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EPSRC CENTRE FOR DOCTORAL TRAINING
IN SCIENCE AND ENGINEERING IN
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Simulation modelling in preservation management: Moving from single measures to complex systems models

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Introduction

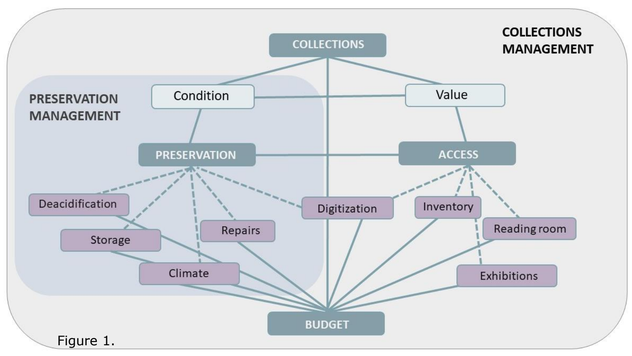


Figure 1.

Archives and libraries collections are preserved to be used, now and for the future generations. In order to find the right balance between use and preservation, it is fundamental that preservation management is not seen in isolation, but in relation to the other archives and library functions, which are part of the collections management [1] (Fig. 1).

In this project we approach preservation and collections management as a complex system and we use simulation modelling to identify the possible interactions within the context of collections management.

This poster presents the methodology that we are using to elaborate the model. So far the model has been built for archive paper collections (bound and unbound) and will report on three main outcomes: chemical and mechanical condition of the collections, physical and digital accessibility and costs.

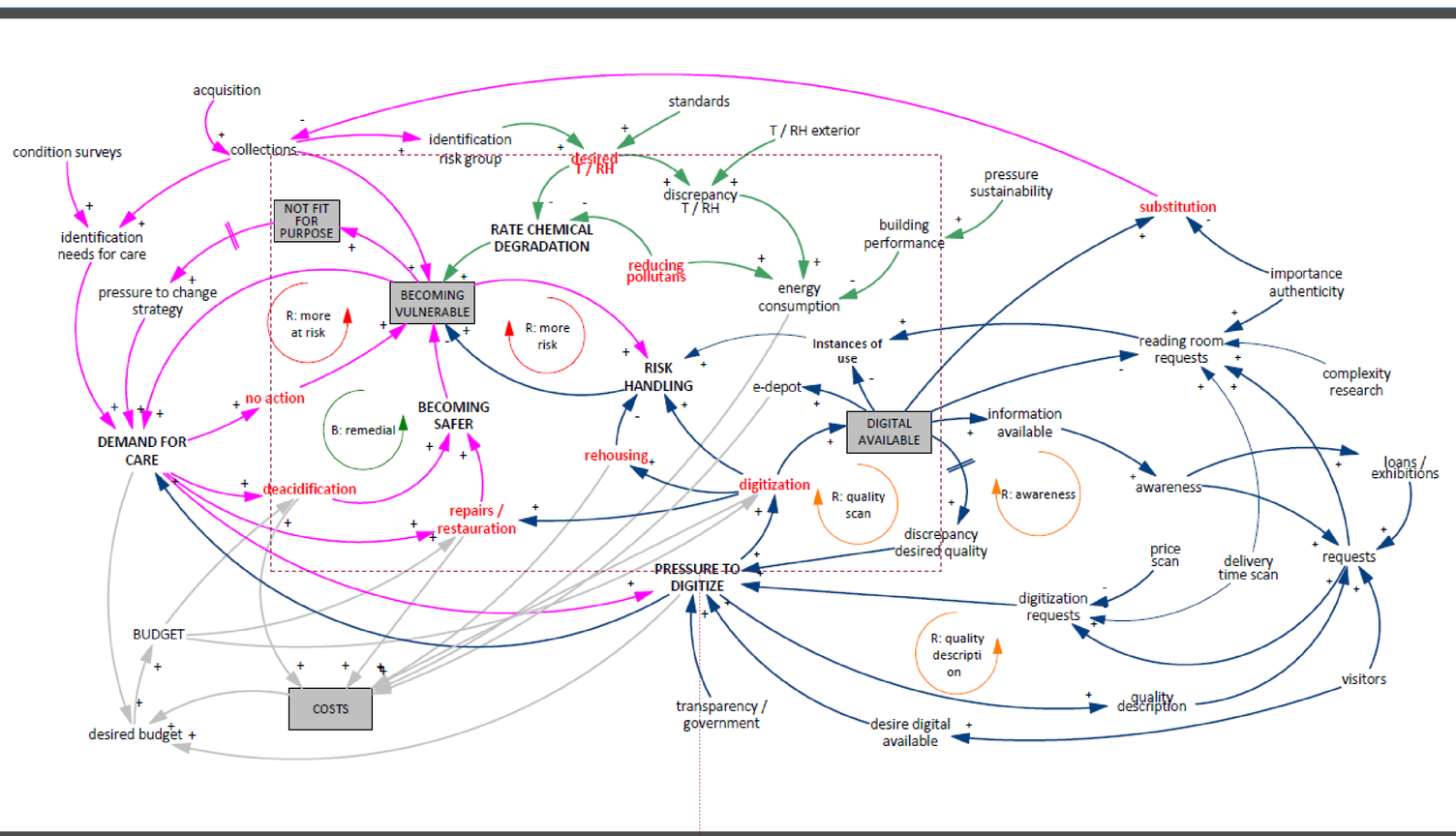
[1] Foot, M. 2006. "Preservation Policy and Planning." In Preservation Management for Libraries, Archives and Museums. London: Facet, 19–41.

