Improved flexible multibody modeling and identification through model-based Design of Experiments and Physics Informed Neural Networks

Application DMP

Questionnaire

Describe the datatypes (surveys, sequences, manuscripts, objects …) the research will collect and/or generate and /or (re)use. (use up to 700 characters)

- Simulation: constructed (numerical) simulation models (software, models), raw and post-processed simulation results (numerical), pre- and post-processing scripts (software), metadata describing model setup and procedures (textual)
- Experimental: raw and post-processed measurement (noise, vibration, geometrical and material properties) data (numerical), post-processing scripts (software), manufactured test-samples and metamaterial demonstrators (hardware), metadata describing measurement setups and procedures (textual)
- Derived: post-processed results (numerical, multimedia), reports (textual), paper manuscripts (textual), presentations (textual, multimedia)

Specify in which way the following provisions are in place in order to preserve the data during and at least 5 years after the end of the research? Motivate your answer. (use up to 700 characters)

- During: the candidate will be the main responsible, supported by KU Leuven central IT. After: the supervisor from the hosting division Frank Naets and the division's research manager Bert Pluymers will have access.
- During: desktop file storage, personal and shared network folders on KU Leuven's network drives, KU Leuven OneDrive/Teams and the department's GitLab, and physical samples stored in the lab.
- After: archiving on KU Leuven's network drives and Open Access repository Lirias, and the department's GitLab, and physical samples stored in the lab. Part of the data can be published in dedicated data journals or made available on Public Repositories (e.g. Zenodo, KU Leuven RDR).

What's the reason why you wish to deviate from the principle of preservation of data and of the minimum preservation term of 5 years? (max. 700 characters)

No wish to deviate from this principle

Are there issues concerning research data indicated in the ethics questionnaire of this application form? Which specific security measures do those data require? (use up to 700 characters)

No issues related to this

Which other issues related to the data management are relevant to mention? (use up to 700 characters)

No other issues to mention

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FWO DMP (Flemish Standard DMP)

1. Research Data Summary

List and describe all datasets or research materials that you plan to generate/collect or reuse during your research project. For each dataset or data type (observational, experimental etc.), provide a short name & description (sufficient for yourself to know what data it is about), indicate whether the data are newly generated/collected or reused, digital or physical, also indicate the type of the data (the kind of content), its technical format (file extension), and an estimate of the upper limit of the volume of the data.

				Only for digital data	Only for digital data	Only for digital data	Only for physical data
Dataset Name	Description	New or reused	Digital or Physical	Digital Data Type	Digital Data format	Digital data volume (MB/GB/TB)	Physical volume
		Please choose from the following options: • Generate new data • Reuse existing data	*Please choose from the following options:* • Digital • Physical	*Please choose from the following options:* • Observational • Experimental • Compiled/aggregated data • Simulation data • Software • Other • NA	*Please choose from the following options:* • .por, .xml, .tab, .csv,.pdf, .txt, .rtf, .dwg, .gml, … • NA	*Please choose from the following options:* • <100MB • <1GB • <100GB • <1TB • <5TB • <10TB • <50TB • >50TB • NA	
Raw and processed vibration measurements (numerical)	Measurement data from experiments	New	Digital	Experimental	Databases (.lms, .mat, .unv), graphs (.fig)	<100GB	
Images and videos (multimedia)	Camera images/videos of samples and test setups	New	Digital	Experimental	mage (.png), video (.mp4)	< 1GB	
Metadata describing measurements setup and procedures (textual)	Metadata of measurements	New	Digital	Experimental	Text (.txt, .docx, .pptx, .pdf)	< 100MB	
numerical simulation models and input files (model)	Structural FE models and flexible multibody models	New	Digital	Simulation data	Commercial finite element software specific formats (.sim, .fem, .prt, .mph), model input files (.bdf, .dat, .m), model matrices (.mat)	<100GB	

Raw and processed simulation data (numerical)	Results from simulations	New	Digital	Simulation data	Simulation result files (.pch, .op4, .mat, .unv, .csv) Databases (.mat), graphs (.fig)	<100GB	
Images and animations (multimedia)	Graphical images and animation output from simulations	New	Digital	Simulation Data	Image (.png), video (.gif, .mp4)	<100GB	
Metadata describing models and simulations setup and procedures (textual)	Metadata of simulations	New	Digital	Simulation Data	Text (.txt, .docx, .pptx, .pdf)	<100MB	

If you reuse existing data, please specify the source, preferably by using a persistent identifier (e.g. DOI, Handle, URL etc.) per dataset or data type:

Not Applicable

Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? Describe these issues in the comment section. Please refer to specific datasets or data types when appropriate.

- No

Will you process personal data? If so, briefly describe the kind of personal data you will use in the comment section. Please refer to specific datasets or data types when appropriate.

