ENHANCERIA	Work package	WP6 Building up a community of users for strengthening RIs
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	Dissemination	Public
	Lead	Norwegian University of Science and Technology (NTNU)

CREATING A CATALOGUE OF ENHANCE RESEARCH INFRASTRUCTURES

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1. Introduction

One of the goals of the ENHANCERIA initiative is the sustainability of research infrastructures (RI), including developing a common understanding of the potential of RIs in terms of novel research and innovation, new skills and job opportunities, and new and more efficient services.
In order to strengthen cooperation, facilitate exchange and stimulate the creation of RI user communities, it is necessary to increase the visibility of research infrastructures within the alliance. Hence, this task aims to produce an on-line catalogue of select ENHANCE RIs that may be shared in different ways, e.g. by providing access for researchers, offering training activities, exchanging methods and technologies, and pooling resources for joint research projects. The catalogue is meant to collect relevant data on RI capacities including human resources, technologies, access policies and user costs and present them in a structured manner.
NTNU has been responsible for carrying out Task 6.2 and task leader has been Dr Thor B. Arlov. The technical solution has been designed, developed, and documented by Anders Onsøien Christensen at NTNU ICT Division. We thank the rest of the WP6 team for their valuable contributions to the realization of the catalogue.

2. Objectives

The general objective of Task 6.2 (O-6.2) is to increase the visibility of existing research infrastructures (RIs) within the ENHANCE alliance. More specifically, the goal has been to create an online catalogue of select RIs and use this to showcase technical capacities and capabilities for internal and external users. It is assumed that making such information easily available on the web will promote and enable researcher cooperation and mobility, which coincides with the goals of Tasks 6.1 and 6.3.

The following expected deliverables of Task 6.2 have been agreed:

- A working (prototype of) online catalogue of select RIs
- A printable catalogue for download
- Documentation of database and technical solution

3. Data collection

Data about the different RIs were not collected specifically for the purpose of an on-line catalogue. Instead, it was decided by the project management that WP2 would collect information from the partners.
The mapping that was carried out in the summer of 2022 as a part of WP2[1] registered 54 different research infrastructures, later augmented by 3 facilities, so that the total number of RIs represented in the Excel spreadsheet database is 57. For each infrastructure (row) there are a maximum of 25 data fields (columns).
Unfortunately, not all the ENHANCE institutions are represented in the material. Seven institutions have provided data. Thus, the current version of the catalogue should be considered as a prototype or pilot.

[1] D2.5 REPORT ON MAPPING ACTIVITIES AND MAIN FINDINGS ON RI PORTFOLIO WITHIN THE ALLIANCE (UPV 31/08/2022)

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4. Data quality

Although the data are comprehensive and useful for many purposes the mapping is not ideal to produce a catalogue with a consistent lay-out. In general, the data fields for input in the mapping were not standardized or restricted to a large degree, resulting in significant differences regarding format and length. Consequently, some of the data need some level of simplification or conversion to be useful in a catalogue format, for example truncation (see further ch. 7 below).

Another weakness of the data is that there is little or no systematic categorization of scientific field and/or technologies associated with the RIs. Furthermore, many of the reported RIs cover several different scientific fields. Thus, it is challenging to create a sensible and searchable catalogue for potential users who expect to find groups of similar or complementary RI and equipment. It would be hard, based on these data alone, to guess the profile or specialty of the RI. A simple word cloud generated by the descriptions of scientific field in the database demonstrates the complexity (fig. 1).

