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Toward Standardised Vocabularies for Norwegian Archaeology

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The Museum of Cultural History (MCH) at the University of Oslo, Norway, has undertaken a series of infrastructure projects with the aim of improving the standardisation of archaeological data and increasing data integration at both a national and international level. This builds on decades of earlier work and includes a revision of shared National database systems (unimus), integration of previously disparate data types and spatial data (ADED), and more recently the development of a 3D publishing platform (BItFROST). These projects feed into broader aims of large-scale data integration as part of the European-wide ARIADNE Research Infrastructure. This article provides an overview of the history and development of these systems in Norway and takes a look at some of the roads still ahead.

1. The Museum of Cultural History, Oslo

The Museum of Cultural History (MCH), University of Oslo, is the largest of the five Norwegian university museums with cultural historical collections and includes *Universitetets Oldsaksamling* (The University's Collection of National Antiquities), which was founded in 1829. Each university museum is responsible for archaeology within each of the five regions of the country, with the MCH responsible for archaeological material in the south and east of Norway. Since a merger in 1999 the museum represents an amalgamation of three separate institutions covering archaeology, ethnography and numismatics (KHM 2012). It also bears primary responsibility for the storage and care of cultural material that pre-dates the Reformation in this region in 1537 (Ministry of Climate and Environment Ministry), a collection that includes a unique assemblage of medieval wooden church architecture and painted sculptures, as well as some of the world's most iconic Viking Age ships and artefacts.

As such, the museum has played a significant role in the development of documentation practices and approaches to data storage and terminology in the Norwegian heritage sector over the past century, work that continues today with efforts to broaden access and integrate data over the internet, both with neighbouring countries and further afield.

Figure 1: The five archaeological museum districts in Norway. The south-east region served by the MCH includes the area with the largest population density and conurbation and consequently the majority of development-led archaeology in the country

MCH and the university museums in Tromsø, Trondheim, and Bergen were included in the aptly named Documentation Project (1991–1997). This project represented the first big push toward digitising analogue data from museums and institutes at faculties of humanities at the Norwegian universities. One goal was to create research databases for the museums. The archaeological part of the project was continued as the Museum Project (1997–2007), which included all the university museums, as well as those with natural historical collections (Ore and Rangsæter 2007). The Museum Project developed into the organisation MUSIT (2007–2021), and in 2009 the Archaeological Museum in Stavanger became a university museum and joined the cooperation. UniMus:Kultur is the present cooperation between the Norwegian university museums with cultural historical collections in Tromsø, Trondheim, Bergen, Stavanger and Oslo (Matsumoto and Uleberg 2021). The focus of system development has gradually shifted from

research databases to a collection management system for archaeology, ethnography, and numismatics. Nevertheless, UniMus:Kultur is a primary source for archaeological research and outreach material, serving the needs of both internal users such as exhibition designers and researchers and external clients such as students, county archaeologists and interested members of the general public. The objects are accessible online through searchable catalogues (unimus.no/portal) and can also be accessed more directly through an open API.

