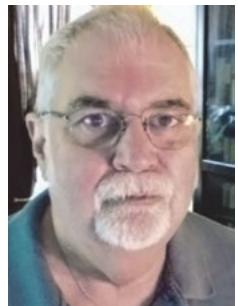


Trajectories for Research: Fathoming the Promise of the NARCIS Classification*†

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Abstract: NARCIS—National Academic Research and Collaborations Information System—is the national research portal for the Netherlands' data and research archiving, which is governed by its own NARCIS Classification. The current instantiation of the classification dates from 2015. The classification is currently made up of two classes—D for the sciences broadly, and E for interdisciplinary areas. The NARCIS Classification is designed specifically and with care for the contents of the NARCIS data portal. The classification mostly represents the sciences. A few anomalous situations are visible in the ontology of the classification: the humanities occupy one division within the sciences, placed between the life sciences and law; and, the treatment of interdisciplinarity, for which a separate class E is set aside for interdisciplinary sciences. A dump of the NARCIS database was used to analyze the population of the NARCIS classification. The life sciences occupy 34% of the NARCIS database. A framework for research networking systems reveals the NARCIS database and its classification meet most objectives, with the only lapse being the output of entities and attributes to ontologies. The NARCIS Classification is also an occupational classification. The NARCIS Classification supports a vital research portal that, in turn, supports a nationally-coordinated research effort designed to provide better inter-institutional communication of scholarly productivity, thus is in itself an information institution, in which domain-dependence is part of its cultural imperative. The NARCIS Classification incorporates an example of top-down politics in which funded disciplines are included and best represented. A perhaps unintended consequence is the encapsulation of forced views. Trajectories for further discussion with regard to continued development of the NARCIS Classification include identity, interoperability, interdisciplinarity, and synthesis.

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1.0 NARCIS and its classification

NARCIS—National Academic Research and Collaborations Information System—is the national research portal for the Netherlands' wide-ranging data and research archiving. NARCIS is a repository that combines publications and datasets from Dutch scholars with texts of peer reviewed publications and other research data (see for example, <https://dans.knaw.nl/en/about/services/narcis>). The NARCIS project began in 2004 as a cooperative project of Dutch research institutes (KNAW, NWO, VSNU, and METIS),¹ resulting in the opening of its original portal in

2007. Since 2011, it has been housed at DANS (Data Archiving and Networked Services, a Division of the KNAW). As of the compilation of this article manuscript, NARCIS contains 1,914,239 publications, 220,873 datasets, and 60,269 people, among other entities (<https://www.narcis.nl/?Language=en>). Literally, NARCIS is “the gateway to scholarly information in the Netherlands.” Researchers, students, journalists, business people, educators, and government officials all rely on the NARCIS portal as the place to begin a search for specific scientific information, including researchers, research projects, research institutes, and datasets; thus, its importance as a national

resource with global informatics implications cannot be overemphasized.

NARCIS is governed by its own knowledge organization system—a classification. The NARCIS Classification is designed to provide access to scientific information from scholars who enter their research into the NARCIS repository. NARCIS Classification symbols are assigned to provide classified access to the knowledge-bases of contributing scholars and research institutes, rather than to index the content of the publications in the NARCIS repository. The current instantiation of the classification dates from 2015. The classification is currently made up of two classes (<https://www.narcis.nl/classification/Language/en>)—D for the sciences broadly, and E for interdisciplinary areas. Altogether there are 223 classes, divisions, and subdivisions (Smiraglia 2017).

1.1 Some history of the NARCIS Classification

The first instantiation of the classification arose in 1992 as the “Classification of the Netherlands Agency of Research Information (NBOI),² who used it to classify contents in the Netherlands Database for Information on Current Research (<http://www.persistent-identifier.nl/urn:nbn:nl:ui:17-c94cc455-1552-4c3e-8b5d-af26ee6a82ae>). This classification had scope notes, and codes were assigned to researchers, institutes, and projects. There were three broad classes: A (areas of application), D (discipline), and C (multidisciplinarity). A classes were:

1. Exploitation and comprehensive management of the physical environment
2. Plant and animal production
3. Industrial production
4. Defence
5. Trade and economic services
6. Environmental planning, town and country planning, regional planning and landscaping
7. Public health and health services
8. Man and society
9. Research aimed at the advancement of general scientific and scholarly knowledge, c.q. not covered by the aforementioned classes

And C classes were:

