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2 Methodological, Structural and Technical Challenges of a German-English Runic/RuneS Database¹

Abstract: The joint academy project *RuneS* is designing an image-based, multi-relational, bilingual database of all known runic inscriptions. Every runic *find* is characterized according to criteria such as *find-spot*, *find year*, *material*, etc., and transliteration and interpretation of the inscription are given (*RuneS 1.0*). Each individual runic *graph* is then documented by a snippet and classified according to a tailor-made typology as a *graph type (variant)* at a formal level; these are subsequently analysed graphemically at the functional level (*RuneS 2.0*). In a second section, data on the runic texts and their socio-historical function are added (*RuneS 3.0*). The database has the two-fold function of serving as a project-internal research tool as well as constituting a searchable digital corpus available to the wider academic public, for instance for comparative studies involving other epigraphic traditions. The structural, technical and terminological challenges posed by this design are highlighted with screenshots of the first module of the database, the *find* fields.

Keywords: runic graph, graph type (variant), grapheme analysis, multi-relational bilingual database, image-based visual documentation/classification

2.1 Introduction

2.1.1 The Main Research Areas and the Specific Profile of *RuneS*

The acronym *RuneS* is a discontinuous shortening from the German syntagm “Runische Schriftlichkeit”, i.e. Eng. “Runic writing”, the first two words of the full project title, namely: “Runic writing in the Germanic languages”. The project is funded by the Union of the German Academies of Sciences and was accepted as a

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long-term research undertaking by the German Academy of Sciences and Humanities in Göttingen in 2010.²

There are two principal domains of investigation, carried out during a research period of six years each: the first focuses on *Runic Graphemics*; the second research topic is *Runic Text Grammar and Pragmatics*. Thus, the project brings together two important current research perspectives on script and writing. In so doing it also draws on results of earlier orality-literacy research carried out by Peter Koch and Wulf Oesterreicher (1985) who introduced this two-fold approach to script and writing analysis.³

The investigations are guided by the concept of the runic script as a *system* or, to be more precise, as a *group of writing systems* that evolved in various ways over the centuries, fulfilling different communicative functions within the respective historical societies. The theoretical approach may therefore be characterized as “systematic”, “comprehensive”, and “context-sensitive”. It is the aim of the project to transcend the boundaries of the traditionally separate research perspectives focusing on the groups of runic writing (i.e. the inscriptions using the so-called rune rows of the older *futhork*, the Anglo-Frisian *futhorc*, the Viking Age *futhork/futhork*, and the medieval Scandinavian runic systems). This aim will be achieved by subjecting the respective inscriptions to uniform methods of investigation, thus making them comparable and productive as sources for comparative studies into the “how” and “why” of specific developments and changes of the runic writing systems in use.

2.1.2 *RuneS* and Digital Epigraphy

One of the aims of the project is the creation of a joint database containing data on all runic inscriptions, i.e. runic epigraphic material, as well as on the so-called *Runica Manuscripta*, i.e. non-epigraphic use of runes in manuscripts.

The backbone of this database is formed by basic data on the runic finds; these include information on the different types of runic objects, on the find-spots and contexts, and on the dating of the objects and the inscriptions they bear. Two extensions comprising graphemic information, on the one hand (i.e. description and classification of runic graphs and further details on their linguistic function and systemic character/affiliation), and text grammatical/pragmatic data, on the other, are connected to this backbone.

² For an overview of the overall research plan and the project structure cf. our homepage [<http://runes.adw-goe.de>].

³ For a more detailed outline cf. the presentation held at the International Conference on Runes and Runic Inscriptions in Oslo 2010 [<https://www.khm.uio.no/english/research/publications/7th-symposium-preprints/runic-writing-scan.pdf>].

This database is designed both as a source of information for the academic community and as a working tool for our own research within the project. It is therefore an ongoing process, with all new research results being entered into the database continuously.

The first module of this database, termed *find* or *RuneS 1.0* (see below), is nearing completion, containing approximately 8,000 entries. The module on *runic graphemics* is currently in the development stage.