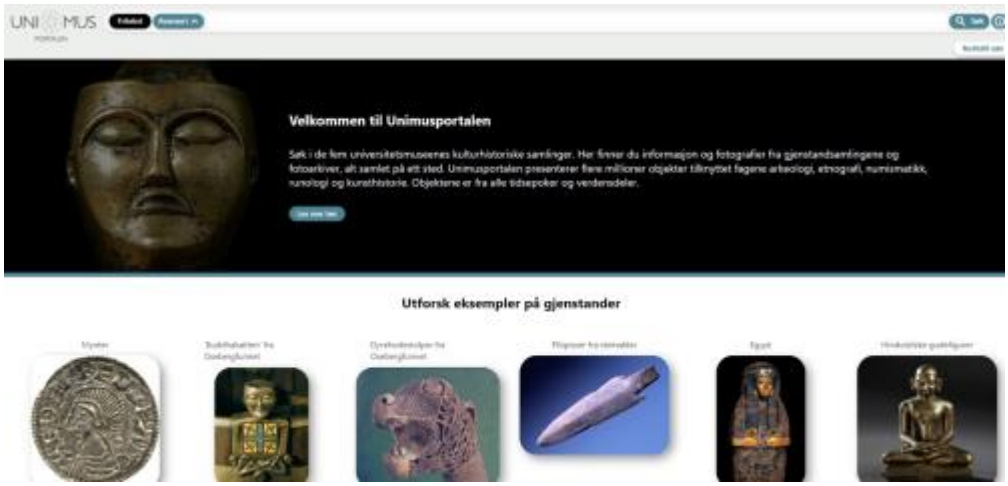


Figure 2: The welcome page of the current online unimus resources

The MUSITark database contains the archaeological collection at the MCH. The entries are georeferenced (Matsumoto and Uleberg 2015; 2021), and can also be accessed through a map-based interface (accessible at https://www.khm.uio.no/forskning/digitalt-feltmuseum). Detailed excavation documentation (plans and feature boundaries) has not yet been made accessible in the same way as other entries, but this is being addressed by an addition to the unimus:kultur cooperation ADED — the Archaeological Digital Excavation Documentation infrastructure project. This project incorporates detailed excavation documentation from the university museums into a single searchable online portal (Ore and Uleberg 2019) and became possible as a result of the commitment to collaboration between the university museums in Norway. In 2011 it was agreed to use the Swedish program Intrasis (intrasis.com) for digital documentation of all excavations. The museums also agreed on a common Intrasis template. This subsequently made it possible to convert and merge all Intrasis projects from separate excavations over the previous ten years into one large GIS system. This migration took into account several revisions to the official template that occurred over time. However, several unofficial adjustments to these templates were also made by individual excavation projects, creating larger variability and extra challenges for ADED's data merger. ADED provides access to a full range of site data, including not only the overall site boundaries and feature level shape data, but also links to written reports, the National Heritage and Environment Register (HER) *Askeladden*, and photographs and artefacts from the excavations that are retrieved via the UniMus API.

The latest addition to these data-sharing efforts is the BItFROST research infrastructure project (KHM 2021) that provides tools for the use of 3D models in

research and teaching and addresses questions of distribution and storage of 3D information. The current web front-end is based on 3DHOP (Potenziani *et al*. 2015), the same technology employed as the ARIADNEplus service that allows for streaming of high-resolution 3D data over the internet. This project is a collaboration with the University of Lund and shares resources with their own Dynamic Collections interface and repository system (Ekengren *et al*. 2021). The web interface not only provides visualisation and interaction but also more advanced research and annotation tools. At present this interface has only been implemented at the MCH but the same approach to collaboration and shared resources lies behind the current initiative and future aims of this work.

Figure 3a: Screenshot of the ADED platform

Figure 3b: Screenshot of the BItFROST (3b) platform

Underpinning the data held by the current MUSITark databases is the event-based CIDOC conceptual reference model and a set of shared vocabularies and

data entry procedures intended to standardise the information recorded by the different staff within the museum. The terminologies are Norwegian-language based, and in some cases multilingual terminologies have also been included. Following the recommendations in the ARIADNEplus project the MCH has extensively mapped these existing vocabularies to the Getty Art and Architecture Thesaurus (AAT) to make the datasets more internationally interoperable. Spatial information is also standardised. Location information draws on Norway's cadastral units; georeferenced information is provided with precision categories; and dates and time periods are registered at the PeriodO gazetteer. Contextual information of the more than 1.5 million entries in the current database is provided through hierarchical relationships that link back to the site codes defined by the HER and, where appropriate, can be augmented with further details such as individual structure and feature numbers from excavations to provide deep and granular search possibilities.