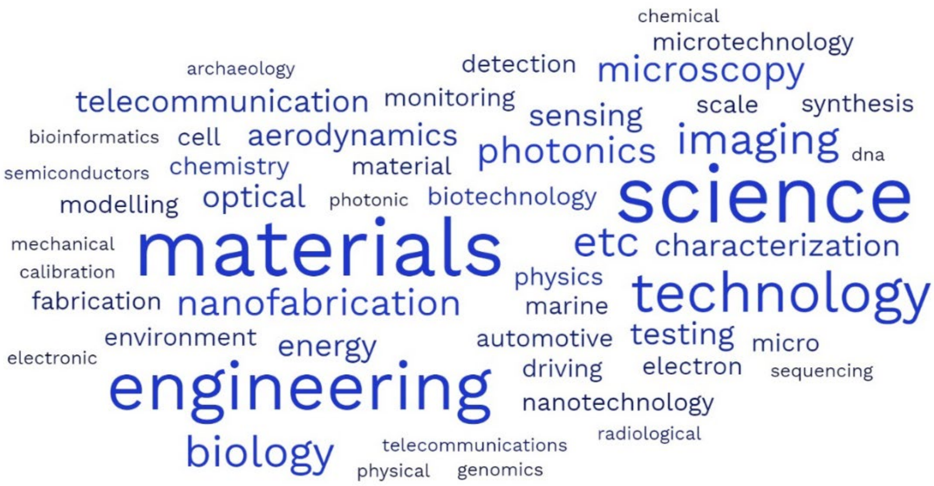

Figure 1 Word-cloud of RI descriptions in the mapping

To make the RI catalogue useful for researchers and technicians within ENHANCE as well as for the members' and alliance's external showcasing, it would be helpful to have some general categories that are "universally" understood. The project team have discussed different approaches, as illustrated in the table below (Table 1). None of these were adapted, however – it was concluded that adding new fields (categories) to the existing database would require approaching the RI owners a second time, which was not desirable. In connection with future updates, standardization can be addressed as well as new categories for sorting and filtering (see ch. 8).

Table 1 Possible RI science categories

Categories	Example	Pro	Con
Research domains (ref. Web of Science)	Life Sciences & Biomedicine, Technology, Physical Sciences, Arts & Humanities, Social Sciences	Universally agreed, recognizable	Too broad, one RI can be relevant for various domains

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Subject areas (ref. Web of Science)	(Physical Sciences) Astronomy & Astrophysics, Chemistry, Crystallography …	Universally agreed, recognizable	Too narrow and specialized, one RI can be relevant for various subject areas
Application	Fabrication, imaging, characterization, testing and simulation, computing …	Good for users looking for capabilities and facilities within their line of work	Primarily technical, does not refer to specific sciences or research areas
Technology, instruments	TEM, SEM, MS, X-ray, HPC, optics, mechanical testing, full-scale test facility …	Good for researchers and techs; precise description of the main capabilities at the RI	Primarily technical, too specific for "outsiders"; one RI can contain many of these technologies

Another way to categorize scientific fields might be to copy the ESFRI Roadmap 2021 science domains, which are recognizable throughout Europe (Figure 2). This categorization seems to be favoured by the WP6 participants and may be implemented at a later stage.

ESFRI Roadmap 2021 Domains

1. Data, Computing and Digital Research Infrastructures
2. Energy
3. Environment
4. Health & Food
5. Physical Sciences & Engineering
6. Social & Cultural Innovation

Figure 2 ESFRI science domains

One way of dealing with overlapping descriptions in the current data is to allow free-text search that returns hits from every RI that matches the search string in its description of scientific field. The risk is that the number of hits may be too high to be useful, but this solution has been implemented anyway in the current version, which also is able to extract science fields from column Q in the spreadsheet database (see below chapter 7).

5. Considerations for the technical solution

Various technical solutions have been discussed during the project, ranging from a simple downloadable PDF catalogue to a full-fledged stand-alone database that is dynamic and continuously updated. The consequences for choice of user interface design and functionality are summarized in chapter 6. It was concluded early on that development of a one-off software application, for example a so-called 'portlet', would be too expensive and time consuming. Instead, it was decided to go for a solution that might be integrated into the ENHANCE web site. This requires integration with code generated by UPV with *Wordpress* software. The technical solution for this implementation is described in chapter 7 below.