C Codes for Multidisciplinarity
 C10000 Biotechnology
 C20000 Development cooperation
 C30000 Technology assessment
 C40000 Women's studies, Gender studies

There was limited faceting built into the system such that codes from the three classes could be assigned together according to specific instructions. For example, A codes “areas of application” could be assigned with D codes “scientific disciplines.” An example given in the instructions was (NBOI 1992, 2, emphasis original): “Rice growing in eighteenth-century China’ will be classified as D34000 and A21000.” In the classification, D34000 is “History” and A21000 is “Crop Production and Crop Protection” in class A20000 “Plant and Animal Production, General,” thus the faceted combination is not quite precise. Still, the advantages of faceting including improved network placement of concepts were minimally present in this instantiation of the classification.

The classification remained vitally relevant as its collaborating institutes merged and evolved. In 1997, NIWI³ was formed as an institute of the KNAW, incorporating six organizations including NBOI. The NBOI database became at that time the NOD (Nederlandse Onderzoek Databank): Dutch Research Database, which was maintained by NIWI until 2005 and by KNAW thereafter. During this period, the classification (now called NOD Classification) was revised in 2000, 2005 and 2009. After 2009, research projects were no longer classified. Other changes were minimal; some “D” codes were changed and some new codes were added; in 2000, “Computer Science” was added. “C” classes remained but were moved ontologically to become part of “D” hierarchies; for example, “C 30000 Technology Assessment” and “C60000 Nanotechnology” appeared under “D14000 Technology.” In 2005, subcodes of “Law D41000” and “Political and Administrative Sciences D42000” were added. As the classification moved online it was edited for web display, which led to the removal of scope notes and “other” categories.

The NARCIS portal was formed alongside NOD in 2007, and from then on has been maintained at DANS since its formation in 2011. The classification, now called NARCIS Classification, was revised in 2015. At this point datasets were classified as kinds of “audience,” the former “A” codes for areas of application were removed and their content was merged with “D” codes for scientific disciplines. There was an attempt to match the NARCIS Classification to a separate classification maintained by NWO. The former “C” codes were expanded and moved to a new hierarchy of “E Interdisciplinarity” codes. New disciplinary codes included:

D18000 Agriculture and the physical environment
 D26000 Veterinary medicine
 D30100 Digital humanities
 D32100 History of science and technology

D32200 History and philosophy of the life sciences ...
 [and others] gathered at D32000 under Philosophy
 and history
 D38000 Area Studies.

This instantiation of the classification is used today. There no longer are instructions about faceting, and indeed, there is no synthesis possible in the NARCIS Classification (such as that arising from the application of facet analytical theory). However, a rudimentary form of facets exists. The NARCIS classification website describes each individually named category as a “facet,” and in practice it is common to apply multiple codes to researchers and institutes, which then can be used as Boolean operators in searching. For example, a research project on “Reflective Bioethics” (<https://www.narcis.nl/research/RecordID/OND1308718/id/1/Language/EN/uquery/bioethics/coll/research>) received two NARCIS Classification codes:

D24200 Health education, prevention; and,
 D32000 Philosophy.

2.0 Domain ontologies in the NARCIS Classification

The NARCIS Classification is designed specifically and with care for the contents of the NARCIS data portal, with the intention of reflecting Dutch scholarship. Designers compare its ontological content with those of other Dutch classifications, e.g., the NWO⁴ Classification used for organizing funding of scientific research, thus the NARCIS Classification ultimately comprises a variety of national research priorities.

Not surprisingly, the classification mostly represents the sciences. Table 1 shows the distribution of divisions within the two classes “D” and “E.”

Class	Division	Number of subdivisions
D	D10000 Science and technology	89
	D20000 Life sciences, medicine and health care	63
	D30000 Humanities	28
	D40000 Law and public administration	11
	D50000 Behavioural and educational sciences	4
	D60000 Social sciences	9
	D70000 Economics and business administration	1
E	E10000 Interdisciplinary sciences	8

Table 1. Distribution of divisions and subdivisions in NARCIS classes.