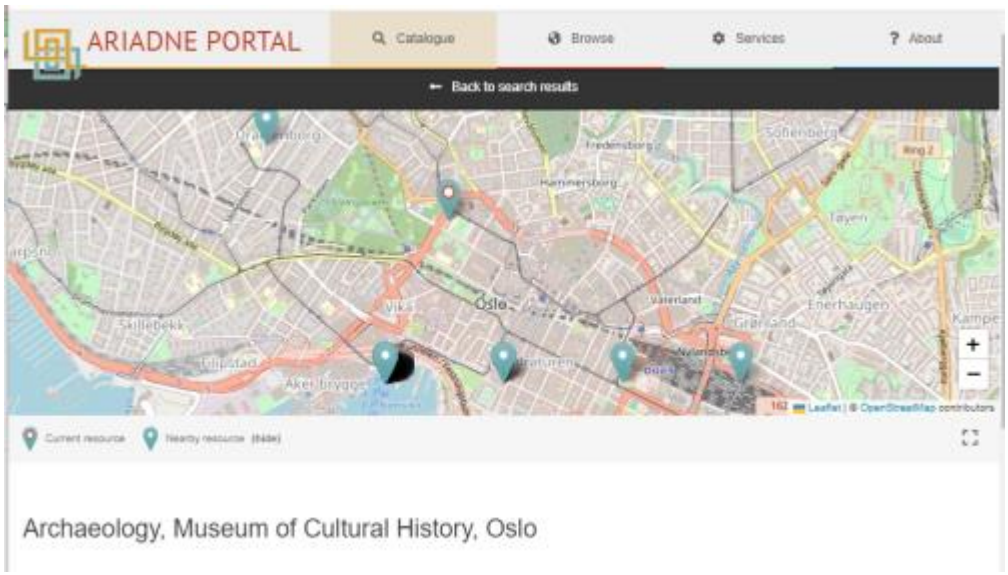


Figure 4: Screenshot of the MCH resources in the ARIADNE portal

2. Terminology and Vocabularies

The vocabularies, terminologies, and structures in the current MCH data systems owe their origins to the Documentation Project of the early 1990s. A vision for the National Documentation Project was the Humanistic Information System. This was a concept that outlined how digitised material from the universities' collection institutions overlapped thematically, and might be interlinked through common vocabularies and place and time terminology, and could be made available for different user groups and organisations. These groups included, among others, the Directorate for Cultural Heritage, national archives, schools, government planning offices, and the national language council.

The humanistic information system.
External users and cooperators (1994)

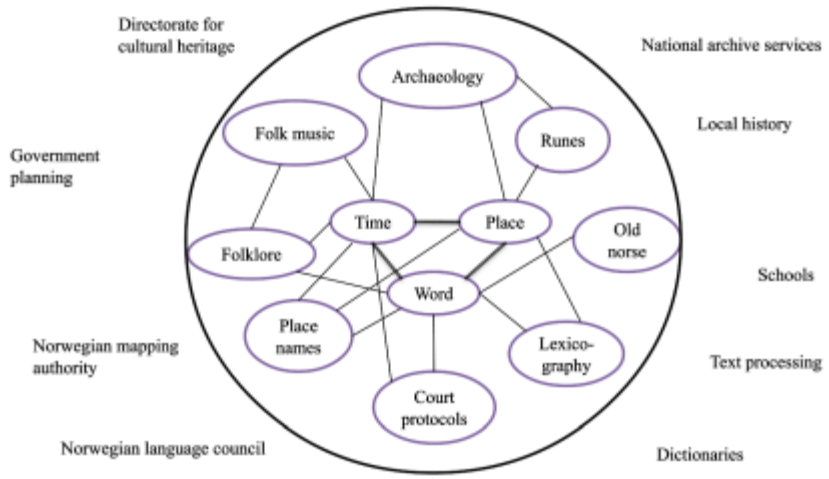


Figure 5: The Humanistic Information System as conceptualised at the time. The image depicts the different stakeholders and degree of subject overlap and interaction with the intended centralised approach to terminology definition