The challenges in creating this digital epigraphy database included both structural and conceptual issues, some of which will be addressed in the following sections of this contribution.

2.1.3 Why is a Digital *RuneS* Database Necessary?

The use of a digital database has a number of advantages over the classical, analog approach, which are of vital importance for the aims of the project and for our joint venture setting, involving several geographically distant research units. On the one hand, the rather rigid structure of a database ensures the consistency of the analytical approach over a longer period of research. On the other, it allows for working with a large amount of complex, and in various ways interlinked, data of different types such as photographs, snippets, representations and descriptions of individual graphs as well as their abstractions in form of graphemes. The variability in combining these miscellaneous pieces of data (e.g., the runic graph-type variants, the material of the runic object, its socio-cultural function, its dating and provenance resp. find-spot) allows for formulating and verifying/falsifying different hypotheses, e.g., on the socio-cultural distribution and development of runic letter forms and on their systematic interplay. All these aspects and functions are prerequisites and necessary to ensure the “systematic”, “comprehensive”, and “context-sensitive” theoretical approach of the project. Our objective is to address, in this way, questions regarding, e.g.: the connection of the use of rounded vs. angular rune forms (along with other aspects of the graph form) with time, place and/or material; the emergence and development of word, syntagm and sentence separation in runic writing; the continuity and change of functions of runic writing in the historical societies; or questions such as the “de-reification” of the inscribed object in Scandinavia, where the inscriptions increasingly occur on purely functional carriers such as rune sticks.

Additionally, the implementation of a database, not only as a documentary device for storing and displaying the results of research, but also as a fundamental working tool for the investigations themselves, makes it necessary to reflect, in a more consistent and systematic way, the overall structure and the individual steps of the envisaged research plan. This research plan has served as the blueprint for the basic database design and development, itself, however, being modified and adjusted in the process. Questions of systematization of the required research data and of

terminological standardization had to be addressed. In the following sections, we will present several of these steps and some related issues, also regarding bilingual terminology.

2.2 Design of the Database

2.2.1 Design of the Database – Step Zero: Basic Considerations

As a prerequisite for the basic design of a database we felt that three factors should be taken into account: 1. the kind and relation of the data to be collated, 2. the required data relations and database queries, 3. the issue of the flexibility to respond to future research questions and different user groups.

In addition to its function as a fundamental working tool for the research teams, it was clear from the outset that the *RuneS* database should be made available online to a broader (academic) public. Thus, the structure and format of the data entries needed to allow for bilingual access in both German and English.

Therefore, the database structure for the research module on *runic graphemics* (*RuneS* 2.0) has to be designed along the lines of the following questions:

1. Which kinds of data are relevant for the graphemic analyses?
2. Which database structure is required to allow for the necessary combinations and different searches of the data to answer the relevant research questions?
3. How does the necessity to provide bilingual German-English data sets and interfaces influence the design of the database?

2.2.2 Design of the Database – Step One: Type of Data?

The main goal of the research module on *runic graphemics* is to document, describe and explain the process of runic writing, specific phenomena of runic writing systems and the diachronic and diatopic development of the runic script. On the one hand, this requires a systematic formal description and, on the other, a functional analysis of the signs recorded on the runic monuments of the sub-corpora involved. This means:

- Graphs and graphic variations should first be described and classified regarding their shape only, without reference to their function.
- The graphic variants should then be subjected to a functional analysis.
- In the course of the functional analysis, graphic variation should be studied with regard to various relations and dependencies: one is the relation to the phonemic system(s) of the language(s) under consideration. Phonemically non-distinctive variation should then be submitted to context-sensitive analyses to discover further distribution patterns based on context factors. A case in point would be the distribution of the Old English *s*-allographs: whereas the *s*-allographs of the

5th and 6th centuries belong to the so-called *diagonal type* (cf. Waxenberger, 2000) with one stave forming a zigzag line (tri- or tetra-partite), it is only in the 7th–9th centuries that the so called *bookhand-s* (allograph) was used (Page, 1973, p. 50, fn. 6).

