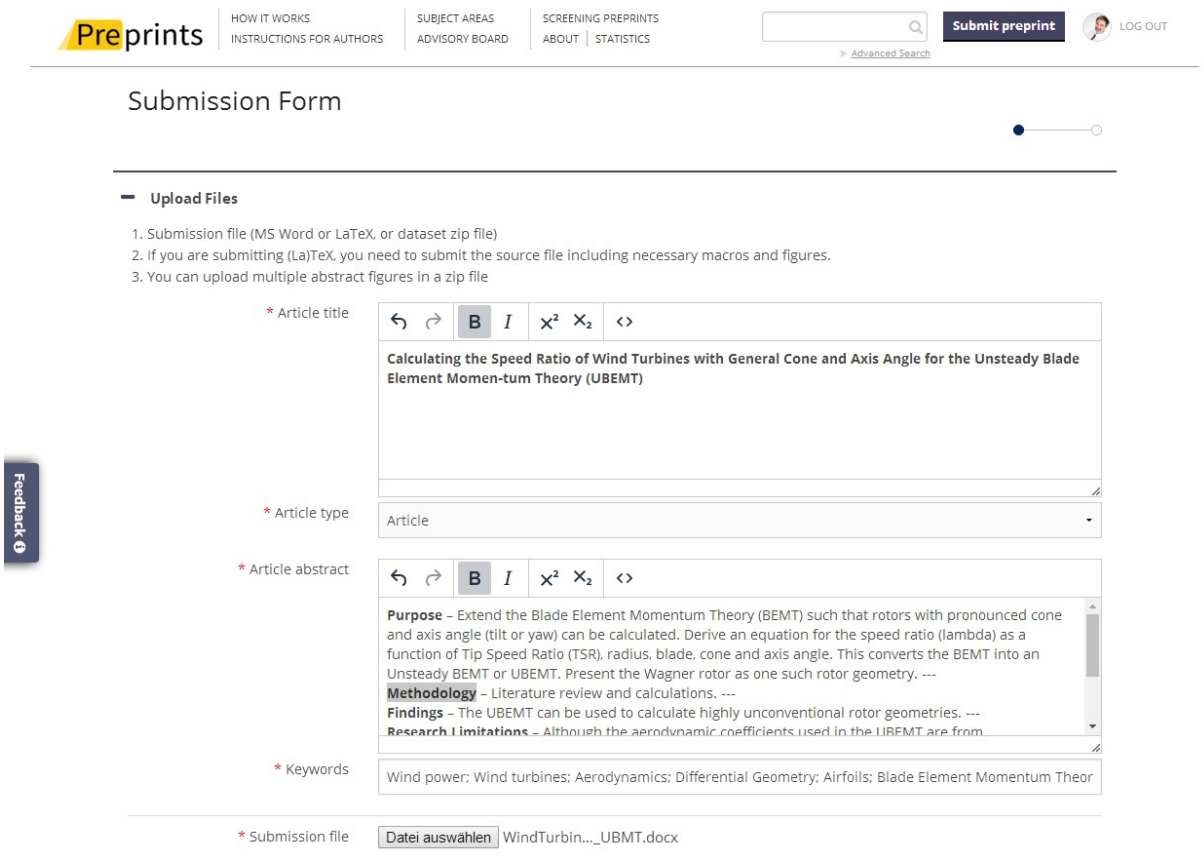

Figure 9.1 First side for the submission form of the article (SCHOLZ 2022)

Also, the attachments of the submit follow below, as Figure 9.2 shows. It is important to select the correct subject and provide all the correct data about the author.

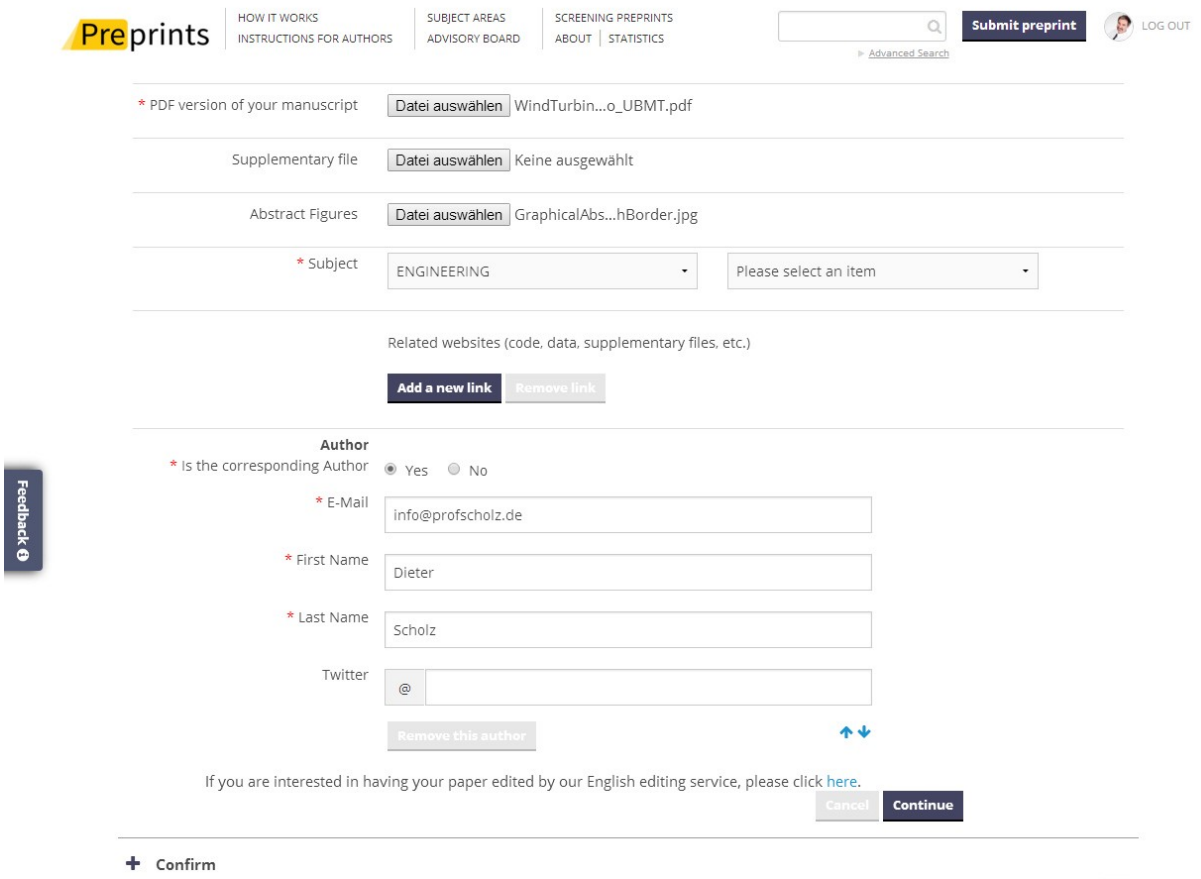

Figure 9.2 Second side for the submission form of the article (SCHOLZ 2022)

Once all criteria are met, the paper can be uploaded to the website via the "Submit preprint" button located at the top right of the page. Before that is made, there is additionally the option to invite readers for the item, like shown in Figure 9.3. One can notify up to ten colleagues.