Phase 1: Causal loop diagram

Qualitative approach

The first step of the modelling process consisted of the identification of the key variables, their causal relationships and their behavior over time. The diagram reveals the f as well as other archive activities eedback loops [2] and was developed with the input of professionals, working in preservation such as acquisition, ordering or access.

[2] Sterman, J.D. 2000. Business dynamics: Systems thinking and modeling for a complex world. Boston: Mcgraw-Hill Education.



Phase 2: Simulation modelling

Mathematical model

System dynamics (SD) and agent based simulation (ABS) are two of the approaches that have been developed to analyse the dynamic behaviour of complex systems. In this research we propose an hybrid model architecture: while preservation management decisions will be modelled using SD, the heterogeneity of the archive records and their behaviour will be captured using ABS.

Model architecture

Archive records are agents with individual characteristics (mechanical, chemical and physical properties, digital availability, popularity among readers, etc). Their behaviour varies according to the dynamic properties of the collection management, modelled in SD.

SD stock triggers a state chart transition in the agents which in turn modifies the stock value.

Randomness and uncertainty

In SD the random features in the real world are reduced to deterministic equations. In contrast, ABS models are built to capture the randomness in the system. In ABS the randomness can be found in the heterogeneity of the agents and stochastic features. Randomness is represented in the simulation model by probability distributions. Introducing randomness allows us to analyse the level of uncertainty present in management decisions.