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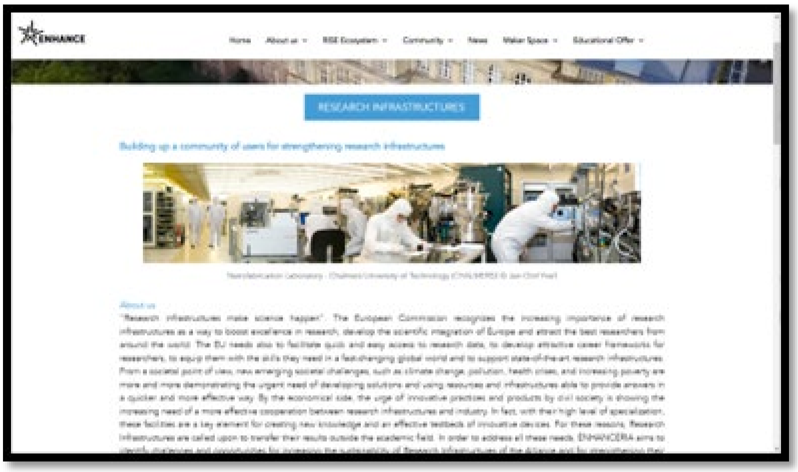

Figure 3 Screenshot of ENHANCE RI web page.

An important consideration regarding technical solution is who is going to be responsible for managing data, maintaining, and even developing the catalogue, including procedures for keeping the catalogue updated. The ENHANCE alliance does not have a central budget for such activities but relies on shared or distributed responsibility for the various tasks. This calls for a cost-efficient solution where the ENHANCE web catalogue largely offers key information that is stable over time and serves as a portal to the web sites of the individual research infrastructures. This way, each RI can keep information about its equipment and capacities updated without going through a central unit or cumbersome verification and QA procedures. Of course, the key information needs to be revised at regular intervals, see chapter 8.

6. User interface and functionality

The expectations and requirements from a user perspective have been discussed in project meetings and may be summarized as follows:

- A useful and user-friendly catalogue
- A dynamic catalogue that allows filtering, sorting, and searching
- Updated information
- Integration with the ENHANCE website
- Categorization of RIs according to ESFRI domains

Regarding the last bullet point, this has not been implemented in the current version (see ch. 5). The other requirements have been met, by and large.
The project has sampled a few similar catalogues for inspiration, such as the ESFRI 2021 Landmarks catalogue and the UArctic Research Infrastructure catalogue, both on-line.[2] None of these have extensive information about the RIs in the catalogue itself but contain hyperlinks to the various facilities. They also offer some level of filtering, sorting, and search options as well as downloading for copy or print. We have also implemented such functionality.
Following the goal of a 'lean' solution with only key-information embedded, we have had to select which data fields to render in the catalogue. Out of a total of 25 fields (i.e. columns) in the database

[2] ESFRI: https://roadmap2021.esfri.eu/projects-and-landmarks/browse-the-catalogue/
UArctic: https://www.uarctic.org/resources/research-infrastructure-catalogue/

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we considered 18 to be potentially relevant. Table 2 shows the data fields that were evaluated for inclusion. The fields that were deemed most suitable for online display are highlighted in green.

Table 2 Selection of data fields in the database

			FUNCTIONS		
Col.	Field name	Data type	Filter	Sort	Search
A	**ID**	Numeric		X	
B	**RI Name**	Text		X	X
C	**Main contact**	Text			X
D	**Main contact email**	Mailto:			
E	**Website**	Hyperlink			
F	**Host university**	Text	X	X	X
G	**Short name**	Text	X	X	X
H	**Size (ESFRI)**	Text	X	X	
I	**Description**	Text			X
J	**RI type**	Text	X	X	
K	**Localized**	Text			
L	**List of services**	Hyperlink			
M	**Price list**	Hyperlink			
N	**LIMS**	Hyperlink			
O	**Booking**	Hyperlink			
P	**Major assets**	Text			X
Q	**Science fields**	Text	X		X
R	**Other info**	Text			X

When it comes to user interface, i.e. lay-out and screen presentation, the requirement of integration with WordPress put some limitations. We chose a rather simple and neutral table format with relatively few data fields in the standard display mode, but with a push-button option to expand the form to contain full information. Responding to wishes from the WP6 team we have also included institutional logo and a photo of the RI in the screen form. Filtering and sorting options are located in a column to the right of the form and use a standard check-box interface. There is also a free-text search option for scientific field. Selection of filters and search strings are additive, making it possible to narrow the search quite well. The options are further described in ch. 8.