The clear distinction between a purely formal description and a functional analysis of the graphs may at first glance seem somewhat overly detailed; after all, the function – i.e. the sound value of most runes – has, for most of the graphs, been determined long ago, at least at a phonemic level. However, a digital database provides an opportunity to go beyond common runological knowledge in several ways:

- Providing a comprehensive and uniform basis for the investigations within the project itself: it is the aim of the project to transcend the boundaries of the traditionally separate research perspectives focusing on the different groups of runic writing (see above, 2.1.1), to make them productive as sources for internal comparative studies. This requires a uniform and consistent description language, transcending the boundaries of the various description and classification systems currently in use for the different runic sub-corpora.
- Providing a comprehensive and systematic basis for further and new approaches within runology: in order to be able to set specific graphic variants in relation to different types of potentially influencing contextual factors such as time, place, material etc., it is necessary to document the relevant context data and thus give as full a description as possible of the runic monuments under consideration. This also includes the purely formal make-up of the individual graphs.
- Providing a comprehensive and systematic, strictly formal description for comparative epigraphic studies: for scholars working with scripts other than runes, the starting point for comparison would be the overall shape of the elements the runic symbols are composed of. By providing as the starting point the formal description, it is hoped the digital database will develop into a vehicle for our overall aim of contextualizing runic research in the wider field of epigraphic and general writing research.
- Providing a solid basis for the description and classification of new runic symbols: since the *RuneS* project started in 2010, two new, i.e. hitherto completely unknown Old English runes, have appeared in two new runic finds: the Baconsthorpe Page-Turner/Tweezers (Baconsthorpe, Norfolk, Mercia, Great Britain, archaeological dating: 700–800 CE) and the Sedgeford Runic Handle/Ladle (Sedgeford, Norfolk, Mercia, Great Britain, archaeological dating: 700–1000 CE). With the help of the formal description, it is possible to classify both new signs as very probably being runes. As such, they will be entered into the database, thus being searchable and analysable at the formal level, i.e. at the level of graph types and graph-type variants (see below, 2.2.3) as well as at the functional level.

2.2.2.1 Backbone of the Database: The *Find* Fields

The first prerequisite for the graphemic part of the database with regard to the comparative, comprehensive, and context-sensitive layout of our investigations was the systematization and digitalization of all “hard facts” about the runic inscriptions and the *Runica Manuscripta*. Hitherto, the runic finds have mostly been studied in different philological research traditions (Scandinavian studies, English studies, German studies), and also, with regard to the objects and their socio-historical context, by historical disciplines such as art history, archaeology or history of religion. This is the first time they have all been brought together as a digital and online accessible corpus, called the *find* fields (Figure 2.1), covering the following aspects of each monument:

1. Basic information has been collected, both from the relevant literature as well as through autopsies of our own, and by communicating with the respective institutions where the object is currently located. This comprises data relevant to identifying the runic monument, including the *find-spot* and the *object*, the *common names* of the runic find, and the *common abbreviations*. Furthermore, there is information on the *find year*, the *present location* of the inscribed object, the *state of preservation of object and inscription*, and the *inventory number or numbers*.
2. With regard to the inscription itself, and for a first overview, a *transliteration*, an *interpretation*, and a *German* and *English translation* are given. These are at present – from the perspective of the *RuneS* project and its investigations – “beta-data” only and serve mostly practical purposes. They represent “the state of the art”, the basic results so far achieved by runic research on the individual inscriptions. As our own planned *RuneS* research may lead to revised versions of these earlier transliterations and interpretations of a number of runic inscriptions, there will be additional versions of these data fields for internal use only. Once the graphemic and text-pragmatic investigations have been concluded, and consolidated, revised data are available, these data will replace the earlier “beta-data” and be made available online as well. This modification is an ongoing process, making the database a reflection of the research process.
3. Apart from these data, the *find* fields provide contextual information on the runic objects and inscriptions at several levels, covering the following areas: the *material*, and the *size* and *dimension*, i.e. the *measurements*, of the object; a *typological classification of the object*, e.g. tool, weapon etc.; information on the *archaeological* or *historic-cultural context* of the object; a (tentative) *dating* of both object and inscription (also in relation to context) – this is based mainly on archaeological suggestions; the *category of the inscription*, comprising classifications such as *runic*, *bi-scriptal*, *mixed*, or *coded* inscription; information on accompanying symbols, such as iconographic elements; an attribution of the inscription to a specific *rune row* (e.g., older *fupark*, younger *fupqrk/fupork* or Anglo-Frisian *fuporc*). All these data represent contextual areas, which may