The Documentation Project presented its first online platform with archaeological data in 1995, material that is still accessible today. This was accomplished with the use of Standardised General Markup Language (SGML) to describe and encode the information previously held within printed, handwritten or typed catalogues (Holmen and Uleberg 1996). The use of SGML provided a more computer-readable and standardised form, opening up the data to queries and complex linking. The SGML formatting was later used to populate the museum's artefact database with information. This kind of digitisation, transformation rather than simply replication of existing records (such as through imaging), meant the museum had to engage directly with the kinds of variation in data one might expect in handwritten ledgers and the development of a discipline over more than 100 years. It also had to accommodate changes in orthography of the official Norwegian languages that took place in 1917. This situation, of major adjustments to written forms of language, is not uncommon in many countries around the world but is perhaps a less frequent concern in the English-speaking countries that have dominated many of the conversations around heritage digitisation.

The nationwide dissemination of archaeological data by the Documentation Project follows a long tradition in the Norwegian archaeological community, starting with catalogues of recent archaeological acquisitions and excavations printed in the annual publication of *Foreningen til norske Fortidsminnesmerkers bevaring* (National Trust of Norway) from 1866 till the early 1900s (Uleberg and Matsumoto 2019). After this period the museums continued to publish new acquisitions, mainly in their own yearbooks or separate publications (Østmo 1998) but returned to a common platform as a result of the Documentation Project. Questions surrounding data reuse, copyright and permissions were not a significant concern during the early stages of developing an online version of existing texts as the information was already published freely. This is quite distinct from digital publishing today where born-digital content may require more careful management of copyright terms, use and reuse. It

should be mentioned that while information was published annually the printed versions of catalogues and reports may have deviated from original ledgers and source material held within the museum. For example, objects in the museum collection that were historical but not archaeological artefacts were omitted from the published catalogues. Today's digital catalogue, in combination with the original catalogues digitised from a microfilm made in 1955, is therefore the first complete publication of the entire collection held at MCH. This long history serves as a reminder that open access to information is not a new phenomenon of the digital era but has deep roots in analogue publishing as well.

3. Standardisation

Standardised approaches to artefact descriptions were essential from very early in the museum's history and for a long time the need for a common vocabulary in Norwegian archaeology was solved by reference to common literature. At MCH, the standard for artefact descriptions in the main catalogue was changed in the year 1900 starting at museum number C20 001. From then on descriptions would be shorter, based on reference to an object in a standard publication or another object in the collection. Standard publications like Oluf Rygh's *Norske Oldsager* (1888), Haakon Shetelig's work on cruciform brooches (1906) and later Jan Petersen's work on Viking Age swords (1919) are examples of publications that became illustrated thesauri central to efficient cataloguing. An example of a standard and sufficient description of a Neolithic axe could be 'as R28', referring to figure 28 in Rygh's work (Rygh 1888, fig. 28). Such entries on their own have limited utility, but just as in today's data systems their value lies less in their individual content but in their relationship to other information.

An active discipline is always evolving, and this will often lead to deviations and changes in terminology that need to be handled. Maintaining and updating references to authority s ources has always been challenging and requires considerable effort. One example of such efforts that demonstrates the importance of common vocabularies to the Norwegian archaeological community as a whole can be seen with the publication in 1976 of Stone Age Vocabulary (Helskog *et al*. 1976). This paper was the result of cooperation between participants from Tromsø, Bergen and Oslo universities. It aimed to provide a single uniform reference for knapped stone tool morphologies in use within Norway. However, this systematic description of typologies has itself been elaborated upon, especially at the museums in Bergen and Trondheim, but later also in Oslo. Such challenges remain with our digital work and the review and adjustment to authority files is part of an ongoing cycle of review and revision. Prior to the adoption of the Getty AAT, for example, the MCH had looked to the British Museum vocabularies (British Museum 1999) for some of the international terminologies.