Arguably, what might generally be designated as sciences and social sciences—apart from the arts and the humanities—are the contents of classes D10000, D20000, D50000, D60000 and D70000. This cluster occupies 74.4% of the 223 classes. To compare we might consider that in the *Dewey Decimal Classification* 23rd ed. (Choi 2017, 8) the same sciences minus psychology (which is clustered with philosophy) occupy 53.41%. A 2008 study of Wikipedia categories showed these sciences occupying 40%. According to Schärnhorst et al. (2016), the Universal Decimal Classification (UDC) uses 72% of its positions for the same sciences. Interestingly, the disciplinary focus of NARCIS aligns most closely with that of the literary warrant-based UDC, which also might be thought of as reflecting a Western European point of view. Comparison with Wikipedia categories is even more complicated, given the distance between the 2015 date of the current NARCIS Classification and the 2008 study of constantly evolving Wikipedia categories; however, the difference here is remarkable.

A few anomalous situations are visible in the ontology of the classification. The first is that the humanities occupy one division within the sciences, placed between the life sciences and law (which precedes the social sciences). Table 2 shows the subdivisions of the humanities.

The distinction among “hard” sciences, humanities and social sciences is not, in itself, unusual; but the appearance of humanities among sciences at all is uncommon in general classifications.⁵ The eight subdivisions range from paleography to area studies; the digital humanities are a second level subdivision of the general humanities division. Apart from the ontological placement, there also is the obvious lack of granularity distinguishing humanities from the other fields in the NARCIS Classification. A further anomaly occurs with information (or information sci-

Class-Division	Subdivision
D30000	D30100 Digital humanities
	D31000 Paleography, bibliology, bibliography, library science
	D32000 Philosophy
	D33000 Theology and religious studies
	D34000 History
	D35000 Arts and culture
	D36000 Language and literature studies
	D37000 Archaeology

Table 2. The subdivisions of D30000 The Humanities.

ence), which is not present in the NARCIS Classification. The term “library science”—a term replaced by “information science” in the 1960s and more recently by the term “information” alone (Smiraglia 2019, 131)—occurs as a division of bibliography, which is a methodology of history under the humanities. Computer science, however, occupies a division with eight subdivisions including information systems, artificial intelligence. In both cases, we must assume the distinctions arise from the specific representation of the Dutch research community.

Another anomaly in the NARCIS Classification is the treatment of interdisciplinarity, for which a separate class E is set aside for interdisciplinary sciences. Table 3 shows the divisions of this class.

According to Szostak, Gnoli, and López-Huertas (2016), interdisciplinarity requires the ability to search together by phenomenon in order to avoid the obstacles imposed by disciplinary boundaries. Using the definitions in their text (7-9), it appears the terms in Table 3 all represent areas of transdisciplinarity. General classifications, such as the UDC, compose symbols for inter-, trans-, and multidisciplines by using synthesis and expressive auxiliary symbols. In the NARCIS Classification, this set of eight transdisciplinary foci is designated specifically and ultimately isolated from the rest of the knowledge base. Again, it seems likely the distinctions made here represent the specific priorities of the Dutch research community.

3.0 Testing the match between ontology and classification

A research stream devised to test empirically the population of a classification was developed by the Knowledge Space Lab⁶ team was described in Smiraglia (2016). The essence of the methods is to analyze collections of classified documents to understand which classes are or are not used, as well as to comprehend regions in a classification where greater or lesser granularity might be useful. Papers by Salah et al. (2012), Smiraglia et al. (2013), and Scharn-

horst et al. (2016) reported different analyses of the population of the UDC based on the OCLC WorldCat, the library at the University of Leuven, and a collection of Portuguese libraries that included a national library and a national digital library. Results showed not only variability in the population of UDC classes but also the concomitant

characteristics of the literatures classed by it, thus demonstrating the flexibility of the faceted UDC. For example (Smiraglia 2015, 353):

This group has discovered the social narrative of the growth of disciplines across the twentieth century, as well as the evolution of the classification played against the political and social backdrop of the twentieth century ...

(354):

Most of the works with UDC numbers in the OCLC WorldCat, at Leuven, and in [the digital library] were published post-1979, although the range stretches from the 17th century to the present. However, in the [national library], the well-populated portion was dated from 1700 to the present; ... ranged from 1875 to the present.

(355):

As regards the most populated classes of the UDC: in Leuven it was 6 “applied sciences,” 3 “social sciences” and 2 “religion;” in the WorldCat 3, 6 and 8 “language and literature.”

The BND had 7 “arts entertainment sport” and 9 “geography, history” at top. PORBASE and BNP mirrored the WorldCat with 3, 8 and 6. ... The differential most likely reflects the academic discourse influencing collection development in Belgium and Portugal

Class	Divisions
E	E11000 Biotechnology
	E12000 Technology in medicine and health care
	E13000 Development studies
	E14000 Migration, ethnic relations and multiculturalism
	E15000 Environmental studies
	E16000 Nanotechnology
	E17000 Greenhouse gas mitigation
	E18000 Biobased economy

Table 3. The divisions of interdisciplinary sciences.