trigger graphic or textual variation and, thus, be decisive for the graphemic and pragmatic evaluation and interpretation of the runic inscriptions.

4. In addition to this, GPS data for all geographical information (i.e. *find-spot*, *present location*, and the presumed place of origin, i.e. the *provenance* of object and inscription – the latter will be added in the course of the investigation), and images of the runic finds are provided.

The design of this first part of the database is influenced in many areas by, and has enormously profited from, already existing databases such as *Rundata*,⁴ the *Danish online database*,⁵ or the *Runenprojekt* database,⁶ as these already present detailed and valuable information on the runic inscriptions of the respective corpora. This applies in particular to the inscriptions in the so-called younger *fuþarƿk/fuþork*, and to the fields of *transliteration*, *interpretation* and *English translation*. However, the *RuneS* database contains additional data in that it also includes the English, Frisian and South Germanic inscriptions as well as the *Runica Manuscripta*. The graphemic and pragmatic data, to be entered subsequently, will be unique to the *RuneS* database, going beyond the description of the object and the inscription by generating, as well as documenting, thematically-based research results.

The screenshot shows the 'Aspa stone' entry on the RuneS database. At the top, there is a navigation bar with 'Project', 'Find list', 'Default queries', 'Find map', and 'Advanced search'. Below this is a map of the find spot in Aspa, Sweden, with a red pin indicating the location. To the right of the map is a photograph of the stone. Below the map and photo are several tables of information:

Information on the object			
Class of object	stone	Material class	stone
Type of object	runestone	Material	fieldstone
Object	stone	Dimensions	185.62-38-
State	good	Completeness	yes
		Ext. dating	725-1100
		Method of dating	arch.
		Context	infrastructure: road, thingstead
		Find year	1667-?

Information on the inscription			
Runerow	younger fuþarƿk/fuþork	Additional markings / icons	yes
Category	run.	State	impaired: good
		Completeness	no

At the bottom right, there is a 'Place of storage' section with the text 'in stone'.

Figure 2.1: Screenshot of the basic (= *find*) information on the Aspa stone (Sö 137), cf. [runesdb.eu/find-list/d/fa/q/////6/f/4782/] (for an overview of the runic objects of our corpus see [runesdb.eu/find-list])

4 [www.nordiska.uu.se/forskn/samnord.htm].

5 [www.runer.ku.dk].

6 [www.runenprojekt.uni-kiel.de].

2.2.3 Design of the Database – Step Two: The Graphemic Section and the Structure of the Database

The purpose of the graphemic analysis is to investigate the relation of sign and sound with regard to the system, as well as with respect to historical and regional variance. The assumption is that we are not dealing with a simple assignment of an individual sound to a sign, but rather with the two entities – sign and sound – each belonging to their own system, the graphemic and the phonemic system respectively, with a systematic functional relation holding between them.

Consequently, the graphemic analyses are divided into two working units: in the first step the graphs occurring in the inscriptions are described with regard to form. A typology of the runic graphs has been devised on the basis of graphic similarities. The second step focuses on the functional content of the signs. This approach makes it possible to answer various questions concerning the relation of the two systems, sound system and sign system, with regard to the so-called grapheme-phoneme correspondences in the runic script.⁷ In addition, by including the runic separators and beginning and end marks, supra-segmental language and communication functions can be determined.⁸ This approach also enables the detection of different types of graphic variants in the material, which can then be analysed regarding their distribution, e.g., in time (diachronically) and space (diatopically). As the formal characterization and typology of the graphs already implies a certain amount of generalization, leading to a first level of abstraction, this description cannot take place on the same data-level as the documentation of the inscription itself, i.e. not within the group of *find* fields, as these represent the level of the actual realizations of the runic signs (reflected in the database by a full-size image of the inscription and its signs)⁹.