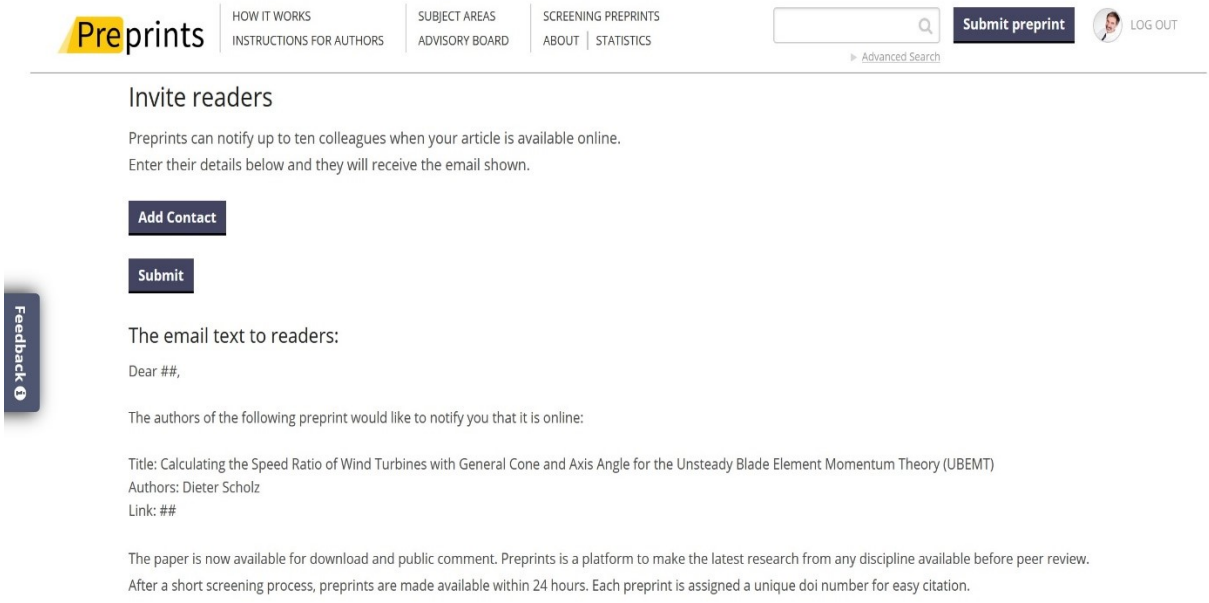

Figure 9.3 Here one can invite up to ten readers and see the email text they get (SCHOLZ 2022)

An account is required for publication, after registration the manuscript can be submitted or uploaded. As soon as the preprint has been submitted, there will be a screening process that typically takes 24 hours. The circumstance when further information is required, the user will be contacted by the Editor.

As Figure 9.4 illustrates, it is possible to see all the articles one has submitted in own account. In addition, there is a view of which step of the process the article is in and which article ID has been assigned.

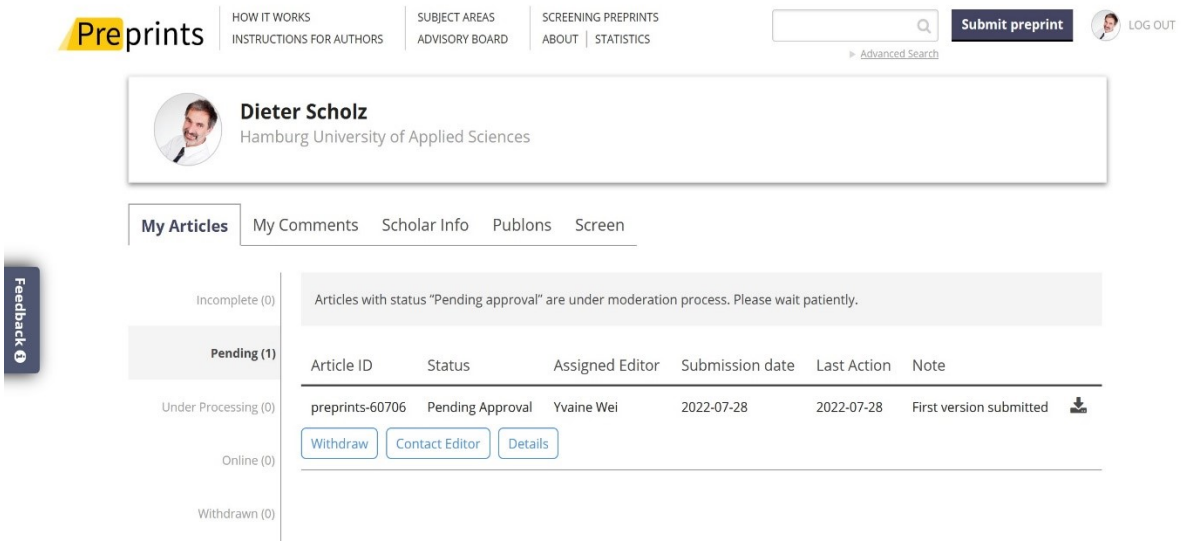

Figure 9.4 An overview of your articles and the steps of the submit procedure (SCHOLZ 2022)

As explained in the previous chapters of the thesis, attention to technical writing rules (chapter 3), Open Science opportunities (chapter 4), digital preservation guidance (chapter 5), and library science (chapter 7) is of significance. Using persistent identifier methods such as DOI or ORCID, uniquely identifiable and discoverable references can be created to ensure that the preprint is always easy to find.

With the help of Open Science concepts, the preprint can be disseminated. To ensure that the paper can be accessed permanently, the methods and concepts listed in Chapter 5 are used for preservation. After publication on preprints.org, various repositories can be considered for permanent preservation.

For the preservation of the preprint for the calculation of the tip-speed ratio, the repository of the digital library of Professor Scholz was used. You can find the preprint there at the reports for AERO, the Aircraft Design and System Group. This library can be accessed via the site library.profscholz.de.

The goal was to create a preprint to publish in the scientific journal Wind. Wind is an international, peer-reviewed, open access journal on wind-related technologies, environmental and sustainability studies.

It is published quarterly online by the Multidisciplinary Digital Publishing Institute, MDPI for short. Preprints.org is a manuscript creation and submission platform run by MDPI.

9.3 After Submission

Once the preprint is submitted and available on the site, you can find and access the article using the title, author name, or various keywords. Furthermore, after uploading, one receives a DOI for the published content.

This DOI is also visible on the website and ensures the permanent availability of the article. The page will then first display the abstract of the article and important bibliographic data of the file. On there, it is possible to download the submitted and published article as a PDF file, as you can see in an example of a published paper in Figure 9.5.

Figure 9.5 Web view of a published paper on preprints.org (PRE 2022)

As can be observed, one gets informative representations about the data of the item. Among other things, the date of submission and the date of publication are shown. In addition, one receives an overview of all authors involved and, besides the abstract below, also keywords and copyright information. On the right side, you can download the article as a PDF and even get information about the reputation of the article and how often it has already been accessed and downloaded.

10 Summary

In the past, for publishing and for successful science communication, people devoted themselves to the core options of publishing in paper form or in oral presentations. These procedures are still used today, especially in science. During industrialization and the subsequent increase in digitization, the methods have expanded and strengthened enormously.

This paper provides an overview of the various concepts of digital publishing and how the digital turn has affected scholarly publishing. Especially for young students and engineers starting their careers, the report can serve as a guideline for shaping their careers. At the beginning of the paper, the basics of publishing were introduced, and general concepts were described, such as requirements engineering or how academic publishing works. It also addressed how these concepts have been influenced in the turnaround of digitization and what roles individual methods play in companies. The management of different areas in companies is crucial for good publishing and for good communication in science. Technical research and development are trivially based on the dissemination of knowledge and its applicability to the widest possible circle of scientists. Good product data management and sensibly designed corporate communications, both internally and externally, drive technology forward and help make knowledge accessible to as many people in the world as possible.