Figure 4 and Figure 5 show the RI catalogue entry display in expanded and compact mode respectively.

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ENHANCE RI — RI Catalogue (#37) — Shorten

Center for Ultrafast Science and Biomedical Optics - CUSBO

POLITECNICO DI MILANO

Website
cusbo.polimi.it

Contact
Antonio Pifferi (scientific director)

Description
The existing instrumentation are based on laser workstations directly developed at the University for studies mostly in the field of biomedical optics and ultrafast laser spectroscopy.
Some installations are unique at world level for what concerns the specifications and performances. In all cases these are not commercial systems but are laboratory workstations for advanced imaging and spectroscopy studies. The know-how at Politecnico di Milano grants smooth operation of the Infrastructures, with support in the experimental phase as well as in the following data analysis. Adaptation of the workstation to the user's needs is also possible.

Science fields
• Time-Domain diffuse optics for non-invasive in vivo diagnostics at few cm depths for applications in e.g. optical mammography, functional imaging of brain activity, tissue oximetry, and also non-clinical use as for non-destructive food quality assessment. • Advanced Optical Microscopy (e.g. light-sheet microscopy, optical projection tomography) for imaging ove wide scale ranges including small organisms. • Photonics for cultural heritage (e.g. non-desctructive analysis of painting via fluorescence or Raman spectroscopy). • Attosecond science with generation and detection of laser pulses at the attosecond scale. • Ultrafast Optical Science based on generation and manipulation of ultrashort light pulses to capture the dynamics of ultrafast events in molecules, nanostructures and two-dimensional materials (graphene, transition metal dichalcogenides). • Coherent Raman Spectroscopy and imaging of biological samples.

Localized
Single-site

Major Assets
• Attosecond beamline for gas phase experiments: isolated attosecond pulses (<250 as), rap. rate 1 kHz for two-color (IR/XUV) pump-probe
• Attosecond beamline for experiments in solids: isolated attosecond pulses (<250 as), rap. rate 10 kHz for two-color (IR/XUV) pump-probe
• Femtosecond XUV beamline: time-delay compensated monochromator, pulse duration 5-15fs tunable 14-55 eV
• Pump-probe set-ups based on tunable OPA (from near-IR to UV) <10 fs time-resolution
• Femtosecond 2D electronic spectroscopy set-ups in near-IR and visible
• Time and angle resolved photoelectron spectroscopy set-up <60 fs time-resolution
• High energy OPA system for HHG in soft-X (>200 eV), photoelectron spectroscopy and transient absorption/reflectivity
• Fs Optical-Pump (400-800 nm) and THz-probe (0.1-10 THz) setup operating in transmission and reflection mode
• Broadband time-domain diffuse optical spectrometer in the 600-1300 nm range
• Time-resolved diffuse Raman spectrometer for non-invasive analysis of turbid media in depth
• Multiple time-domain systems for in-vivo imaging of brain and muscle oxygenation with multi-channel capability and acquisition rate up to 10 Hz.
• Hybrid system time-domain near infrared spectroscopy and diffuse correlation spectroscopy for in-vivo tissue blood perfusion and oxygenation monitoring.
• High-throughput (up to 180 Mcounts/s), 7-wavelength (635-1060 nm) time domain scanning diffuse optical imager (for e.g. optical mammography) to quantify total blood content, blood oxygenation, water, lipids, and collagen.
• Light sheet and optical projection tomography microscopes for imaging mm-sized chemically cleared samples, small organisms, and single cells
• Time-resolved and spectrally-resolved photoluminescence devices for the remote imaging of artwork surfaces and the micro-imaging study of artwork micro-samples and artist materials.