Due to the fact that inscriptions in general consist of more than one graphic sign, all of which need to be formally classified in a different way, we also have a multi-relational connection between these data. On the other hand, the graphic similarities of two given runic signs in two different inscriptions – i.e., the one on object A, the other on object B – may be so close that they would have to be generalized as realizations of one and the same type of runic sign. This in turn means that the database needed to be conceived of as a relational database with a bilaterally multi-relational structure.

⁷ An illustration of this approach to the formal description and functional interpretation of a recently discovered new rune in an inscription from Sedgeford can be found in Waxenberger, 2017.

⁸ This is relevant for the subsequent text-linguistic and pragmatic issues, some of which are discussed in Zimmermann, 2017, along with an illustration of the text-linguistic and pragmatic approach applied to the Rø Stone.

⁹ It should be pointed out that the process of negotiating copyright issues with various museums over the production and use of such snippets is highly time-consuming and at times very problematic.

Due to the comprehensive structure of the corpus of investigation in the *RuneS* project and its context-sensitive approach, the description template for the assignment of the graph to a typology must take into account the respective realizations of the signs in the different rune rows (with regard to their potentially systematic functionalization), as well as graphic features that might be due to contextual and socio-historical factors only. The description template therefore needs to be designed in a very fine-grained way, e.g. concerning the position of the twigs and hooks on the stave as well as their specific form and technical execution. Thus, the typological characterization of the graphs in the database takes account of both micro- and macro-typographical features (Figure 2.2). Our typology is differentiated into:

1. *graph-type variants*, a lower level of abstraction where finer details in the execution of graphs are registered (Mårtensson, 2011, 115ff.), e.g., type of vertex (“crossing” or “with” resp. “without contact”) or “rounded” vs. “angular” form of compositional elements, etc. Even at this lowest level of formal characterization, the signs described are not confined to a single occurrence in one inscription only. This means it is possible to set the formal characterization of a variant in relation to several inscriptions and the realizations found there.
2. *graph types*, a level of abstraction where the graphic variation taken into account concerns the “basic shape of the graphs and their distinctive [formal] features” (Mårtensson, 2011, 113ff.), i.e.: number of the elements stave, twig, hook and dot and their position in relation to each other, as well as the elements involved in each vertex.
3. The individual realizations are included for the sake of illustration in the respective graph-type variant table as *snippets*.

We thus have two levels of increasing formal abstraction in addition to the snippet of the individual graphs (visually, the two abstraction levels are presented by graphic depictions of the respective “types” = depiction of the typologically indicative features).

The functional analysis, i.e., the so-called grapheme analysis, represents a further level of abstraction. Thus, additional individual datasets are required to allow for linking different sound-related and non-sound-related functions to the formal realizations and the various formal types of the graphic variants.

On the technical side these layers of abstraction are implemented using a hierarchical structure of entity types. Thus, the relationships between the graphs, individual compositional elements and the interpretation/categorization of a graph are distributed over different parts of the database. The collection and generation of graphemic data for the database is performed in two steps, also reflected in the database structure (Figure 2.3).