Proper academic dissemination and publication of research papers and results also play an important role, as can be read in chapter 3. Based on this, scientists can also enhance their reputation and increasingly develop themselves further. Guidelines must be followed for successful writing, communicating, and publishing in technical research. For example, it is important to know whether new results have already been established by other scientists in order to avoid getting into legal trouble or to be able to obtain patents or defensive publications on one's own. The choice of the publication venue is of great importance, good peer reviews promote the reputation of the scientist or the company and correct source references and writing methods of the technique make the publication attractive and helpful. Systems such as IMRAD help with the proper structure of scholarly work, and with Internet service providers such as Perma.cc, links and sources can be safely stored and referenced for perpetuity.

Chapter 4 has shown an insight into the nature of open science. As already mentioned, the most unrestricted possible access to knowledge from all over the world is crucial for the promotion of research and technology. Open Data and Open Source Software make knowledge accessible to many people regardless of their location or possible technical or social barriers. Open Educational Resources open the door to a broad spectrum of science and work for young students. With the help of research information systems and licenses, scientists can make their research data available publicly or in their chosen spectrum and advance science even further.

Chapter 5 indicated different digital storage methods for archiving research data and literatures. Beyond that, it is about how they have become established in science. The principle of FAIR

data provides a good guideline for the correct electronic archiving of data. Repositories in research institutes or online storage services such as Zenodo represent archiving methods that have become widespread and established. In addition, unique indexes and web-based indexing make it much easier to find data.

Following chapter 6 described methods for creating machine-readable web pages. HTML, as the pioneer of the Internet, laid the foundation for the design and development of web pages. These forms of markup languages are used for structuring and formatting texts and other documents; in addition, so-called tags describe the properties, affiliations, and presentation forms of sections of a text.

Chapter 7 specified and covered the advanced use of repositories, especially in science. The chapter also looks at the classifications and systems used in the largest libraries in the country and the world, and the influence of controlled vocabularies and altmetrics. It also provides insight into various cataloging research tools and whether or not they are free to use or only partially available.

Among the most interesting was chapter 8, which showed how the influence of social media on publications in science has increased. It provides young aspiring researchers specifically for research and science and how to access them. ResearchGate and Academia.edu represent the two largest and most widely used platforms in this regard. However, platforms such as LinkedIn and Xing also give young professionals, who may not want to work in research and would rather conquer industry, the opportunity to network with other companies or individuals and advance both their own work and the work of others. For personal development, these platforms represent good networking opportunities. And the fact that the world in general is also always increasing in speed, means that communication is also greatly accelerated and improved here.

In the last section of the thesis, Chapter 9, a practical example of publishing was carried out to show how these methods of digital publishing can be applied and lead to good results. A preprint on the topic of wind energy was created and publishing methods were applied that were shown in the previous chapters.

11 Recommendations

Scientific publications for research and development have played an important role in good science communication for centuries. During human evolution, a wide variety of methods and techniques have been developed that are still in use today and are constantly being refined. For a successful career, as an individual or as a company, it is important that knowledge can be passed on and that there are as few obstacles as possible to this. Technical conditions have a great influence on this, especially on networking and the rapid dissemination of knowledge and literature. It will be interesting to see how the classic concept of the book as a medium evolves and what electronic developments emerge from it. E-books and e-learning platforms, such as those we have at the University of Applied Sciences in Hamburg, are far from reaching their limits.

If we stick to the example of the electronic book or the electronic publication of articles in general, we can see that, among other things, intuitive manageability is becoming increasingly important. It remains to be seen how storage methods will develop and how they will be made smarter, especially for long-term archiving and new technologies. Finding data with a wide variety of online libraries and unique indexing for articles and literatures will continue to be refined so that knowledge is also as accessible as possible to everyone in the world.

Summarizing the turnaround and impact of digitization in terms of digital publishing, it quickly becomes clear that in terms of speed and interconnectedness, science is advancing tremendously. Many believe that the book, or paper-based publications in classic tangible form, may be stripped from the future and that most publishing will be digital only.

It is important for companies and individuals to observe the increasing technological advances and to adapt them as well as possible. Often, many things fail due to a lack of technical knowledge for reasonable long-term archiving of data, or for digital communication with other scientists or companies.

It will also be interesting to see how the influence of social platforms develops further and what new opportunities arise for customer acquisition or for corporate communications. Unlike in the past, the use of social platforms such as ResearchGate or LinkedIn are becoming more widespread and they are showing increasing influence on the success strategies of companies and individuals.

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Appendix A – Article: Calculating the Speed Ratio of Wind Turbines with General Cone and Axis Angle

The following pages display the created preprint about the calculation of the speed ratio of wind turbines with general cone and axis angle for the Unsteady Blade Element Momentum Theory – UBEMT. I started with creating an initial draft of the manuscript, based on LINDEMANN 1985 and LINDEMANN 1988. The author of the article, Prof. Scholz, submitted the paper on preprints.org. If one wants to see what the article looks like once it is published, one is welcome to download it from the website as described in chapter 9. In the public PDF, the markings of the journal, such as the symbolizing purple bar with the preprints.org logo, will be visible.

Article

Calculating the Speed Ratio of Wind Turbines with General Cone and Axis Angle for the Unsteady Blade Element Momentum Theory (UBEMT)

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Abstract: Purpose – Extend the Blade Element Momentum Theory (BEMT) such that rotors with pronounced cone and axis angle (tilt or yaw) can be calculated. Derive an equation for the speed ratio (lambda) as a function of Tip Speed Ratio (TSR), radius, blade, cone and axis angle. This converts the BEMT into an Unsteady BEMT or UBEMT. Present the Wagner rotor as one such rotor geometry. --- Methodology – Literature review and calculations. --- Findings – The UBEMT can be used to calculate highly unconventional rotor geometries. --- Research Limitations – Although the aerodynamic coefficients used in the UBEMT are from measurements in steady flow conditions, they can be used with success. --- Practical Implications – Also conventional Horizontal Axis Wind Turbines (HAWT) with noticeable cone and axis angle should be calculated with the UBEMT. The accuracy of power calculations of these HAWTs can be slightly improved. --- Originality – Analytic equations for rotors with cone and axis angle have barely been discussed.

Keywords: Wind power; Wind turbines; Aerodynamics; Differential Geometry; Airfoils; Blade Element Momentum Theory; BEMT; BEM; HAWT; Wagner rotor

1. Introduction

For the past decades, wind power is the leading source of renewable energy. It is the world's fastest growing energy source due to its reliability and cost-effectiveness [1]. Wind energy systems [2] or **wind turbines** [3,4] are well covered in textbooks in English or other languages like German [5-8].

The dominant wind turbine design is the **Horizontal Axis Wind Turbine** (HAWT) with blades usually rotating in front of the tower. A closer look reveals that HAWTs often have an axis with a small angle to the horizon. Furthermore, the blades may show an angle with the axis not exactly 90° (Figure 1). Such angles are used to ensure clearance between the blades and the tower, considering rotor blade bending under loads. Clearance to the tower is not only common sense, but also required by the international standard IEC 61400-1 [10]. **Cone angle**, **axis angle** and overhang (Figure 2) may be used concurrently, but can only be used to a limited extent. Tilting beyond 5° may introduce unwanted cyclic loads, while coning results in a moment at the blade root due to centrifugal forces on the blade [1]. Coning and tilting also results in a reduction of power or require longer blades to maintain power [12]. An additional overhang causes increased loads on rotor bearings.

Installing **wind energy systems offshore** has several advantages. Additional sites become available, wind speeds are higher than on land, and turbulence is lower. The visual impact is reduced and noise impact on humans is also reduced. Certainly, there are also many disadvantages with offshore wind energy. Disadvantages combined result in higher costs. For water depths up to 50 m, wind turbines are installed on the sea floor. At a certain water depth, floating structures are less expensive than those installed on the

sea floor [1]. Figure 3a shows one example of a floating HAWT. A long cylindrical buoy is anchored with mooring lines. It floats upright due to ballast at its base.