This need for shared terminology has increased exponentially since the adoption of archaeological data systems and the explosion in information generated by changes in heritage management and the increase in development-led archaeology. The five university museums have made a great effort to create a common vocabulary for archaeology in Norway, but a single authority list has so far remained out of reach. This is the result of several factors, such as the different ecological zones in Norway

influencing distinctive subsistence strategies and therefore diverse archaeological material, but also the different size of institutions, internal organisation, and long research traditions. The human factor in shaping our data structures cannot be overstated and it is often simple, practical needs acting at the level of the individual that most strongly influences their development. For example, users cataloguing artefacts prefer short lists that are limited to artefacts likely to be acquired within a given work period. As such, highly specialised terminology for unique specimens in the collection are omitted. However, all artefact terms that have been in use can be activated if required. On the rare occasion that an artefact type not included in the list is discovered or acknowledged, it is possible to enter a new term or to include a term used earlier, but a balance must be reached between the complexity of the underlying data, the usability of terminologies and the needs, skills and experience of the employees working with the information.

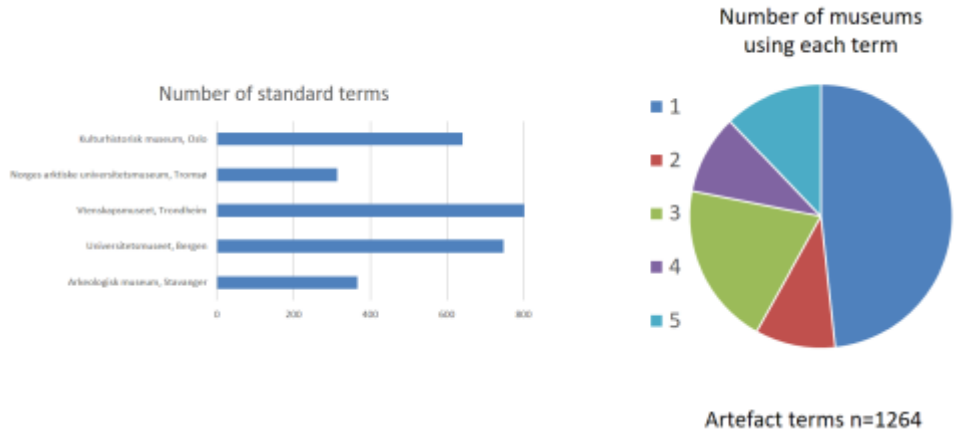


Figure 6: Example of the not-quite common vocabulary used in Norwegian archaeological data. Variation in terms comes both from regionally distinct archaeology but also variations in orthography, spelling and research tradition

Direct reference to standardised terms works well when clear examples can be identified but the real world is often more ambiguous. When the first version of the artefact database at MCH was made in the 1990s, it was decided that there should be three levels with varying degrees of standardisation to categorise the artefacts. This was to avoid fields with partly overlapping meaning that could lead users to register the same type of information in different fields. The fields for the three levels were named Artefact (*Gjenstand*), Form (*Form*) and Variant (*Variant*). This was to allow a more flexible way to describe objects through searchable and groupable text terms, the kinds of information that might have been previously described only through reference to illustrations or sample objects, while still retaining a degree of control over input. An example is a Neolithic stone axe that can be described as Artefact = Axe, Form = Thin butted, Variant = Blandebjerg type. The field Artefact has a fixed vocabulary, the field Form has a list of suggestions linked to the choice previously made for Artefact, but can be free text, and the field Variant is free text. Although it was usual to describe an artefact type and refer to the artefacts illustrated in Rygh's *Norske Oldsager* as type specimens, a specific field for type was not included but instead could be registered in the free text Variant field. In this schema, data were further normalised according to other rules. Terms excluded adjectives and material was separated from the artefact terminology. All flint axes would be

normalised to material = flint, artefact = axe, and all core axes (*kjerneøks*) would be normalised to artefact = axe, form = core axe. The need to normalise terminology was larger in this earlier stage before string queries were developed that could return partial as well as exact matches. One possibility for managing some of the uncertainty in data entry would be to define synonyms within the system that the user did not have to generate. However, more restrictive normalisation simplifies the export and reuse of data for other use, such as in a GIS or an Excel file.

