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**System Dynamics and Serious Games**

This paper deals with the relationship between serious games and system dynamics. Games have been used in SD since the beginning. However, the field of serious gaming also has its own development. The purpose of this contribution is to provide a broad overview of the combination of serious gaming and SD and discuss the state of the art and promise. We first define serious game, simulation and case study and then point out how SD overlaps with them. Then we move on to define the basic components of a game and continue with an outline of important decisions and challenges of game design. After reviewing different possible purposes of SD-based simulation games, we discuss various approaches to game design with specific attention paid to learning effects. We also review the evolution of the interest for serious gaming in SD over the past 40 years. Our conclusion is that interest has oscillated between rising and declining, but that serious gaming is being recognized as an important component not only in educational settings, but also in policy design. We finish by offering important research questions for the future.

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**Mautam famines in Mizoram: An exploratory system dynamics approach**

Mizoram, a state in the Northeast of India, is affected every half-century by cycles of crop damages and famines. These events - locally known as Mautam - have been hypothesized to follow the periodic flowering of bamboo forests and subsequent rodent outbreaks. As such, the 1958-1960 Mautam resulted in a significant loss of lives; more recently, a 2007-2008 outbreak caused heavy damages to crops. However, the dynamics of the bamboo and rodent ecosystems remain poorly understood, as are their interrelationships with Mizoram's agriculture. This draft paper therefore presents an exploratory System Dynamics model of Mizoram's Mautam phenomenon, focusing on the application of a systematic framework for uncertainty analysis. Furthermore, a representative set of policies was tested under deep uncertainty to evaluate possible outcomes. Preliminary results indicate that although the model is highly sensitive to the properties of the human and rodent population subsystems, emphasizing market connectivity to facilitate food imports may be a promising and robust policy.

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**Development of a generic Smart City model using MARVEL**

The concept of the 'Smart City' is seen as double edged sword that should alleviate societal and environmental problems as well as fuel economic growth. Literature has identified many important characteristics of Smart Cities but has not yet provided a systemic approach that describes the interdependencies between these characteristics. The current study was conducted in support of an integrated approach for developing Smart City initiatives. We used group model building and interviews together with the MARVEL method to describe the interrelations between People, Environment, Living condition, Governance, Economy and Mobility. MARVEL is a method and a tool for developing CLD-

like causal models. The model forms the basis for a systemic framework to supports diverse sets of stakeholders in the development and analysis of future smart city initiatives. We demonstrate how various functions of MARVEL can be used to perform qualitative analysis to this end.

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**Modern Nonlinear Optimization Techniques for an Optimal Control of System Dynamics Models**

We study System Dynamics models with several free parameters that can be altered by the user. We assume that the user's goal is to achieve a certain dynamic behavior of the model by varying these parameters. In order to find best possible combination of parameter settings, several automatic parameter tuning methods are described in the literature and readily available within existing System Dynamic software packages. We give a survey on the available techniques in the market and describe their theoretical background. Some of these methods are already six decades old, and meanwhile newer and more powerful optimization methods have emerged in the mathematical literature. One major obstacle for their direct use are tabled data in System Dynamics models, which are usually interpreted as piecewise linear functions. However, modern optimization methods usually require smooth functions which are twice continuously differentiable. We overcome this problem by a smooth spline interpolation of the tabled data. We use a test set of three complex System Dynamic models from the literature, describe their individual transition into optimization problems, and demonstrate the applicability of modern optimization algorithms to these System Dynamics Optimization problems.

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**Exploring Duplicate Orders in a Single-Manufacturer Multi-Distributor Supply Chains**

This paper seeks to better understand how duplicate orders may dynamically influence the general performance in a single-manufacturer multi-distributor supply chain. We analyze a system where manufacturer sells her products through two distributors and the distributors sell the products to final customers. If a distributor is not able to satisfy his final customer demand, the unsatisfied demand will be backlogged and the customer will also place the order to the other distributor with certain probability. When the customer demand is satisfied by any of the distributors, the customer will cancel the duplicated order to the other distributor. Finally, when final customer demand exceeds available distributors supply, distributors often hedge against shortages by inflating orders to the manufacturers. Our results allow us to characterize the supply chain performance according to different probabilities to duplicate orders, different times to build manufacturer's capacity and the well-known anchoring and adjustment heuristic to model distributor orders and manufacturer capacity investment.

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**A System Dynamics Model to Analyze the Role of Smart Grid Pricing Policies in Governing Electricity Consumption in Urban Areas**

In this paper the role of Smart Grids pricing policies in governing the dynamics of electricity usage in urban areas is analyzed. A conceptual system dynamic