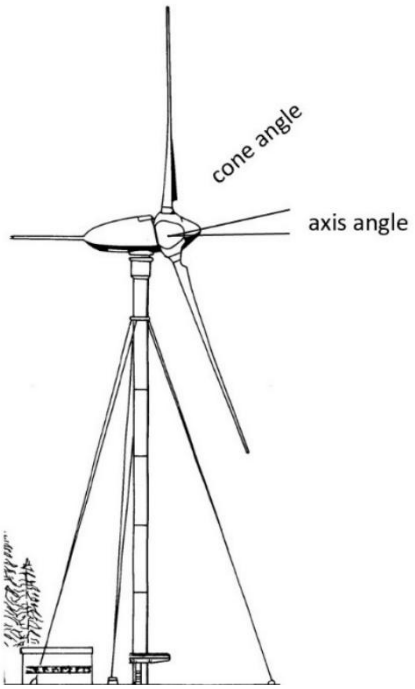


Figure 1. Axis angle (nominal: 10°, oscillating nave) and cone angle (9°) of the German 3 MW research wind turbine GROWIAN ("Große Windenergieanlage" – "large wind turbine"), 1983 – 1987. The blades rotated on the leeward side of the tower. Based on [9].

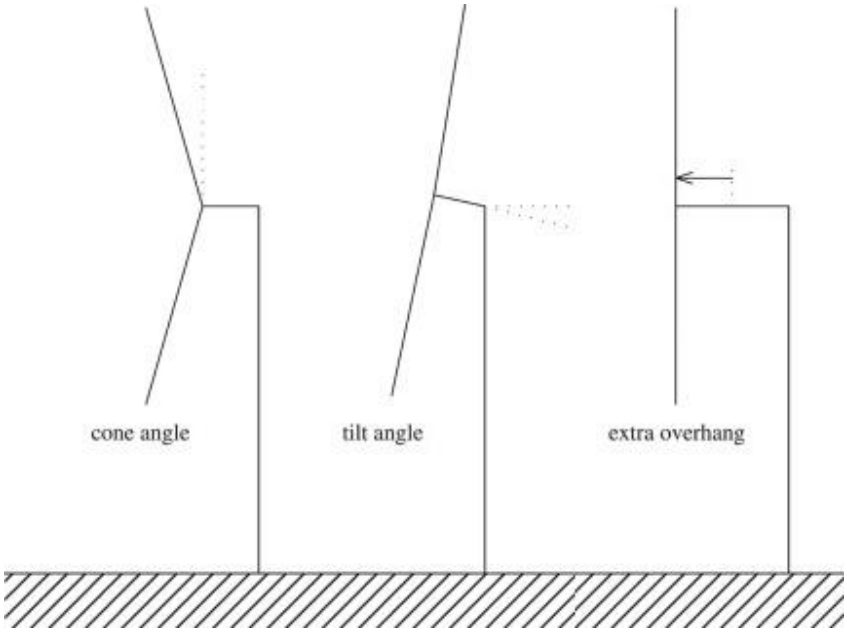
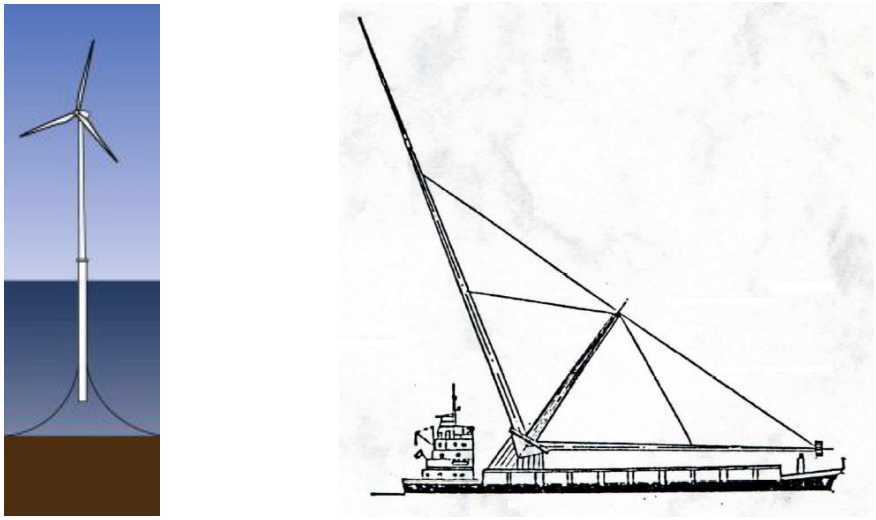


Figure 2. Geometry variations with cone angle and axis (tilt) angle of a HAWT to ensure clearance between blade and tower. Based on [11].

The **Wagner rotor** (Figure 3b) is a proposal from the 1980th especially as a wind turbine for deep water offshore use. The idea is to mount a wind turbine without a tower on a conventional ship. The Wagner rotor applies large cone and axis angles (Figure 4).



(a) **(b)**

Figure 3. Deep water offshore wing turbines. (**a**) Wind turbine with horizontal axis mounted on a perpendicularly floating buoy (based on [1]). (**b**) Asymmetric Wagner rotor with pronounced cone and axis angle mounted on a ship (reproduced from [12]).

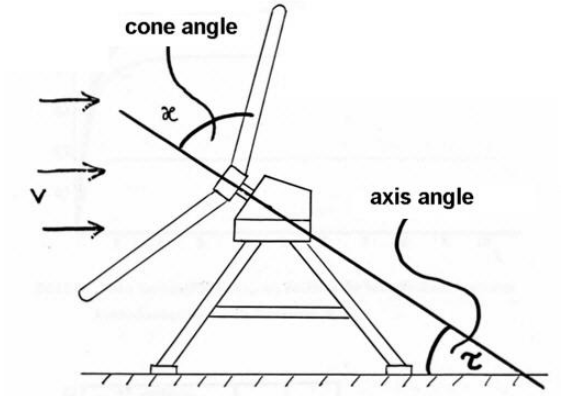


Figure 4. Wagner rotor onshore. Defined are cone angle, κ (kappa) and axis angle, τ (tau). The axis angle leads to tilt of the rotor plane. Based on [12].

Calculating the **power output of wind turbines with pronounced cone and axis angle** as shown on Figure 1, Figure 3b, and Figure 4 has to take this geometry into account. Lift and drag on the blades depend on the relative speed. Blades on a tilted (more horizontal) rotor disc move against the wind during one half of the revolution and move with the wind during the other half of the revolution. The same is true if the rotor would experience a yaw angle instead. With a cone angle it has to be noted that only the component of the relative wind vector shows an effect that acts on the airfoil. A flow along the length of the blade remains without primary effect.

Wind power calculations are based on a nondimensional rotational speed known as the **tip speed ratio** (TSR). For TSR, the Greek letter λ (lambda) is used in equations. To be more precise, λ can be calculated anywhere along the length of the blade at a radius r. TSR is calculated at the blade tip, where $r = R$ and $\lambda = \lambda_t$. The index t stands for "tip". For HAWT, the speed ratio, $\lambda(r)$ is the ratio of circumferential speed, u and wind speed, v. ω (omega) is the angular velocity in 1/rad and ν (nu) is the rotational speed in 1/s or in revolutions per minute (rpm) divided by 60.

$$\lambda(r) = \frac{u(r)}{v} = \frac{\omega\, r}{v} = \frac{2\pi\, \upsilon\, r}{v} \quad ; \quad \lambda_t = \frac{\omega\, R}{v} = \frac{2\pi\, \upsilon\, R}{v} \tag{1}$$

This article shows, how cone and axis angle can be considered in the calculation of power output of wind turbines and how this can be done based on an extended calculation of λ. The practical purpose of this article is to add an equation $\lambda = \lambda\ (r,\tau,\kappa,\theta)$ to the aerodynamic calculation of wind turbines and to extend the Blade Element Momentum Theory (BEMT) to certain unsteady flow conditions. The equation $\lambda = \lambda\ (r,\tau,\kappa,\theta)$, which is based on radius, cone and axis angle is not new. It had been derived in the Appendix of a report, written by the author in 1985 [12]. This German report was made available online decades later and published in repositories. However, the equation never reached any larger visibility.