The technique involved the importation of UDC class-marks and bibliographic records associated with them so that not only was it possible to analyze specific applications of UDC's facets, but also to associate them with dates and places of publication among other specific bibliographic indicators, and even to some extent with subject terms that could be compared to the interpreted UDC strings.

3.1 Population of the NARCIS Classification: organizations, persons, projects

A dump of the NARCIS database was used to analyze the population of the NARCIS Classification. The dump was created on 11 September 2016. The individual classification assignments were transformed into a spreadsheet for

analysis. Figure 1 below shows a visualization of the population of the classes in the NARCIS database.

The large, yellow section on the right is for D20, the life sciences, which occupies 34% of the NARCIS database. Clearly, all of the other sections are much smaller. An immediately obvious conclusion is that the life sciences drive the research community that is represented in the NARCIS database. What is not so clear, and we must remember this question as we move along, is whether that is representative of the Dutch research community at large, as well. All of the other sections contain 6% or less—the next largest are D40 law and D60 social sciences. Here we must stop to consider the distinction in granularity between a class based on law (and public administration) and another based on the social sciences—all of them—that are equiv-

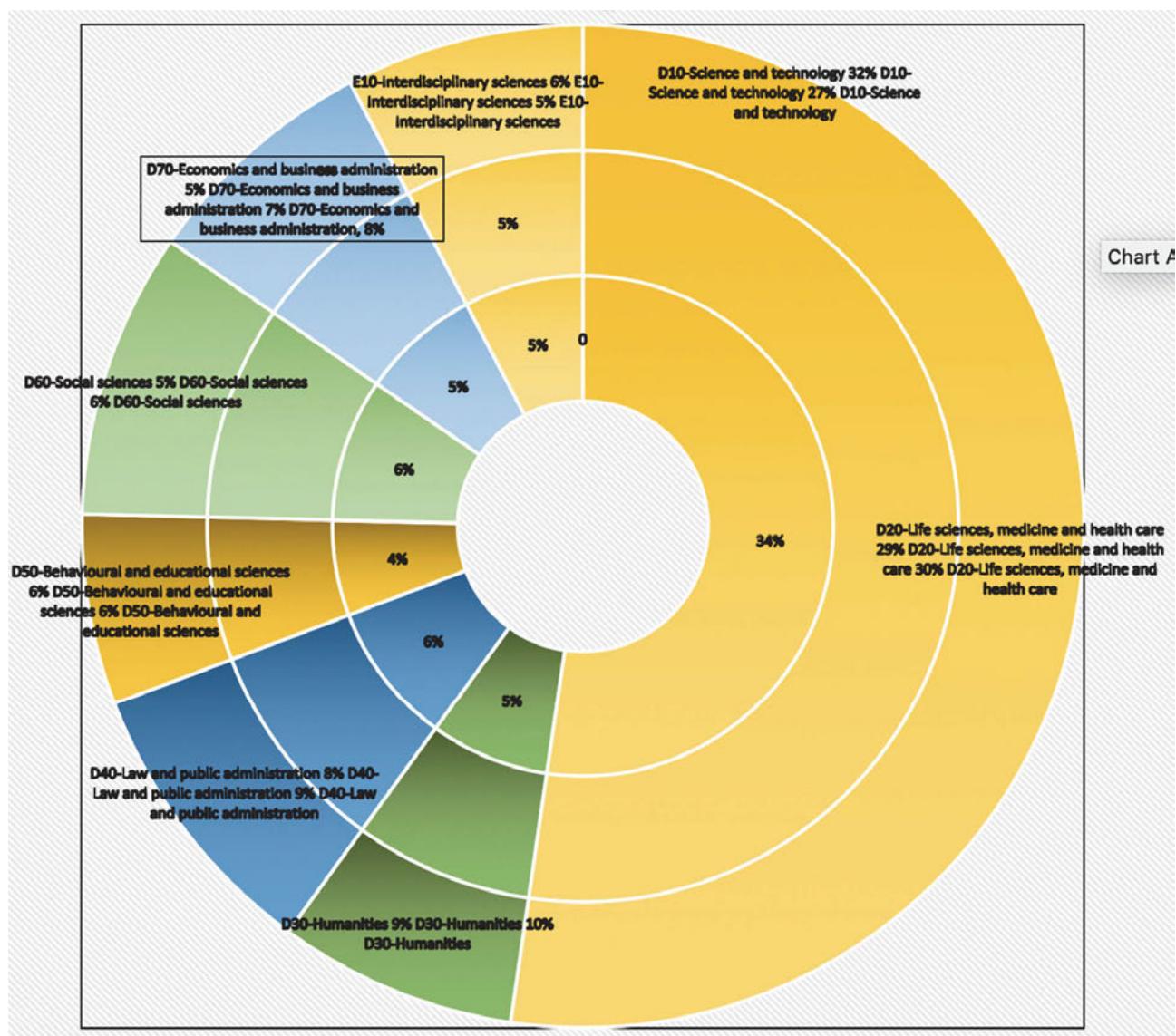


Figure 1. Population of the NARCIS Classification in the NARCIS database; inner ring “projects,” middle ring “persons,” outer ring “organizations”

Projects ⁷		Persons		Organizations	
D23 medicine	10579	D23 medicine	4903	D10 science and technology	2205
D21 life sciences	9724	D21 life sciences	3447	D20 life sciences, medicine and health care	1972
D22 biology	7016	D18 agriculture and the physical environment	2950		
D14 technology	5013	D70 economics and business administration	2903		
		D14 technology	2590		
		D22 biology	2446		

Table 4. Most populated classes.

Projects		Persons		Organizations	
D30 humanities	7	E18 biobased economy	18	E14 migration, ethnic relations and multiculturalism	10
E17 greenhouse gas mitigation	2	D40 law and public administration	16	D68 social security studies	9
D26 veterinary medicine	0	E10 interdisciplinary sciences	6	E18 biobased economy	8
D38 area studies technology	0			E10 interdisciplinary sciences	2
E10 interdisciplinary sciences	0				
E12 technology in medicine and health care	0				
E14 migration, ethnic relations and multiculturalism	0				

Table 5. Least populated classes.

alent in population. There are three sections with 5% of the population—these are D30 Humanities, D70 Economics, and D10 science and technology. Behavioural sciences bring up the lead.

Tables 4 and 5 show the most and least populated classes.