Other information
It would be useful to add to the mapping the information about the RI participation to national/international networks or to distributed Infrastructures. E.g. CUSBO is part of LaserLab Europe from an European point of view and it will be part of I-PHOQS from a National point of view. Another useful information could be the inclusion of the RI into the ESFRI Roadmap.

(no pictures)

Figure 4 RI entry display in expanded mode

ENHANCE RI — RI Catalogue (#37) — Expand

Center for Ultrafast Science and Biomedical Optics - CUSBO

POLITECNICO DI MILANO

Website
cusbo.polimi.it

Contact
Antonio Pifferi (scientific director)

Description
The existing instrumentation are based on laser workstations directly developed at the University for studies mostly in the field of biomedical optics and ultrafast laser spectroscopy.
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Localized
Single-site

Major Assets
• Attosecond beamline for gas phase experiments: isolated attosecond pulses (<250 as), rap. rate 1 kHz for two-color (IR/XUV) pump-probe • Attosecond beamline for experiments i…

Other information
It would be useful to add to the mapping the information about the RI participation to national/international networks or to distributed Infrastructures. E.g. CUSBO is part of LaserL…

Figure 5 Screenshot of RI catalogue entry display in compact mode

Below, Figure 6 shows a screenshot of the full catalogue with filtering, sorting, and search options.

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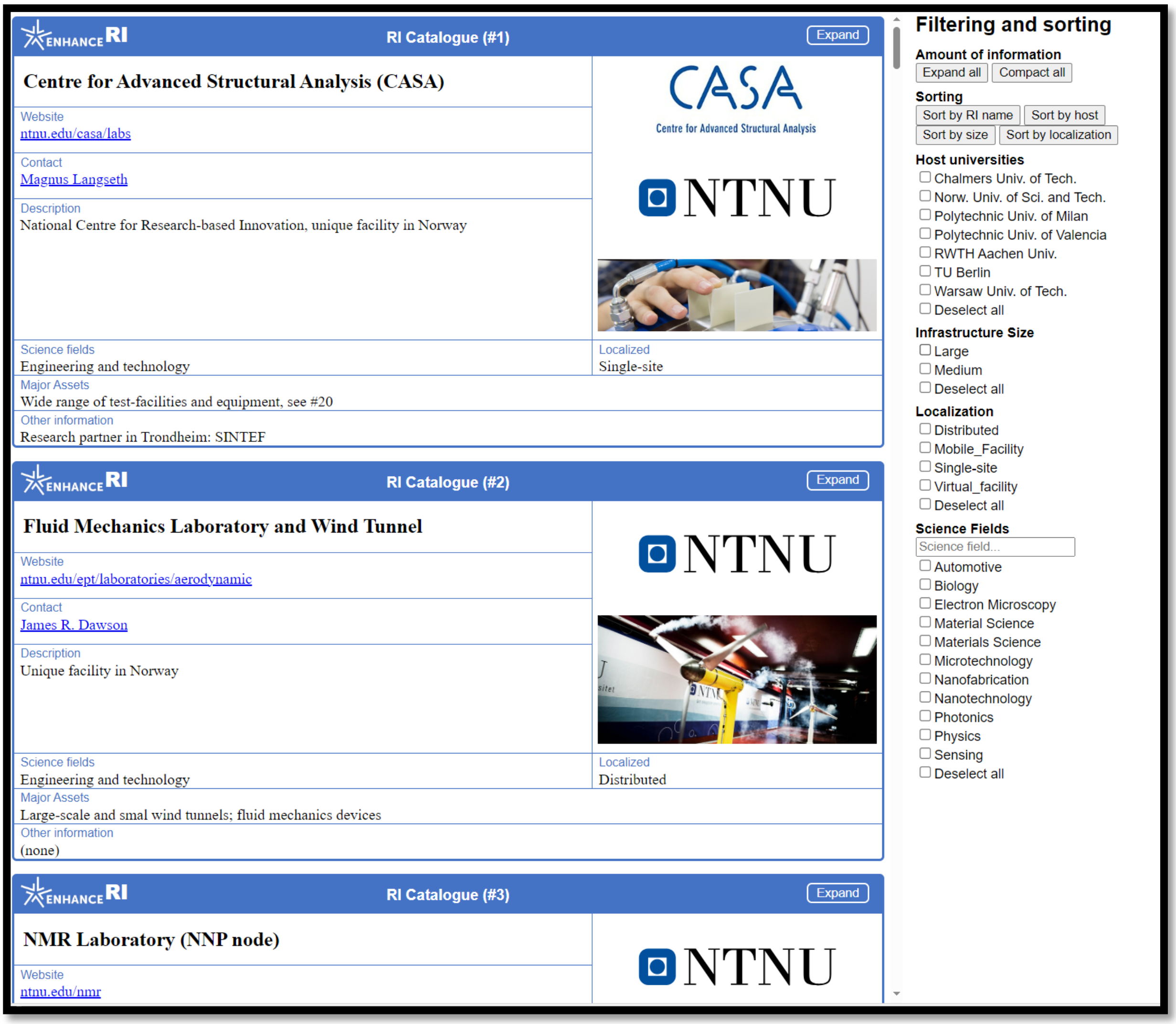