A **literature review** including above mentioned sources [1-10] and more, e. g. [13-18] showed no mention of including cone and axis angle into the calculation of power output of wind turbines. In one paper [19] the cone angle was systematically varied, leaving the axis angle always at 0°. The authors found that the turbine suffers a reduction of power with a cone angle, κ less than 90°. Calculations were done with Qblade from the Technical University in Berlin, Germany. The more recent version of Qblade [20] has moved from the BEMT to the Lifting Line Free Vortex Wake (LLFVW) method. The numeric code allows input of rotor cone angle, rotorshaft tilt angle, and/or rotor yaw angle on the fist tab of the simulation setup dialog. Qblade allows superb visualization of the rotor wake in addition to the output of rotor (global) parameters like turbine power. The inclusion of yaw in the BEMT (without cone angle) is covered in [21].

Structure of the article: Chapter 2 introduces a wind turbine with pronounced cone and axis angle. Chapter 3 talks about fundamentals of the Blade Element Momentum Theory (BEMT). Chapter 4 extends the BEMT to the unsteady case due to pronounced cone and axis angle. Chapter 5 derives $\lambda = \lambda\ (r,\tau,\kappa,\theta)$ as input to the Unsteady Blade Element Momentum Theory (UBEMT). Other documents written or supervised by the author, include on the same topic:

- Results from the UBEMT applied to the Wagner rotor [12].
- Equations for the BEMT, systematically listed and derived [22, 24].
- The BEMT applied to a HAWT compared to measurements [23].
- The setup of an Excel program for the UBEMT and its application [24].

As such, these results are not repeated here in detail.

2. The Wagner Rotor

The Wagern rotor (Figure 5) is named after his inventor Dr. G. Wagner from Sylt, Germany. He published his idea in the early 1980th. Here are the abstracts with his own words.

Abstract from 1982 in [25]:

A newly developed wind turbine is described. Its rotor - called Wagner rotor after its inventor - is neither based on a horizontal nor a vertical shaft. The shaft has an inclination angle of 50°. The turbine has anchored a rotor blade following the principle of a suspension bridge … The whole plant is mounted on a ship.

Abstract from 1982 in [26]:

During the past year, a large model of a floating windmill has been working near Sylt, the most northerly Island off Germany. Its maximum power is 250 kW, the length of the blade is 25 m and the length of the ship, 30 m … The advantages of offshore windmills are their low price (500 U.S.$/kW), short building time and lack of problems with transportation or siting … Floating windmills have several special problems. First there is the necessity of a low centre of gravity, secondly the construction must be simple and robust. The Wagner rotor was developed with consideration of these problems. The axis of the Wagner rotor has a tilt angle of 45° or 55°; the angles between blades and axis (cone angle) are 55°. The bearings, gears, generator and nacelle are inside the ship. The tips of the blades are also connected with wire ropes to a pylon positioned on the axis. The disadvantage of the Wagner rotor is that the blades are 1.7 times longer than the wings of horizontal axis turbines with equal power rating. However, the cost of the blades is 10% of the total cost of the windmill (including the ship), and therefore this is of no particular concern.

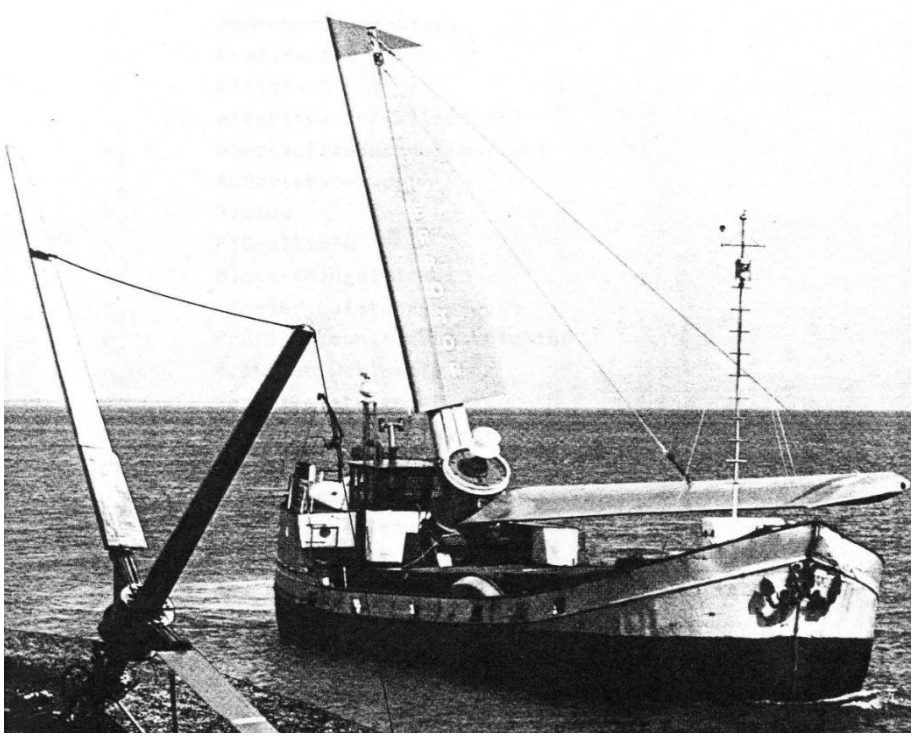
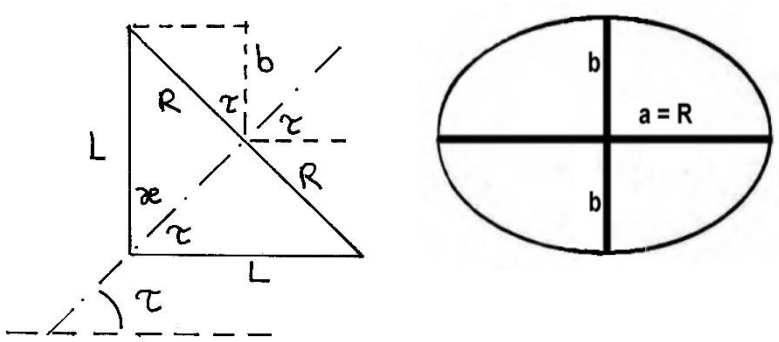


Figure 5. Two Wagner rotors. Left: An onshore version. Right: A deep water offshore version. [12]

In 1985 test results from Germanischer Lloyd, Hamburg, Germany, financed by the German Ministry for Research and Technology were published in [27]:
For utilization of wind energy at sea Dr. Wagner from List/Sylt has proposed a novel system, a prototype of which he installed aboard the vessel Tanja I. The operating performance of the prototype Wagner Rotor I was to be determined. The investigation programme was not confined to determination of wind velocity and direction and of the output capable of being picked up at the generator. Beyond this, it was to be attempted to simultaneously determine the stresses acting on the rotor blade and structures adjacent to the foundation. Also, the vessel's vibration behaviour and stability during operation of the system was to be assessed. The system presented did not permit any performance/wind velocity charts to be prepared, as it was impracticable to operate the system in the stationary condition for a prolonged period and as the system was not provided with a governing device. The Wagner Rotor I has to be started by means of a motor and only with wind velocities in excess of 10 m/sec it continued to rotate automatically. Related to the size of the installation its mechanical and electrical output measured is extremely low. Considering the limited quantity of energy generated per year it appears to be impossible to derive any substantial economic benefit from the system in the concept presented.