These two tables demonstrate, on the one hand, the efficacy of the classification given that so few classes (only 5), some of which were new to the classification in the 2015 instantiation, actually are unused. On the other hand, we also see that the life sciences, in particular, could probably benefit from further granularity to disambiguate the content of classes.

4.0 Discussion

4.1 Research Networking Framework

Soergel and Tafuto (2013) presented a framework for designing and evaluating the functions and characteristics of research networking systems, intended to be a generic template for the creation of knowledge organization systems and the backbone of research networking systems in all sorts of scientific environments. The major components of such a system are application functionality and technical

capacity. Users (but this is undefined) are key to the design of systems, which they are thought to rely on for:

- Promotion and tenure;
- Grant writing;
- Cross-institutional collaboration;
- Evaluating researcher output;
- Notifying researchers of upcoming opportunities;
- Notifying when work, data or projects are cited; and,
- Outsourcing entities and attributes to ontologies.

With regard to this framework, the NARCIS database and its classification are designed to meet most of these objectives, with the only lapse being the output of entities and attributes to ontologies. This latter objective is often thought of as an automatic function of semantic web functions, but in reality, more often, it relies upon inter-system networking and human output of specific entities and attributes. NARCIS Classification is well-designed in all attributes according to Soergel and Tafuto, except for the output of entities and attributes to ontologies. On the other hand, as we have seen, NARCIS Classification, though a faithful representation of the content of the NARCIS database, is hardly a leader in scientific research

ontology but rather relies on representation of uploaded content.

4.2 NARCIS is an occupational classification

To this point we have considered the NARCIS Classification as a scientific and research classification. But we must also consider the fact that science and research are occupations for the persons and organizations who are represented along with some of their projects using the NARCIS Classification. Thus, the NARCIS Classification is also an occupational classification. According to Hourihan Jansen (2017, 60ff), occupational classifications are systems: a) for organizing occupational information; b) for analyzing occupational experience; and c) for structuring occupational skills. Occupational classifications are used primarily to control populations, especially with regard to movement. This raises the question, is the NARCIS Classification used to control domain migration? That is, do the domains represented in the NARCIS Classification represent a concretization of the Dutch research community such that movement among domains or the introduction of new domains is restricted? If so, even if this is only inferentially the case, we must consider the ethical implications.

