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FORMING A GENERAL SYSTEM DYNAMICS TRANSITION METHOD BETWEEN SYSTEM ARCHETYPES AND SIMULATIONS



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ABSTRACT

The field of system dynamics and its simulations are criticised for the lack of validation, verification testing and model construction guidance. In contrast, the field of systems engineering specialises in those areas. The thesis aims to develop one general system dynamics approach which guides new system dynamists during simulation construction, with appropriate verification and validation tests. The approach is referred to as the Loop Stock Transform (LST) and used to translate conceptual system archetype models into mathematical simulations. A mixed research method approach is used to develop the LST consisting of a literature review on model formulation, systems engineering Vee Diagram, two rounds of the Delphi research method and simulations of the four system archetype case studies. The Delphi participant group consists of nine field experts with more than 100 years of combined system dynamics experience. The LST is iteratively evaluated in each Delphi round to improve group agreement levels and the LST method. The Delphi consisted of five Likert scale questions tested for agreement using the statistical Cohen's Kappa technique. Additional open-ended questions provide more insight into the review, while the content analysis is used to interpret the open questions.

The Cohen's Kappa value increased from 0.32 to 0.62 (substantial agreement). Only two of five Likert scale question results show support for the method in round one, while in round two, all five question results support the LST. The final LST uniquely adopts the Vee Diagram as a foundational paradigm with 18 different validation and verification testing points. Thereafter, the LST is applied to the Fixes that Fail, Limits to Growth, Eroding Goals and Escalation archetypes. All four simulations verified the unique behaviours and recommendations made by the system archetype literature. Delphi participants especially found the simulations valuable to generate deeper insight and understanding into the different archetypes. However, the participant concerns relate to the number of steps that the LST has, which can prevent future adoption in the absence of comprehensive learning material. The simulation results show that the adopted systems engineering validation and verification paradigm can reproduce the literature behaviours and insights. The Delphi results reveal overall support of the LST and that the LST can transform conceptual models into mathematical simulations. Future research opportunities include developing learning material, evaluating students' appetite for the LST, and more practical LST applications.