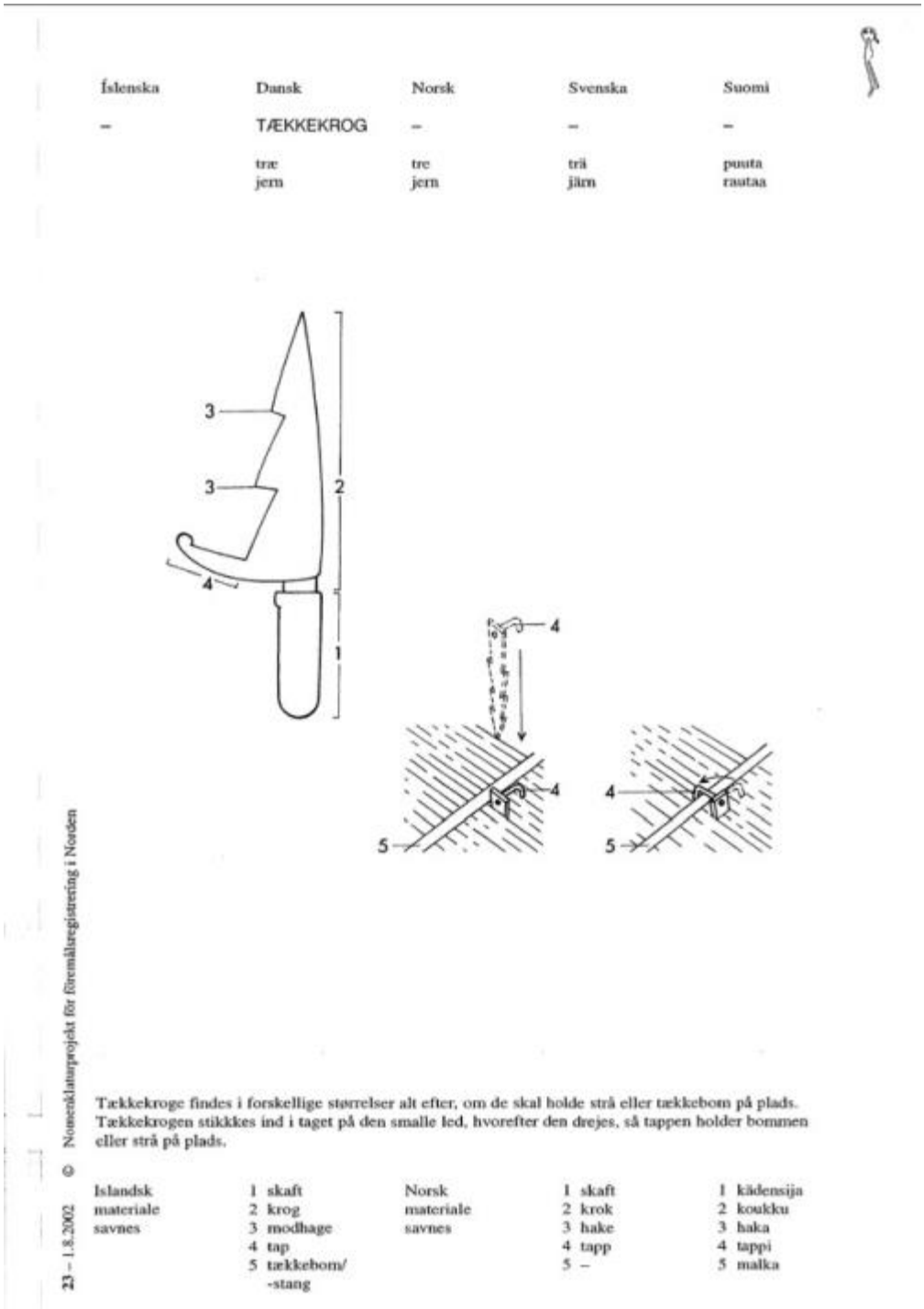
Normalisation of archaeological terminology can only be done to a certain extent with the texts. Orthographic changes, like replacing 'sværd with 'sverd' (sword), which was an orthographic change in Norwegian in 1917, is straightforward. The same applies with changes from one well-defined term to another. In some cases, an old term can cover the meaning of two or more terms in modern terminology. As such, simple string replacements or direct mapping to new terminologies has not been sufficient, but instead it has been necessary to study each artefact physically and reclassify them according to the updated determination. A similar problem arises when translating to different languages in MCH's ethnographic database. A specific object term in one language can be translated to two or more possible terms in a second language, with yet another set of not quite overlapping terminology in a third language. This becomes even more complicated when the vocabulary is extended to emic terms in addition to standard terminology in each language. The solution we have chosen for the ethnographic collection is to have a fixed list of terminology in Norwegian *bokmål*, and specify language and terminology in free text fields.