Figure 6 Screenshot of RI catalogu with filtering and sorting

7. Technical documentation

Solution design

Based on the assumption of infrequent updating of the information for this pilot version, a simple design was chosen. The data for the RIs is stored in a spreadsheet, from which a static HTML-page is generated by the following process:

1. The spreadsheet containing the RI data is exported as a .csv file.
2. A Perl script reads the .csv file and generates HTML code for the catalogue.
3. Any images of logos or laboratory pictures must be available when the Perl script is run. Typically, such material is located in a subdirectory called ‘Pictures’.
4. The output HTML code is stored on a webserver together with the image files for logos and picture from the labs.

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The resulting code implements the whole of the catalogue, including the filtering, long and short versions, and a printed version. Some JavaScript code, CSS definitions, and a favicon are encoded inline into this HTML file to keep the number of files down.
The printed version of the web page does not show the filtering and sorting options in the output, although any values set for filtering and sorting will take effect on the output. The printed version will always use the long format of the descriptions, and each description will start at the top of a new page.
The web catalogue may be browsed on a mobile phone depending on the size and resolution. However, we have not developed a version specifically suited for the size of mobile screens. That might be considered at a later stage if the catalogue is going to be used frequently.
For simplicity, logos related to RI with id no N must be named logo-ri-N.jpg. The file types accepted are svg, jpg/jpeg, and png, but really any image type accepted by web-browsers could be used. Similarily, lab pictures should be named similar to pict-ri-N-x.jpg, where “N” is the id number of the relevant RI, and “x” is a serial number for pictures related to that RI. The serial number “1” is set directly below the logos in both short and long version, while pictures with the other serial numbers are shown at the end of the long version of the catalogue entry. The nameing schema for logos and pictures should be discusses in order to arrive at a convenient system.
Note on the RI id: As a unique identifier for each RI, the serial (row) number from the first column of the spreadsheet is used. While this works, there are two caveats here: Firstly, the numeric id isn’t intuitively related to the corresponding RI, while a short lab name or a lab abbreviation, possibly in combination with institution acronym, would be more intuitive. Secondly, since the RI id is used to identify the images of logos and pictures, any renumerating (e.g. shifting of the numbers in case of insertion of an additional RI) will make the pre-existing images of logos and pictures refer to a different lab, giving inconsistency in the data. This is likely to be a source of confusion and errors when updating information. Fixing it would require selecting another unique identifier for the labs. The best candidate for such would be the acronym or abbreviated institution-RI name, and some attention should go into preventing duplicates. A naming scheme where the RI is identified by a combination of the host university short name and the RI name acronym would probably suffice, since host university are likely to enforce acronym uniqueness within their domain.
Note on Science Fields: Since the format of the data in column Q - Science Field varies a lot between the RIs, a pragmatic solution was chosen. Science fields are extracted from the data on the assumption that they are divided by commas, semicolons etc, and are less than 30 characters long. While this does not catch all the science fields listed, and does not enforce standardised spelling, it is close enough to give a representative impression in the pilot version of how a list of science fields would work. The science fields explicitly listed in the righthand sidebar are those listed by at least three RIs.