Despite this devastating result, it may still be worth to look again at the old concept for deep water offshore application. It needs to be considered that the ship-mounted wind turbine of Figure 5 was based on a one-man-effort and his private finances. The Wagner rotor has certainly the potential to produce power. The power reduction factor compared to the HAWT can be calculated.

A first order calculation looks at the rotor disc geometry. Following a first intuitive idea, a cone angel $\kappa = 45°$ could be applied on a ship (Figure 6). To have the rotor blade in its lowest position horizontally along the deck of the ship, the axis angle would need to be $\tau = \kappa = 45°$. From a rotor blade length, L follows a Radius, $R = L \sin \kappa$, which forms the semi-major axis, a of the ellipse. The length of the semi-minor axis, b of the ellipse is calculated from $b = R \cos \tau = L \sin \kappa \cdot \cos \kappa$.



(a) **(b)**

Figure 6. Geometry of the Wagner rotor. (**a**) Side view of the Wagner rotor shown with a cone angle of 90°. *L* is the length of the rotor blade. Angles are defined as in Figure 4. (**b**) The projected area towards the wind is an ellipse with semi-major axis, $a = R$ and semi-minor axis, b.

The projected area of the Wagner rotor is an ellipse with area, A_{WR}. The horizontal axis wind turbine has a projected area, A_{HAWT}. This is the largest possible area swept by a rotor blade of length *L*. The Wagner rotor should maximize the ratio of the two projected areas. Equation (6) is plotted as Figure 7.

$$A_{WR} = \pi\, a\, b = \pi\, L \sin\kappa \cdot L \sin\kappa \cdot \cos\kappa \tag{2}$$

$$\text{with } \sin x \cos x = \frac{1}{2}\sin 2x \tag{3}$$

$$A_{WR} = \frac{1}{2}\pi L^2 \cdot \sin\kappa \cdot \sin 2\kappa \tag{4}$$

$$A_{HAWT} = \pi\, L^2\,; \tag{5}$$

$$\frac{A_{WR}}{A_{HAWT}} = \frac{1}{2} \cdot \sin\kappa \cdot \sin 2\kappa \tag{6}$$

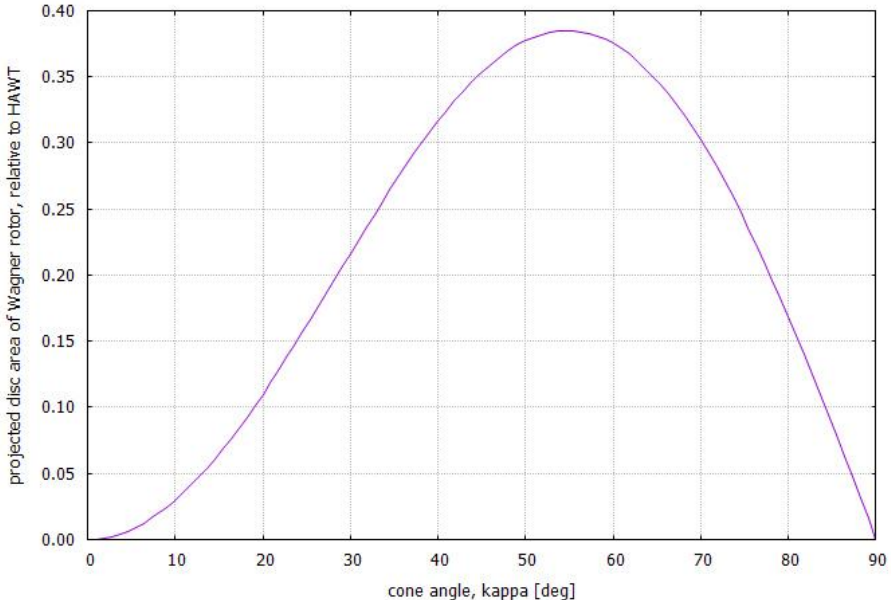


Figure 7. The projected disc area of the Wagner rotor, A_{WR} relative to the maximum possible disc area as given by the horizontal axis wind turbine, A_{HAWT}. Plot of (6). Maximum at $\kappa = 54.74°$ with $A_{WR} / A_{HAWT} = 0.3849$.

The maximum of the ratio of the two projected areas can be found from the derivative of (6) set to zero. This yields an optimum cone angle, $\kappa = 54.74° \approx 55°$. Wagner also proposes this number in [26], which is more than the first intuitive idea of a cone angel, $\kappa = 45°$ (Figure 6a). A cone angel $\kappa = 55°$ is depicted in Figure 3b. With $\kappa = 55°$, (6) yields a ratio of 0.3849. With a rotor blade longer by a geometry factor of 1.61 the same projected area could be achieved as with the HAWT. Conservatively rounded up, this is the factor 1.7, which Wagner mentions in [26].

Calculations in [12] show that the overall aerodynamic efficiency of the Wager rotor is only about half of the efficiency of a HAWT. To make up also for this, the projected area would need to be twice as big and the rotor blade longer by a factor of $\sqrt{2}$. Together with the geometry factor, the rotor blades of a geometrically optimum Wagner rotor would need to be longer by a factor of $1.61 \cdot \sqrt{2} = 2.28$. With the same rotor blade as used for a HAWT, the Wagner rotor only produces $0.385 \cdot ½$ or 19% of the HAWT output.

The Wagner rotor using the same rotor blade would only be economically superior to a floating deep water HAWT, if overall operating costs are more than five times lower.

3. The Blade Element Momentum Theory (BEMT)

Almost all engineering-level aerodynamic design calculations for Horizontal Axis Wind Turbines (HAWT) are done with the Blade Element Momentum Theory (BEMT) [28]. Since the flow changes with the radius of the rotor, the rotor disc is divided into several annular rings at radius, r (Figure 8). The aerodynamic forces at each blade element are represented by the lift coefficient and drag coefficient known for the airfoil in place. At best, aerodynamic coefficients should be available from wind tunnel measurements for all 360° of angle of attack. Conservation of energy tells us that the wind turbine reduces the velocity of the flow when power is extracted. Conservation of angular momentum tells us that the braking momentum of the generator must be equal to the angular momentum exerted on the flow. This starts the flow to rotate. The energy of the rotating flow is dissipated downstream and lost.

The angle of attack at the airfoil follows from the angular velocity of the blade and the wind speed. Of interest is the flow at the disc. It is assumed that half of the wind speed reduction and half of the final rotational speed is present in the plane of the rotor disc. At the disc the speed ratio is called **effective speed ratio**, $\lambda_2 = u_2 / v_2$, where the "2" denotes the flow condition at the rotor disk. From λ_2 the angle of attack at the airfoil can be calculated. The calculation is iterative. Vortices are shed from the tip of the blades and are accounted for by a tip loss factor. Equations are given in [12, 22-24].

If only the change of energy and axial momentum is considered (which is equivalent to an operation with infinitely high rotational speed), optimum power extraction is found with a final reduction of the horizontal speed to 1/3 of wind speed. The horizontal speed cannot be reduced to zero, because the air needs to flow continuously past the turbine. With the reduction of the horizontal speed to 1/3 of its original value, a maximum of $C_P = 16/27$ or 59% of the power of the moving air can be extracted. At lower rotational speed (or speed ratio, λ) the power coefficient, C_P reduces drastically. The power extracted from the rotor is

$$P = C_P \frac{1}{2} \rho A v^3 \quad . \tag{7}$$

A is the (projected) disc area, ρ is the air density, and v is the wind velocity. C_P is the result of the BEMT. An example for a C_P-λ-diagram is given in Figure 9.