- No

Does your work have potential for commercial valorization (e.g. tech transfer, for example spin-offs, commercial exploitation, …)? If so, please comment per dataset or data type where appropriate.

- Yes

The work in this project can result in research data which has potential for tech transfer and valorisation. Novel models and methodologies will be developed which interact with and/or are based upon existing models and methodologies of the hosting KU Leuven Division LMSD. The IP of the latter lies with KU Leuven and the Division LMSD and will also hold for the further developments made in this project. The KU Leuven Division LMSD has expertise in and an excellent track record regarding tech transfer and valorisation which will be leveraged upon in this project. The research manager of the Division LMSD Bert Pluymers will be consulted regarding these IP aspects.

Do existing 3rd party agreements restrict exploitation or dissemination of the data you (re)use (e.g. Material/Data transfer agreements/ research collaboration agreements)? If so, please explain in the comment section to what data they relate and what restrictions are in place.

- No

It is noted that novel models and methodologies will be developed, which interact with and/or are based upon existing models and methodologies of the hosting KU Leuven Division LMSD research group. In addition, the work in this project fits in the research of the hosting KU Leuven Division LMSD, where related activities within other projects are developed and can leverage upon the developments in this project to enhance interaction. The IP of the models and methodologies of the hosting research group lies with KU Leuven and the Division LMSD and will also hold for the further developments made in this project and for future developments based on these. Reference to existing models and methodologies of the hosting KU Leuven Division LMSD will be made by citing the associated journal paper publications.

Are there any other legal issues, such as intellectual property rights and ownership, to be managed related to the data you (re)use? If so, please explain in the comment section to what data they relate and which restrictions will be asserted.

- No

Commercial finite element software specific formats (.sim, .fem, .prt), model input It is noted that novel models and methodologies will be developed, which interact with and/or are based upon existing models and methodologies of the hosting KU Leuven Division LMSD research group. In addition, the work in this project fits in the research of the hosting KU Leuven Division LMSD, where related activities within other projects are developed and can leverage upon the developments in this project to enhance interaction. The IP of the models and methodologies of the hosting research group lies with KU Leuven and the Division LMSD and will also hold for the further developments made in this project and for future developments based on these. Reference to existing models and methodologies of the hosting KU Leuven Division LMSD will be made by citing the associated journal paper publications.

2. Documentation and Metadata

Clearly describe what approach will be followed to capture the accompanying information necessary to keep data understandable and usable, for yourself and others, now and in the future (e.g., in terms of documentation levels and types required, procedures used, Electronic Lab Notebooks, README.txt files, Codebook.tsv etc. where this information is recorded).

Metadata on experiment-related data :

- Raw vibration measurements: a measurement report per measurement dataset will detail the software parameters & instruments settings, dimensions, measurement methodology and procedural information on how the data was collected, required sensor & exciter labels and positions as well as units of measurements and calibration settings. This metadata is by default saved in the data files generated by the measurement software.
- Processed vibration measurements: a readme file.txt will accompany the dataset, describing the labels and definitions of variables, the units of measurements and how the raw data have been processed.
- Photos of the measurement setup with clarifying file names, date and timestamps will be added as additional clarification.

Metadata on simulation-related data :

- FE and multibody simulation models and raw & processed simulation result data: a readme.txt file will describe the parameters, definitions, units and software settings used to construct the models/ obtain the result data. Modelling assumptions and underlying equations will be clearly reported such that each simulation result is accompanied with a description of the validity range of the model/ result data. This information is kept either in the CAE file format, or in an accompanying txt file. In addition to the metadata per datatype as outlined above, a readme.txt file will be created which describes the structure of the dataset.

Will a metadata standard be used to make it easier to find and reuse the data? If so, please specify (where appropriate per dataset or data type) which metadata standard will be used. If not, please specify (where appropriate per dataset or data type) which metadata will be created to make the data easier to find and reuse.

- Yes

Where possible, the EngMeta metadata standard will be used. Otherwise, although not formalized, state-of-practice standards will be used regarding metadata. On the one hand, standardized CAE file format information and structure will be used. On the other hand, when working with transferable neutral text formats for experimental and simulation data, common engineering practice is used, deploying tabulated structures with clear column and row headers. A clear folder structure will be adopted for the data storage, in accordance with the different tasks carried out during the project. In every (sub)directory, a readme file will list all the present subdirectories and files as well as where the data is used and stored. Whenever publication or sharing of a dataset would

be considered, it will be re-evaluated if an applicable metadata standard is available and can be applied to enhance sharing.

3. Data storage & back-up during the research project

Where will the data be stored?

- Shared network drive (J-drive)
- Personal network drive (I-drive)
- OneDrive (KU Leuven)
- Sharepoint online

Above listed options are currently used and envisioned. In the context of BADM service of KU Leuven, the applicant is setting up an appropriate data storage approach for the hosting research group. When further matured, this approach will also be adopted, selecting the right storage option for the right type of data at the right moment during/after the project.