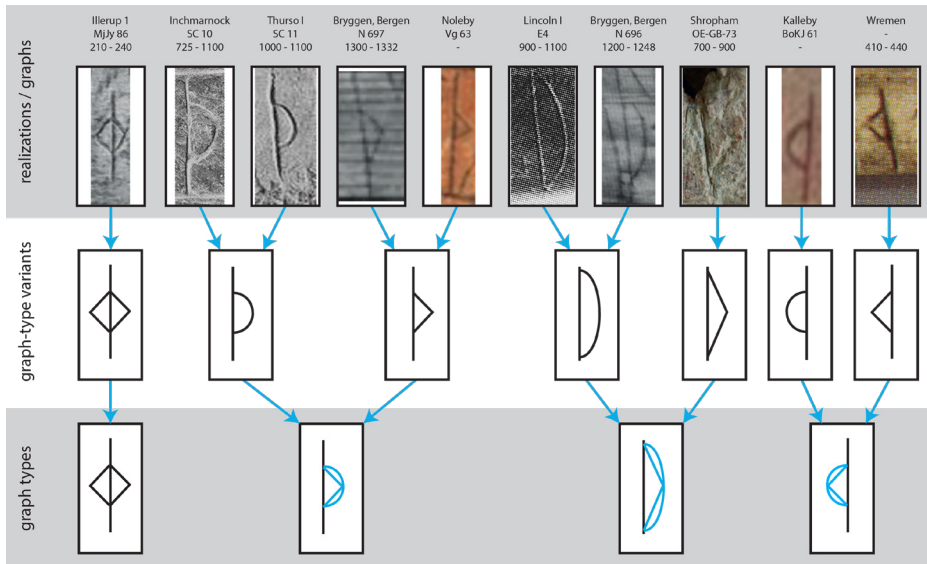


Figure 2.2: Random sample of snippets of the *ð*-rune with the assigned graph-type variants and graph types

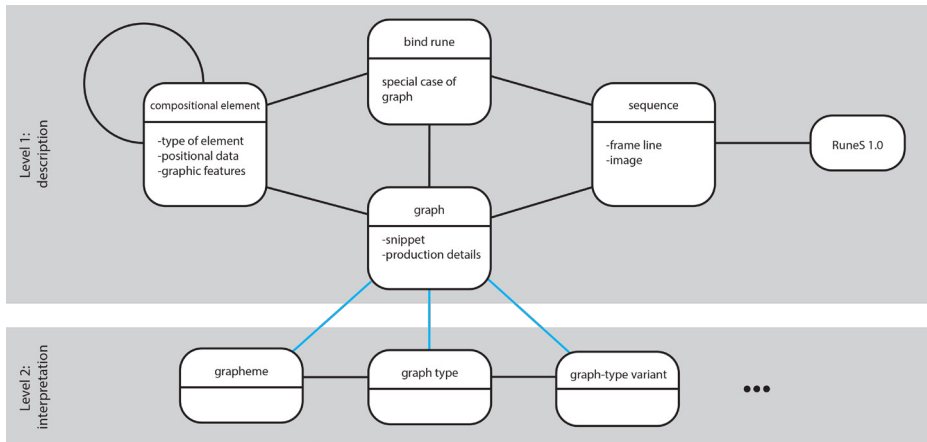


Figure 2.3: Highly simplified structure of the graphemic section of the database

On the first level, the compositional elements are described individually. For each type of element (staves, twigs, hooks and dots – and the individual vertices) coordinates and details concerning their graphic form are stored in a database table. A hierarchical tree structure of these elements is employed to allow for the automatic extraction of information on the relative position and relationships between individual elements. This tree structure also enables the efficient categorization of special cases like bind

runes, where several graphs are combined into a single graph. Furthermore, data concerning the graph as a whole are collected. Most importantly, an interpretation of the graph is given, including its mapping onto a graph-type variant, a graph type and other features (cf. blue lines in Figure 2.3).

On the second level, data concerning the historical relationships between graph types, graph-type variants, graphemes etc. are stored in the database. These relationships are populated using the graph interpretations given for individual graphs and are set to emerge automatically while data concerning individual graphs are collected. This structure represents the actual use of graphs and their functions, making it a very useful research tool which will be available to the public on the *RuneS* website.

Using the graphemic data collected in this step, a number of research tools can be offered to our users, allowing for a range of sophisticated research questions. For example, when combining these data with the *find* data collected in *RuneS 1.0*, historical and geographical distributions of the uses and forms of graph-type variants and graph types can be automatically visualized.