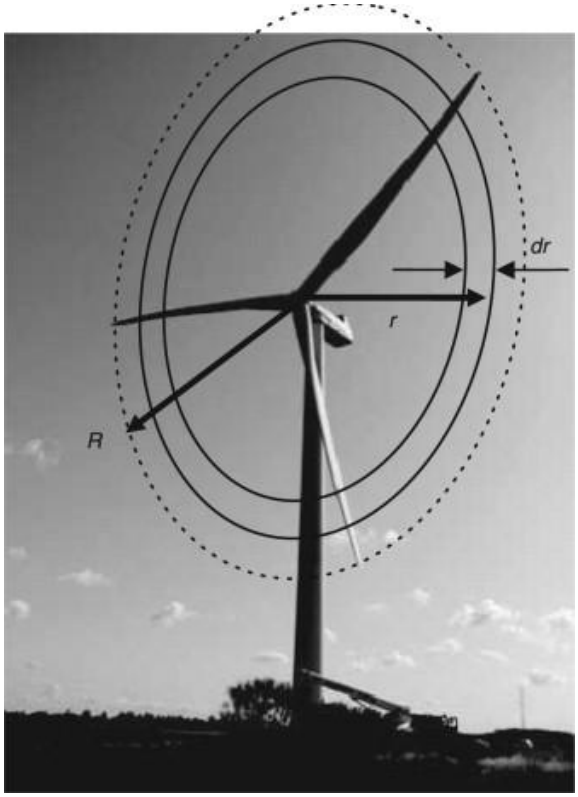


Figure 8. The Blade Element Momentum Theory (BEMT) divides the disc area into several annular rings of width *dr* at a representative radius, *r* [2].

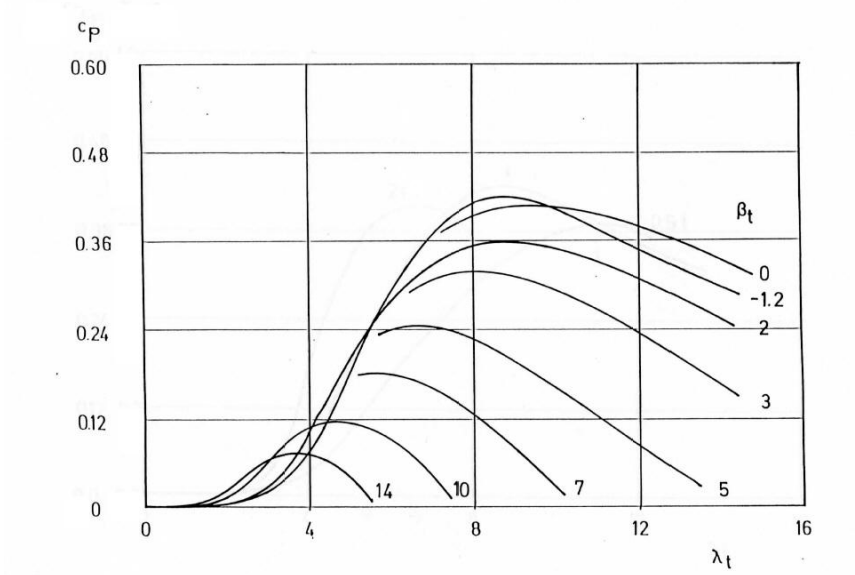


Figure 9. Example of a C_P-λ-diagram. Plotted is the power coefficient, C_P versus tip speed ratio λ_t with blade tip angle, β_t as parameter. Wind energy converter "Adler 25" of Maschinenfabrik Köster, Heide, Germany. Calculations with (U)BEMT [23].

Most wind energy textbooks touch upon the BEMT, but often do not go to the root of the equations with required iteration. This article has to refer to previous work. For historical reasons, there are different ways of writing the equations of the BEMT. As such, it can be confusing when working with different sources.

4. The Unsteady Blade Element Momentum Theory (UBEMT)

Unsteady flow at the blade element can be caused by turbulence or by changing wind speeds with height [22]. This is not the topic here. But even in uniform flow, unsteady flow at the blade can be caused by an axis angle or a yaw angle. A cone angle by itself does not cause unsteady flow, but further complicates the calculation.

As explained in the Introduction, blades on a tilted rotor disc move against the wind during one half of the revolution and move with the wind during the other half of the revolution. In order to account for these changes with blade angle, blade elements are not only differentiated by radius, r (Figure 8), but in addition also by blade angle, θ (Figure 10).

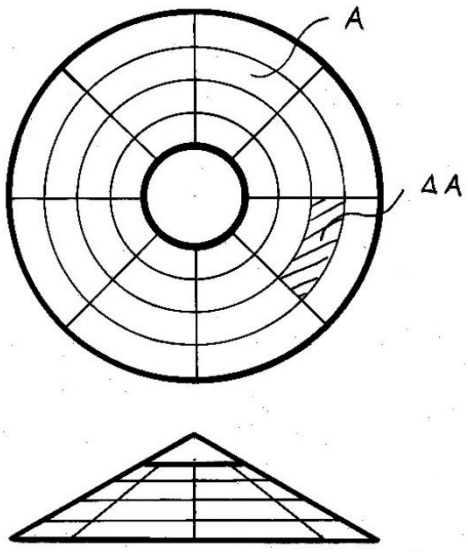


Figure 10. Blade elements of the Unsteady Blade Element Momentum Theroy (UBEMT), which is considering cone and axis angle. The total area, A is divided into many elements ΔA along the radius, r and the blade angle, θ.

In the same way as in the BEMT, the angle of attack can be calculated for each blade element from the effective speed ratio at the location of the disc, λ_2. The Unsteady Blade Element Momentum Theory (UBEMT) adds to the BEMT another calculation loop to account for the blade angle, θ (Figure 11) and adds an equation for the speed ratio, λ, which is derived in the next chapter. In [23] it was found that a HAWT with an axis angle of 10° showed not more than 1% reduction in the power coefficient when the UBEMT was used instead of the assumption of a truly horizontal axis. This is a reassurance than can only be obtained from a calculation with the UBEMT.

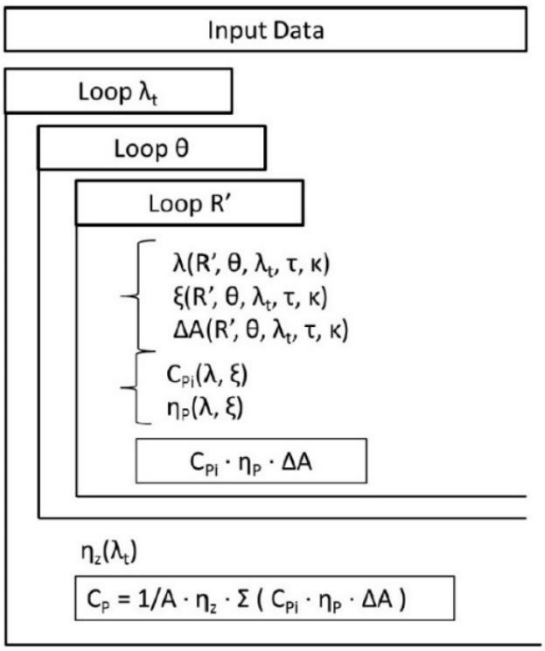


Figure 11. Unsteady Blade Element Momentum Theory (UBEMT). A C_P-λ-Diagram is calculated in three nested loops. Details in [12].