4. Multilingual Does Not Equal Multicultural

The political sphere of the choice of language has always been keenly felt within Norwegian domestic archaeology, perhaps more so than other European countries as a consequence of the two official languages, *Nynorsk* and *Bokmål* in use throughout the country's modern history. The importance of language and archaeological terminology is even more acute in areas of the country with Sámi and other language groups and of course within the museum's ethnographic collections. However, despite the long-standing need for internationalism in our computer systems, and the existence of organisations like Unicode for over thirty years, implementing multiple languages is not a trivial task. The museum has endeavoured to tackle these shortcomings in the past. A web page in Inuktitut, French, English and Norwegian languages (KHM n.d.) is the earliest example of the museum's effort to overcome some of these challenges and implements these different languages in both the online portal and the underlying catalogue. There is of course much more work to do. English remains the *de facto* default language at foundation system levels, and even today many essential softwares are unable to cope with non-English characters. English terms and western concepts also underpin many of the data structures in use, and only in recent years has the digital heritage sector seen a new level of maturity toward ideas of copyright, access and ownership as well as a reappraisal of the power structures represented by our digital knowledge systems. This is demonstrated by initiatives such as Local Contexts and the recent

Europeana-funded project at The National Museum of World Culture in Sweden (Munoz *et al*. 2022).

So far, this discussion has concentrated on the vocabularies at the MCH and textual terminologies that make up the data structures and associations between them. However, the dominance of text owes more to limitations of our early ICT structures than it does to the objectives of the discipline. As we have seen, many of the early approaches to standardising artefact descriptions in Norwegian archaeology relied upon imagery, or even familiarity with physical objects. The use of non-textual language for communicating complex, often ill-defined or hard to translate concepts is a common part of language learning but has also been used to good effect in exchanging terms and concepts in Scandinavian archaeology. The project *Nomina Rerum Mediaevalium* (1982–2002) sought to provide terms for elements of common medieval objects in the five Nordic languages; Danish, Swedish, Norwegian, Icelandic, and Finnish. One of the great values of this illustrated approach was that clear and meaningful information was still accessible even where large disparities between terms in the different languages existed. For example, an item commonly used in one region may have several specific terms for each element of the object, but only one, or none at all, in other languages. While hierarchical vocabularies and ontologies such as CIDOC-CRM provide some methods to represent these relationships they quickly lose the nuances that might be represented and understood through the use of imagery. The mass digitisation projects of the past decade have seen the collection of imagery for a great many of the museum's artefacts. For the time being, however, the more granular labelling, and linguistic equivalence has not been implemented.



Íslenska	Dansk	Norsk	Svenska	Suomi
–	TÆKKEKROG	–	–	–
	træ	tre	trä	puuta
	jern	jern	järn	rautaa

Tækkekroge findes i forskellige størrelser alt efter, om de skal holde strå eller tækkebom på plads. Tækkekrogen stikkes ind i taget på den smalle led, hvorefter den drejes, så tappen holder bommen eller strå på plads.