Integration with WordPress

The catalogue can be integrated with WordPress in various ways, varying in complexity and visual integration with WordPress. The three options tested are, in order of increasing complexity and integration:

1. WordPress could link to the catalogue as an external page. No catalogue data is included into WordPress, and no WordPress menus or design elements are visible when the catalogue is shown. To implement, use a link directly to the URL of the catalogue.
2. WordPress could show the catalogue in an iframe window. To implement, add HTML code similar to the following into a WordPress page: <p><iframe width="1000" height="800" src="https://..." title="Enhance Catalogue"></iframe></p>

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3. To get a higher degree of integration, a WordPress page is created or edited with the default WordPress block “Custom HTML” and the content of the HTML file of the catalogue is copy-pasted into this block. In this case, the HTML code in the WordPress page must be updated if the content of the catalogue changes. The definition of height and width ought to be tuned for this integration into WordPress. Suitable variants for WordPress and non-WordPress are found at the start of the CSS file, which again is included in-line at the beginning of the HTML file.

Other ways of integrating the code may be possible, depending on suitable WordPress plugins, or even by writing a special-purpose WordPress plugin.
If one of the first two of the listed methods is used the HTML code of the catalogue needs to be available at a URL on Internet. In all three cases the images of logos and pictures from labs must be available from a location on Internet. This URL should be defined at the top of the Perl script before the HTML code is generated.

Updating information

To update the catalogue, the process of regenerating the HTML code must be run again, from the cvs-file and the directory of images. This also applies if the update is purely the addition of extra logos and pictures. It will be possible to stream-line this process, but the details for this depends a lot on the setup.
Regarding the update of RI key information, see chapter 8

Future needs

The current code is quite fast, since the size is well below 500kB for 56 RIs. In the unlikely event that the number of RIs increases to thousands of RIs, this scaling up will at some point break down with respect to memory usage, CPU-time or similar. Some future optimalization is possible, but the gains are likely to be only linear with the current design.
The current solution is based on the csv-export from the spreadsheet of information. As this collects data from multiple sources, it also combines data that originally were stored using various character sets. Ideally, all data should be in a universal character set, like UTF-8. However, this is hardly feasible in practice since much of the input is likely to be cut-and-paste from existing documents at each university or RI.
The current exported csv file uses the character set Windows-1252, which is a superset of the ISO-8859-1, with additional characters for bullets points, quote marks and others. The code to convert and generate web page results in UTF-8 and extensive use of HTML entities. The system employs some heuristics to reconstruct characters that have been “lost” due to character set issues during the collection of data. In the current data set, this is mostly a matter of national letters in names not covered by the Western European Latin-1 character set (mostly Polish letters) and Greek letters used in various technical contexts. While it not possible to reconstruct these letters in general, the rich context in which the lost characters occur have allowed a high degree of confidence in the reconstruction for the current data set. However, in a scaled-up version, a better method must be found, one that avoids the loss of information during character set conversion, rather than to try to reconstruct them.
The current catalogue has not been thoroughly evaluated with respect to universal design, that is user interface principles which facilitate the use by people with disabilities. Much work would need to be put into adding and retrieving alternative texts and descriptions of pictures. However, the overall visual design for the catalogue is such that it will be feasible to implement this.