5. Derivation of the Speed Ratio λ for a Wind Turbine with Cone and Axis Angle

The wind speed is written as a vector $\overrightarrow{v_w}$. The calculation requires the wind to flow only from the inside to the outside of the cone surface. This requirement is fulfilled (Figure 12) if:

$$\tau < \kappa \tag{8}$$

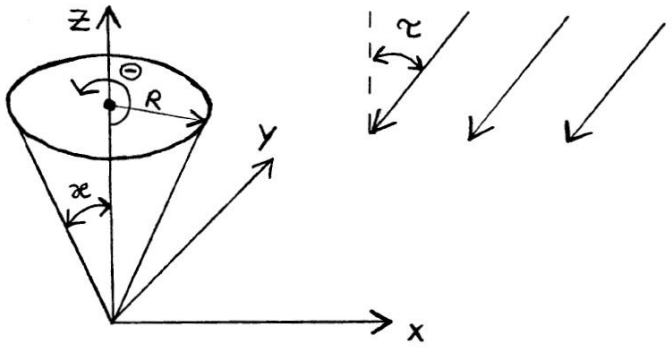


Figure 11. Chosen Cartesian coordinates to derive the speed ratio for a wind turbine with cone and axis angle [12]. The turbine rotates about the z-axis. The wind vector (or the turbine) is tilted by an angle τ with respect to the z-axis in the x-z-plane. Tilt, τ can also represent yaw.

The calculation of the speed ratio, λ is divided into three parts:
Calculation of the velocity v.
Calculation of the velocity u.
Calculation of λ from $\lambda = u/v$.

5.1 Calculation of the Velocity v Perpendicular to the Surface

Differential geometry is used to calculate the component of $\overrightarrow{v_w}$ perpendicular to the cone surface. All data is given in Cartesian coordinates. The cone surface is described by:

$$\vec{x} = (r\cos\theta,\ r\sin\theta,\ r\cot\kappa) \tag{9}$$

with $\qquad 0 \le r \le R \qquad$ and $\quad 0 \le \theta \le 2\pi$.

R is the biggest possible radius in the cone (Figure 6). The Wind speed is described by

$$\overrightarrow{v_w} = (-v_w\sin\tau,\ 0,\ -v_w\cos\tau) \tag{10}$$

$\overrightarrow{x_r}$ is the partial derivative of the vector $\vec{x}$ with respect to r.
$\overrightarrow{x_r} = (x_r,\ y_r,\ z_r)$ is the tangent on the cone shell in r-direction.

$\overrightarrow{x_\theta}$ is the partial derivative of the vector $\vec{x}$ with respect to θ.
$\overrightarrow{x_\theta} = (x_\theta,\ y_\theta,\ z_\theta)$ is the tangent on the cone shell in θ-direction.

$$\vec{n} = \overrightarrow{x_r} \times \overrightarrow{x_\theta} \tag{11}$$

The normal vector $\vec{n}$ is perpendicular to the cone shell surface described by of $\overrightarrow{x_r}$ and $\overrightarrow{x_\theta}$ in point $\vec{x}$. The normal vector results from the vector product of $\overrightarrow{x_r}$ and $\overrightarrow{x_\theta}$.

$$\vec{n} = \begin{pmatrix}\cos\theta\\ \sin\theta\\ \cot\kappa\end{pmatrix} \times \begin{pmatrix}-r\sin\theta\\ r\cos\theta\\ 0\end{pmatrix} = r\begin{pmatrix}-\cot\kappa\cos\theta\\ -\cot\kappa\sin\theta\\ 1\end{pmatrix} \tag{11}$$

The projection of $\overrightarrow{v_w}$ in direction $-\vec{n}$ is

$$v_{w\,\vec{n}} = \frac{-\overrightarrow{v_w}\,\vec{n}}{|\vec{n}|} \tag{12}$$

$-\overrightarrow{v_w}\,\vec{n}$ is a scalar product. The negative direction must be selected for the normal vector because $\vec{n}$ is directed inward into the cone.

$$-\overrightarrow{v_w}\,\vec{n} = \begin{pmatrix} -v_w \sin\tau \\ 0 \\ -v_w \cos\tau \end{pmatrix} \cdot r \begin{pmatrix} -\cot\kappa \cos\theta \\ -\cot\kappa \sin\theta \\ 1 \end{pmatrix} = r\, v_w\, (\cos\tau - \sin\tau\ \cot\kappa \cos\theta)$$

The length of the vector its

$$|\vec{n}| = r\sqrt{(-\cot\kappa\cos\theta)^2 + (-\cot\kappa\sin\theta)^2 + 1^2}$$

$$|\vec{n}| = r\sqrt{\cot^2\kappa + 1} \quad .$$

$$v = v_{w\,\vec{n}} = \frac{-\overrightarrow{v_w}\,\vec{n}}{|\vec{n}|} = v_w\, \frac{(\cos\tau - \sin\tau\cot\kappa\cos\theta)}{\sqrt{\cot^2\kappa + 1}} \tag{12}$$

The projected velocity $v_{w\,\vec{n}}$ perpendicular to the cone's surface is the required velocity v.

5.2 Calculation of the Tangential Velocity u

The circumferential or tangential velocity u also depends on the wind speed. It increases when the wing runs against the wind and vice versa.

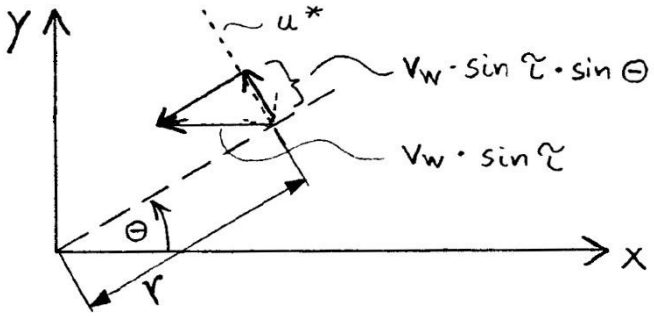


Figure 12. Velocities on the rotating blade [12].

$$u^* = \dot{\theta} r = \omega r \tag{13}$$

$$u = \omega r - v_w \sin\tau \sin\theta \tag{14}$$

5.3 Calculation of the Speed Ratio λ

From the calculated speeds u and v, the speed ratio λ can now be calculated.

$$\lambda = \frac{u}{v} = \frac{(\omega r - v_w \sin\tau \sin\theta)\sqrt{\cot^2\kappa + 1}}{v_w\,(\cos\tau - \sin\tau \cot\kappa \cos\theta)} \tag{15}$$

The tip-speed ratio (TSR) at the blade tip on the Wagner rotor is conveniently defined as

$$\lambda_t = \frac{u}{v} = \frac{\omega R}{v_W} \quad . \tag{16}$$

Solved for ω

$$\omega = \frac{\lambda_t v_W}{R} \tag{16}$$

and introduced into (15) yields the final equation

$$\lambda = \frac{\left(\lambda_t \frac{r}{R} - \sin\tau \sin\theta\right)\sqrt{\cot^2\kappa + 1}}{\cos\tau - \sin\tau \cot\kappa \cos\theta} \quad . \tag{17}$$

6. Conclusions

The Blade Element Momentum Theory (BEMT) can be extended to an Unsteady Blade Element Momentum Theory (UBEMT). For the UBEMT the rotor disc needs to be divided not only along the radius, r but also over the blade angle, θ (Figure 10). One more calculation loop is necessary to account for the blade angle (Figure 11). An equation (17) is derived for the speed ratio, λ, which accounts for the geometry in a rotor with pronounced cone and axis angle. The UBEMT can be used to calculate unconventional geometries like the Wagner rotor. The Wagner rotor still has a slight chance to reach economic advantages as a deep sea offshore wind turbine over other configurations. Conventional horizontal axis wind turbines (HAWT) often show small cone and axis angles to reach sufficient clearance between blade and tower – especially if the rotor is located upwind from the tower and the blades are flexible and highly loaded. The accuracy of power calculations of these HAWTs can be slightly improved using the UBEMT. Although the aerodynamic coefficients used in the UBEMT are from measurements in steady flow conditions, they have been used with success in an UBEMT.

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Data Availability Statement: All relevant data is contained in the document.

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