Islandsk		Norsk		
materiale savnes	1 skaft 2 krog 3 modhage 4 tap 5 tækkebom/ -stang	materiale savnes	1 skaft 2 krok 3 hake 4 tapp 5 –	1 kädensija 2 koukku 3 haka 4 tappi 5 malka

Figure 7: Example of an annotated depiction of a tækkekrog — roof hook — in Nomina Rerum Mediaevalium, illustrating the challenge of mismatching terminologies and concepts between regions and language groups

5. Looking Ahead

Possibilities of going beyond the restrictions of strict term-based linking that influenced the design choices of the 1990s have greatly improved. This is exemplified by the advances made by the large search engine companies and their approach to natural language learning. Many of the major search engines and the

next generation of Digital Asset Management Systems (DAMS) (e.g. netx) now provide 'search by image' features as well as auto-classification and tagging systems. Content-based searching in all spatial dimensions remains an active area of research, as demonstrated by the recent special section of *Computers and Graphics*. This issue includes examples of the use of deep learning to search 3D data repositories based on hand-drawn sketch input and multi-modal (from point cloud to CT data) cross-analysis, while popular technology news has been dominated by advances in AI and deep learning this past year. These generative algorithms do not stop at text-to-image but include text-to-sound and more recently text-to-3D generation (Nicol *et al*. 2022). Combined, these features promise many exciting opportunities for discovering and understanding our collections. The conventional barriers between text and multimedia content are fast being eroded, offering a glimpse of a future that is perhaps more similar in concept to the *Nomina Rerum Mediaevalium* than we might have imagined possible when beginning down the road to digitisation.

However, experience has also taught us to be cautious about the promise offered by new technologies, the findability illusion we have become familiar with when exploring the expanse of the internet remains a very different challenge to retrieving exactly what you know exists in a collection you are personally familiar with. While the recent computational advances unquestionably have potential, the hard work done so far in aligning and implementing terminologies will likely have utility in the years ahead. We should also remember that the data these algorithms function on are only a small part of what ascribes meaning and identity to the objects in our collections, nor are the challenges of linguistic or cultural dominance and bias resolved by these new technologies, which are themselves a product of the cultures and biases of those who develop them and the datasets they are trained on.

6. Conclusion

Reflecting on the work with digital cataloguing undertaken over the past three decades, and the century and a half of manual cataloguing before this, it is clear that a lot of progress has been made in the standardisation of information and the interoperability of data within Norway but many more challenges still remain. Many of the current data systems at the museum began with the dream of a single large and unbiased structure, with large-scale data aggregation that could house and make searchable all information in one place. The reality, however, is somewhat different. Over time a different more natural concept appears to be developing, that of core-and-periphery data stores with interoperable, but fundamentally distinctive, structures that work in constellation. This approach is not only important for linking internationally with partners within the same discipline, but extending beyond boundaries of individual specialisms as is perhaps more appropriate for the inherently multi-disciplinary pursuit of archaeology. In time this approach may prove to be more useful across a range of scales as smaller projects, data collection systems, and data publication tools are increasingly structured self-contained databases and knowledge systems themselves.

As mentioned at the start of this article, the development of the museum databases has taken place over many years and across a series of consecutive projects.

Consequently, approaches to the implementation of the underlying data structures have varied over time. Current trends in the data science community, feedback from the museums' user-base and available personnel have all left their mark on how the data is stored and organised. This includes quite fundamental structural design questions. For example, the degree of adherence to CIDOC-CRM ontologies and implementation of multilingual support varies between the sub-databases of the MUSITark data collection. Implementation of internal references between datasets have also been influenced by the limitations of the technologies employed. Until recently most of the museum's data records were handled through an Oracle database. This is being migrated to a PostGres solution that provides different opportunities for interacting and sorting data and requires a complete rewrite of the user interface. Such migrations are not only essential as software companies sunset ageing modules but are also driven by changes in society and market forces. All of these internal and external pressures, the long histories of establishments and the far-reaching and transformative effects they have on our interaction, understanding and appreciation of data are perhaps most succinctly described by Huggett's term 'Archaeological Data Imaginaries' (Huggett 2022). As more types of data are stored and published online and we find ourselves increasingly reliant on the eerie powers of complex AI we will undoubtedly discover new challenges of standardisation and perhaps new more complex definitions of what constitutes 'a vocabulary'.

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