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A FUZZY FINITE ELEMENT MODEL TO STUDY KNOWLEDGE TRANSFER PROCESSES

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ABSTRACT

Evolution processes became recently one of the most important research focuses of applied mathematics and computational modeling. The driving force behind this importance research field is the application it finds mainly in biological, ecological and social systems [1-3]. This extraordinary advance is largely due to the computational capacity at our disposal nowadays.

This paper presents a model that is intended to help understanding the process of knowledge transfer among groups belonging to a certain segment of the same society or possibly the interaction process between different societies. Despite the limitations of the model, the results are plausible and intuitively consistent. So, if the model doesn't reflect completely the reality nonetheless it allows for some enlightenment that puts in evidence important and some times hidden correlation among concrete facts. If taken judiciously the results could help decision makers to implement important actions to foster the generation and transmission of knowledge.

Certainly the model is a simplification but as a first approximation suggests very interesting correlation, particularly the relative importance of knowledge generation, knowledge transmission and learning speed.

The knowledge chain is limited and focused on the relatively narrow spectrum of technologically oriented production system. We assume that scientific output is at one of the ends and some final product or service at the other end. In-between are all activities concerning the path science-engineering science-technological development-design-tests-product engineering-manufacture-commercialization. This approach assumes also a smooth transfer between two adjacent cells or components of the chain.

The knowledge transfer is sequential, meaning that only adjacent cells communicate with each other.

Another important hypothesis in our model is that the system has a positive feedback. It is an optimistic view of innovation and translates well what has been observed in the last 20 years. We mean by that the increasing of knowledge density with the active individuals or groups belonging to the knowledge chain. In other words we are in presence of an accelerating dynamical process.

Under such assumptions, the knowlwdge transfer process is governed by a typical reaction-diffusion equation [3,4] of the form:

$$K_0 \frac{\partial^2 \theta}{\partial x^2} + 2\alpha C_0 \theta = C_p \frac{\partial \theta}{\partial t} \quad ; \quad x \in [0,1] \; ; t \in [0,T]$$

The variable $\theta(x,t)$ is a measure for knowledge transfer, whereas the parameters K_0, C_0, C_p and α are respectively: the Cognitive Permeability, Creativity, Cognitive Impedance and Investment intended to enhance productivity.

Models for social phenomena are naturally non-probabilistic, due to imprecisions and / or lack of informations in the determination of the characteristic parametes of the model. To study the uncertainty behavior of the presented model, related to the inherent difficulties to precisely quantify these parameters, a Fuzzy Finite Element Procedure is proposed, and some numerical experiments are performed to highligt such uncertainties.

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