System dynamics (SD): high abstraction; macro level

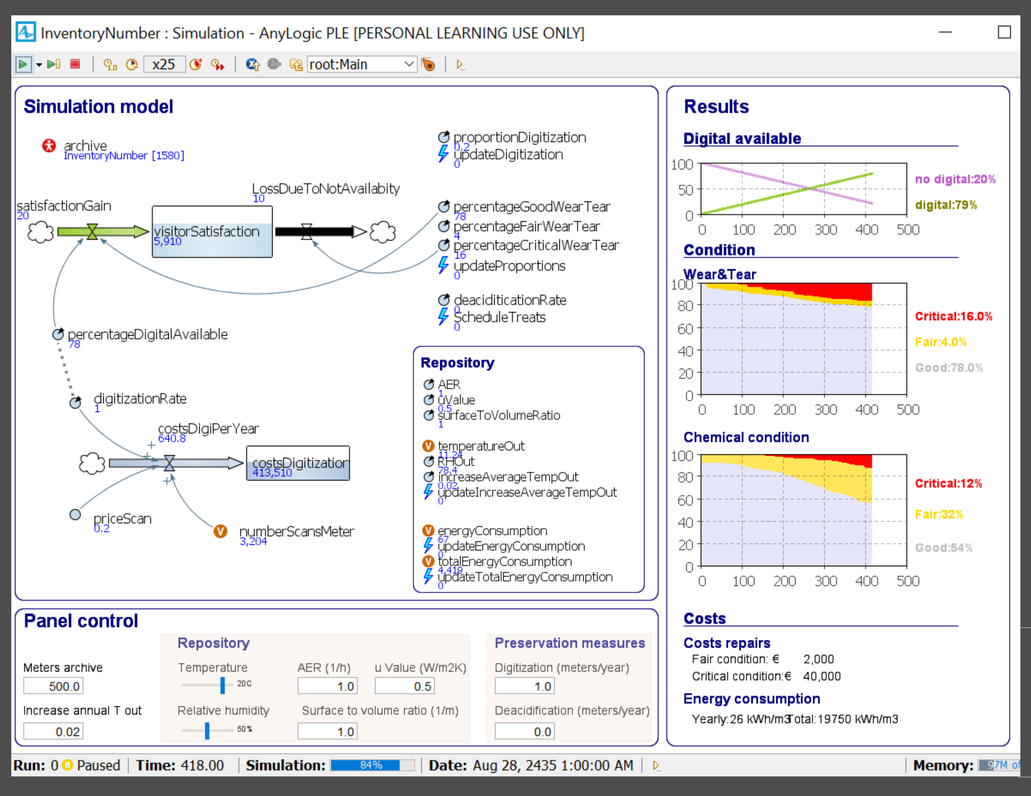
In SD stocks are accumulations which are altered by inflows and outflows. The rate of the flows are regulated by variables.

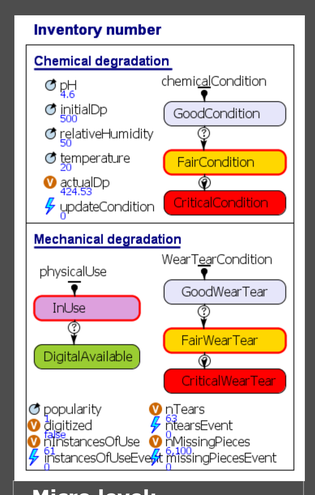
System structures and their interactions lead to system dynamic behaviour. Once the (causal) interactions are formulated in equations and the initial conditions are fixed, the one possible outcome is calculated. Therefore, SD allows to abstract from single events and concentrate on policies stead.

Agent based simulation (ABS): from micro to macro level

ABS models individual agents with a state chart where events trigger the transitions between states.

ABS aims to capture the heterogeneity of the agents, with different behaviours and past experiences. These differences among the agents lead to the dynamic behaviour of the system.





Micro level:
Individual agent (archive record) with his own properties

Macro level:
Decisions variables that affect the behaviour of agents. The decisions variables are part of the System Dynamic

Results

Due to the stochastic features the outcome of two experiments may be quite different. How different the experiments are will depend on the extent of the stochastic variation in the model. Experiments need to be repeated multiple times to gain statistical confidence on the results.

Mathematical formulation

- ODE's
- thresholds
- algorithmic rules
- if-then rules

Software package:

AnyLogic

Panel control

At the beginning of the run parameters values as well as decisions variables can be chosen. During the run the values can be adjusted.

What-if scenario's can be explored to analyse the effect of different preservation management decisions.

Data source

1. Statistical relationships and experimental descriptions obtained in experimental settings (damage-functions);
2. Demographic data obtained from surveys to characterize the deterioration of the collections;
3. Figures on operational costs, energy consumption or times a year that objects/collections are accessed by visitors (physically against digitally).

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