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Links to code

The code has been uploaded to https://github.com/anderchr/enhanceria
A demo version of the catalogue is running at https://folk.ntnu.no/anders/enhanceria/

8. Future updating and quality assurance

An online RI catalogue is only as good as its data allow. For such a service to be useful in the long run and not only for the limited lifespan of the existing database, the catalogue information must be updated regularly. This is crucial for internal as well as external users to return to and use the service.
Each participating institution and infrastructure will of course be responsible for the information on the local web sites. Either the institution or the individual facilities must also provide the correct key information for the catalogue database, which is unique and (probably) managed by the institution hosting the catalogue. They must also scan their entries for wrong or dead hyperlinks. Consequently, the partners need to agree on procedures and intervals for updating and quality assurance (see recommendations below, chapter 9).
The next time the database is being updated, the catalogue host is advised to use a common input form that standardizes data formats (length, type, character set), for example in the shape of a fixed, pre-formatted Excel spreadsheet that can be easily read into the database. This will make it far easier to provide uniform output on screen and print.
Apart from the regular and coordinated updating exercise there should also be milestones for technical revision. During the first major overhaul one should probably assess the key information data fields and either confirm or change the selection. At this point also new fields may be added to the database, for example the science categories mentioned in chapter 4. Should the software platform for the ENHANCE website be altered in the future, the catalogue code must probably be modified and adapted as well (see chapter 7).

9. Summary and recommendations

WP6 Task 6.2, lead by NTNU, was to produce an online ENHANCE research infrastructure catalogue based on data from a mapping performed by WP2. The dataset consists of 57 entries (i.e. individual infrastructures) from 7 of the partner institutions. We have delivered what we believe is a functional solution which by and large meets the requirements and expectations of the users within the WP6 team. Testing and quality assurance remains to be carried out, however, since hosting of the ENHANCE website at the very end of the WP6.2 project period has been transferred from UPV to TU Berlin. Thus, at the time of reporting, the catalogue has not yet been published on the website but it is accessible for testing by the partners.

The RI catalogue is HTML based and can be implemented in various ways either on a WordPress platform or on standard websites that allow the HTML code to run in a window. It is dynamic in the sense that the displayed information can be compacted or expanded, and the entries filtered, sorted and searched in a number of ways. The catalogue itself – or rather the selection of data fields – presents key information about the RIs and most importantly provide contact information and links to the local websites where hopefully more detailed and updated information may be found. The catalogue relies on a unique base of data provided by the institution and/or the facilities themselves. These data need to be updated at regular intervals in a coordinated procedure.

The WP6.2 team consider its work complete by tis delivery but would like to make some recommendations about the following up:

1. The ENHANCE partners should designate a proper arena or body to decide standards and procedures regarding the implementation and development of the RI catalogue. A project organization like ENHANCERIA cannot be responsible for that.
2. The responsibility for hosting and managing the database should probably rest with the host of the alliance's website, for the time being TU Berlin. Thus, there will be a single authentic source for the online catalogue information.
3. When the current version of the catalogue has been tested and implemented on the ENHANCE website hosted by TU Berlin, all ENHANCE partners should be encouraged to have some of their select RIs presented in the catalogue to make it more relevant, representative, and attractive for internal as well as external users.
4. An input form for RI key information should be designed and made available as soon as possible to make data collection easy – for example as a pre-formatted Excel spreadsheet form with drop-down selection lists for data that need to be standardized.
5. Before the first update takes place, preferably by the input form suggested in 4, the partners should assess and possible revise the key information fields. At this point, it may be convenient to introduce new categories for filtering and search – for example ESFRI science domains.
6. The institutions and/or the individual RIs must keep their local information updated and verify that the corresponding links in the catalogue are always correct, and if not, notify the host. They must also provide key information when that is requested and in the required format.
7. RIs that are represented in the catalogue should also be profiled as 'ENHANCE RI' on the local web pages, for example with a proper ENHANCE logo. Also, each partner institution should consider putting links to the online catalogue in visible places on their website.

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