4.3 Intentional action

We see clearly the extent to which a classification such as NARCIS literally represents the domains that make up the user network for the NARCIS database. But a new research stream in knowledge organization asks us also to consider the extent to which the apparent representation is, in fact, politically influenced by its meta-domain (in this case, the Dutch research community) such that it goes beyond the simple empirical representation of categories of research. Smiraglia (2014) suggested political disciplinarity comes about as the result of social epistemological forces. If the goal of the NARCIS database is to properly represent scholarship contained within, then an empirical basis for the structure of the classification is demanded. The anomalies uncovered above, however, lead us to ask whether the absence of some domains and misnaming and misplacement of others are, in fact, evidence of political cultural pervasiveness. Such pervasiveness (Smiraglia 2015) can be the consequence of social epistemological imperatives to concretize and protect the meta-domain.

Tennis (2013) has termed this unseen objective disciplinary violence. Tennis suggests domain representation comprises levels of intention that lie on trajectories from the accidental to the intentional, which parallels a trajectory from the subjective to the objective. In other words,

what might appear accidental (such as an omission or misnaming or misplacement) might in fact be subjective and intentional. When the action is intentional the effect is what Tennis terms “subjective violence,” forcing a point of view on the domain at large. This is a component of the cultural synergistic imperative for an information institution (such as NARCIS the database and the classification) to disseminate its culture by concretization for preservation.

5.0 Conclusions: summary and trajectories

It is clear that the NARCIS Classification supports a vital research portal that, in turn, supports a nationally-coordinated research effort designed to provide better inter-institutional communication of scholarly productivity. The NARCIS Classification, then, is in itself an information institution, in which domain-dependence is part of its cultural imperative. Unlike general bibliographic systems, domain-dependent institutional classifications are designed to meet specific domain requirements over and above either user needs or general knowledge discovery priorities. It is acknowledged that the classification is derived by and for the research institutes of The Netherlands, and, therefore, that it reflects well the cultural imperatives of the Netherlands' research community.

The NARCIS Classification was constructed and is maintained in what might be described as “push” mode—the agencies for which it is a tool used to describe precise content of their domains. This incorporates an example of top-down politics in which certain disciplines are included and best represented. A perhaps unintended consequence is the encapsulation of forced views—Tennis’ “subjective violence.” Discontinuities in the representation of the research community positively represent the most highly functional parts of the Dutch research community, but emergent communities have no home and the absence of synthesis prevents the representation of complexity.

Trajectories for further discussion with regard to continued development of the NARCIS Classification include:

- Identity: should this classification represent occupations, education levels, or expertise?
- Interoperability: the NARCIS Classification domains can easily be mapped with other scientific, research, and occupational classifications.
- Interdisciplinarity: inter-, trans-, and multi-disciplinarity are high priorities for global knowledge discovery; the classification isolates interdisciplinary communities and obscures the phenomena of interest to interdisciplinary research.

- Synthesis: the NARCIS Classification could easily become more flexible through the addition of simple synthetic features and a structured grammar, thus allowing representation of complex concept units.

Notes

1. KNAW (Koninklijke Nederlandse Akademie van Wetenschappen): Royal Netherlands Academy of Arts and Sciences; NWO (Nederlandse Organisatie voor Wetenschappelijk Onderzoek): Netherlands Organization for Scientific Research; VSNU (Vereniging van Universiteiten): Association of Universities in the Netherlands; and METIS Research Information System.
2. NBOI (Nederlands Bureau voor Onderzoek Informatie): Netherlands Agency for Research Information.
3. NIWI (Nederlands Instituut voor Wetenschappelijke Informatiediensten): Netherlands Institute for Scientific Information Services.
4. NWO (Nederlandse Organisatie voor Wetenschappelijk Onderzoek): Netherlands Organization for Scientific Research.
5. For example, in the UDC classes “0 Science and Knowledge,” “3 Social Sciences,” “5 Mathematics. Natural Sciences,” “6 Applied Sciences,” and part of class “9 Geography” constitute the sciences; the remainder “1 Philosophy. Psychology,” “2 Religion. Theology,” “7 The Arts,” “8 Language. Linguistics. Literature,” and the remainder of class “9 ... Biography. History” constitute the humanities.
6. Knowledge Space Lab was a project of the Virtual Knowledge Studio and later resident in the eHumanities Group, both institutes of the KNAW.
7. Most project classification ended in 2009.

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