How will the data be backed up?

- Standard back-up provided by KU Leuven ICTS for my storage solution
- Personal back-ups I make (specify below) The cloud-based and ICTS storage solutions are backed-up as part of the offered services. Backups from local desktop file storage to personal KU Leuven network drive will be regularly performed (e.g. using SyncBackFree backup software to mirror). In addition, back-up snapshot copies on personal external hard drives will allow to recover data files as additional redundancy.

Is there currently sufficient storage & backup capacity during the project? If yes, specify concisely.
If no or insufficient storage or backup capacities are available, then explain how this will be taken care of.

- Yes

How will you ensure that the data are securely stored and not accessed or modified by unauthorized persons?

On the one hand, in this project no sensitive personal data will be used. On the other hand, both cloud and ICTS based storage solutions are only accessible via proper credentials which are centrally managed. Hence, unauthorised access via legal means is not possible.

What are the expected costs for data storage and backup during the research project? How will these costs be covered?

In case expenses are needed, part of the allocated project budget can be used. However, this is currently not expected.

4. Data preservation after the end of the research project

Which data will be retained for at least five years (or longer, in agreement with other retention policies that are applicable) after the end of the project? In case some data cannot be preserved, clearly state the reasons for this (e.g. legal or contractual restrictions, storage/budget issues, institutional policies...).

• All data will be preserved for 10 years according to KU Leuven RDM policy Particular focus for data preservation will be on:
• Data at the basis of publications such as journal papers, conference papers and presentations or posters. All data related to Open Access publications will be retained on Public Repositories (like RDR, Lirias).
• Developed models and measurement datasets which are likely to be reused in the research unit for future research and/or

valorisation activities and for future research of the researcher. Potentially large (intermediate and non-processed/raw) result and measurement files will be discarded to reduce required storage space if the simulation models and experiments allow to recalculate/remeasure the results easily and at low cost and time

Where will these data be archived (stored and curated for the long-term)?

- Large Volume Storage (longterm for large volumes)
- Shared network drive (J-drive)
- KU Leuven RDR

What are the expected costs for data preservation during the expected retention period? How will these costs be covered?

Expected costs for storage beyond project duration will be limited and covered by the research group.

5. Data sharing and reuse

Will the data (or part of the data) be made available for reuse after/during the project? In the comment section please explain per dataset or data type which data will be made available.

- Yes, in a restricted access repository (after approval, institutional access only, …)

Different data availability schemes will be considered, assuming “as open as possible, as closed as needed”. For embargoed and restricted data, metadata describing the content of datasets will be openly accessible.

If access is restricted, please specify who will be able to access the data and under what conditions.

For now, the data sharing policy “upon reasonable request” is envisioned (assuming “as open as possible, as closed as needed”). The precise procedures to evaluate access requests and to control access such as end-user agreements, data sharing agreements will have to be evaluated still.

Are there any factors that restrict or prevent the sharing of (some of) the data (e.g. as defined in an agreement with a 3rd party, legal restrictions)? Please explain in the comment section per dataset or data type where appropriate.

- No

Where will the data be made available? If already known, please provide a repository per dataset or data type.

Relevant datasets will be made available via KU Leuven RDR, Zenodo or similar.

When will the data be made available?

Publication related data will be made available upon publication of the results. Consolidated datasets can be made available at the end of the project. For the latter, the need for a possible embargo/restrictions will be evaluated, as clarified in the first point of this section

Which data usage licenses are you going to provide? If none, please explain why.

- CC-BY 4.0 (data)
- Data Transfer Agreement (restricted data)

- Other (specify below)
The datasets uploaded as open access datasets will be provided under a CC BY-NC- ND 4.0 license. For embargoed/restricted datasets, Data Transfer Agreements will be considered if appropriate.

Do you intend to add a PID/DOI/accession number to your dataset(s)? If already available, you have the option to provide it in the comment section.

- Yes

What are the expected costs for data sharing? How will these costs be covered?

Possible costs linked to open repositories and costs related to preparing data and uploading it, if any, will be covered by the project budget.

6. Responsibilities

Who will manage data documentation and metadata during the research project?

The applicant will be the responsible for data documentation & metadata.

Who will manage data storage and backup during the research project?

The researcher will be responsible for data storage & back up during the project, with support of KU Leuven central IT and local IT (SET-IT). The applicant has received information at the start of this project on the guidelines which apply in the hosting research group. For the implementation, the applicant can rely on the support of the Division LMSD's research manager Bert Pluymers

Who will manage data preservation and sharing?

The applicant will be responsible for ensuring data preservation and reuse. Towards the end of the project, responsibility for long-term data preservation and reuse will be assigned in agreement with the KU Leuven Division LMSD research manager Bert Pluymers.

Who will update and implement this DMP?

The applicant bears the end responsibility for updating & implementing this DMP.