2.2.4 Design of the Database – Step Three: The Bilingual Layout

2.2.4.1 Bilingual Terminology: Choices

In the context of establishing the graph-typological description templates, it is also necessary to decide on terminology. Due to the bilingual character of the database, this means not only deciding on a single term for a certain phenomenon in each language, possibly from a panoply of already existing usages, but to decide on twin terms in both languages for each and every feature to be entered, thereby ensuring identical search potential and identical search results in the two language versions. Each term pair therefore needs to be discussed with regard to its internal compatibility.

This has sometimes led to the rejection of established terms, such as the terms *Lesung* vs. *reading* (see above, 2.2.2.1, the *Find* Fields), as a survey of selected research sources revealed that the latter, the English term *reading*, has been used in a wider sense than the German term, including both transliteration and interpretation. This is not compatible with the database structure and the terms have therefore not been employed here. Instead, we are using the English-German set: *transliteration/Transliteration*.

In the context of the graph-typological description, it became necessary to narrow down and systematize the existing terms for the elements a runic sign may be composed of. In English, these were (*main*) *stave/staff*; (*side*) *twig, branch*; *hook, crook, chevron, angle, pocket*; in German we found (*Haupt-*)*Stab*; *Zweig*; *Haken, Buckel*. Our selection, to be implemented for the first time systematically in the graph-typological entries into the database, is as follows: *Stab* – *stave*; *Zweig* – *twig*; *Haken* – *hook*; *Punkt* – *dot*.

In this way, the selection and refinement of terminology made necessary through the database requirements will hopefully also lead us to greater precision at the content level, while at the same time instigating reflection on the suitability of established terminology.

2.2.4.2 Bilingual Terminology: Technical Aspects

The support for multiple languages has to be deeply integrated into the database design. Our database uses two different approaches for different kinds of fields, where the nature of the data is the differentiating factor (Figure 2.4).

run_constants				run_find				
id	group	trans_de	trans_en	id	obj_complete	material	is_trans_de	is_trans_en
42	obj_complete	„ja“	„yes“	1	42	45	„ich, Widuh...“	„I, Widuh...“
43	obj_complete	„nein“	„no“	2	42	45	„Alugod“	„Alugod“
44	material	„Stein“	„stone“	3	43	46	„Ich, Unwöd...“	„I, Unwöd...“
45	material	„Metall“	„metal“	4	43	44	„Sie kämpften...“	„They fought...“

Figure 2.4: Simplified view of bilingual data in the database

For most fields in our database the number of possible values is finite, e.g. the field *completeness of the object* can only carry the values “yes” (“ja”) or “no” (“nein”). These constants are stored in a separate table, *run_constants*, with columns for each language. The database fields in question contain pointers to the corresponding values in *run_constants* that are substituted for their translations when data is displayed. In order to differentiate which constants belong to which fields, a grouping column has been introduced. Note that all this happens in the back-end and is not visible during data entry or on our website.

Other database fields like the *translation of the inscription* may contain very specific data and cannot be included in *run_constants*. For these types of fields, we have employed multiple fields in the same interface (a German one and an English one).

An ideal solution for supporting additional languages would be a table with the columns *id*, *reference*, *group*, *language* and *translation*, where the column *reference* is used to store the pointers employed throughout the database and *language* contains a unique identifier for the language of the *translation*. This way the database would support an infinite number of languages without the introduction of additional columns. However, since our database is not likely to support additional languages, we decided that the computational overhead of this approach would outweigh the benefits.

2.2.5 Design of the Database – Step Four: Data Mask for the Input of Graphic and Graphemic Data

The graphemic data collected in the database are of an extremely visual nature since elements are described according to their size and relation to each other. A lot of these data may be computed automatically once the exact layout of the individual compositional elements is known. Thus, an interactive mask has been programmed that focuses on the visual aspects of the compositional elements of the graphs rather than the specific data stored in the database. Users can place compositional elements directly onto a reference image (if one is available) and specify their positions by simply moving them around (Figure 2.5). The system automatically computes relevant research data from the coordinates of the graphs and their compositional elements and offers a range of options to further specify the nature of these elements (e.g., *tools used for production* or *the sequence of production*). Data entry is performed in three distinct steps:

1. The position of the *frame line* defining the upper and lower boundaries of the sequence of graphs is collected.
2. The *compositional elements* of the graphs are described individually. In this step, coordinates and details concerning the form of staves, twigs, hooks and dots are collected. Elements are organized in a hierarchical tree structure, allowing us to extract information on the relative position and relationships between individual elements automatically.
3. Data concerning the graph as a whole are collected. Most importantly, an interpretation of the graph is given in this step, i.e. its mapping onto a graph-type, a graph-type variant and other features. These mappings are automatically informed by previous mappings assigned to visually similar graphs: when choosing which graph-type the current graph belongs to, the mask automatically suggests graph-types that are visually similar to the graph in question. This way the user's navigation of a large network of graph-types is assisted and the efficiency of data entry is improved.

As mentioned in section 2.2.3, a structure representing the historical relationships between graph interpretations is set to emerge automatically from the data given in step three. However, this is set to happen under human supervision, and an interface for the analysis and regulation of these data will be created. The data collected this way represent the actual historical use of graphs and their functions, making them a very useful research tool that will be available to the public on the *RuneS* website.

In addition to automatically handling the storage of the positional and relational data in the database, the mask also extracts snippet images for each individual graph (if a source image is available). The use of a visual and guided tool like this has the additional advantage that errors in the data are immediately visible, while they would potentially remain hidden and obscured if these data were collected solely in text form.



Figure 2.5: The graphemic data input mask

2.3 Concluding Remarks

To sum up, the *RuneS* database will ultimately consist of a documentation of the runic finds, a graph-typological (i.e. formal) as well as a graphemic (i.e. functional) analysis of all runic signs, and a text-linguistic and pragmatic description and analysis of the complete inscription in context. It will display the research results of the *RuneS* project and enable users of the online version to combine the provided data according to their own research objectives.

Naturally, the development and implementation of such a complex digital tool has not been without its specific problems. One of the recurring problems during the implementation of the first two parts of the database was the reduction of complexity engendered by a digital database. In some cases, this initial problem proved to be a fruitful catalyst for reaching new clarity, e.g. in the development of a new, joint bilingual terminology for the labels of the individual fields or the options within the fields, or in coming to more theoretical and methodological accuracy with regard to the transliteration system of the inscriptions. This meant scrutinizing traditional, runological terminologies in both German and English, and establishing a common usage within the project.

However, the structure of different fields with clearly defined options, while enabling and facilitating research by the ensuing searchability, may lead to the obfuscation of open questions. In order to make transparent such open issues while preserving the searchability of the database, different solutions were developed. Where

a set of data did not fit clearly into any one of the categories evolved from the bulk of the material, either due to the state of research or the nature of the object to be categorized, this was marked by giving it a “dual label”, i.e. a dual categorization. This was the case, for example, with the classification of an inscription as “older fuþark” or “younger fuþark/fuþork”. The dual value “older fuþark/younger fuþark” was integrated into the list of options of the data field “rune row”, e.g. for the Lousgård bead or the Roes stone. An open commentary field reflects the state of the art with regard to the issues under debate. Here, the user may also find differing interpretations and datings, etc.

The next step, after the completion of the graphemic part of the database, will be the development of the text-linguistic and pragmatic part (*RuneS 3.0*). Future directions also include linking with the respective data sets of other digital projects that are thematically relevant: digital versions of runic editions (e.g., *Digitala Sveriges runinskrifter*),¹⁰ online dictionaries such as the *Dictionary of Old English*,¹¹ or archaeological databases such as the *Portable Antiquities Scheme*.¹²

We hope very much that we are, in this way, in the process of building a database that will not only help us in conducting our own *RuneS* research, but also serve as a digital information platform and a search tool for all colleagues interested in runes, as well as runic and other forms of epigraphic writing.

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¹⁰ [<https://www.raa.se/kulturarv/runor-och-runstenar/digitala-sveriges-runinskrifter/>].

¹¹ [<https://www.doe.utoronto.ca/>].

¹² [<https://finds.org.uk/>].