Cybernetic Approach to Project Management: Where Sense Making Intelligence is needed

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Abstract The original cybernetics of Norbert Wiener concerns self-regulation and equilibrium stabilisation around specified goal – mainly through negative feedback. This is an attractive preposition for project management. Yet complexity and chaos of projects are better reflected by non-linear systems, which in turn are better manageable in adaptive and self-organised distributed systems with positive feedback.
Paper presents the mental model of project management based on cybernetic system approach with several asynchronously running decentralised subsystems based on specific component-goal oriented processes.
Without claming the wholeness or completeness of the solution the indices of possible project performance improvements provide sufficient justification for continuing research in this area.

Keywords: cybernetic project management, non-linear systems in projects, finite models, initial conditions sensibility, complex systems, negative and positive feedbacks, multiple equilibriums, L-Timer™

1. Introduction

Project Management is about control and communication with more or less well defined goal. Wiener named this field of theory, "whether in the machine or in the animal" cybernetics after the Greek steersman (χυβερνήτης) (Wiener 1948, 1961). The general model of cybernetic system with feedback through the environment is depicted in Fig. 1.
This androgynous approach suits well the project management Humans, aided with technical means attempt to bring project towards predefined goals. The Environment which provides the Feedback is the project, System Mechanics – the project management, Goal – the project goal. Wiener tried to express his cybernetic model with one equation. As it may be possible for logical variables (and still

complex, see (Lent 1989)), for multi value variables we obtain complex non-linear relationship (Wiener, 1948, 1961), (Kaplan, 1984, 1991). Complex systems do not lock into stable state but also do not dissolve in chaos. They store the information and exchange it.

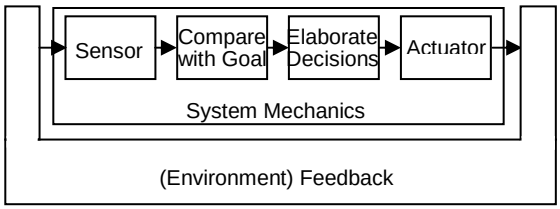

Figure 1. General cybernetic model

Complex systems are spontaneous, adaptive and alive (Waldrop 1992). Usually the system theories view the cybernetic systems as closed systems with predictable equilibrium; in early approach through finite number of possible states. However, the non-linear nature exposes high sensitivity to the initial conditions and multiple equilibriums. Cybernetics treats the environment as a similar system – which is not the case (each project is different). In effect a finite models of dynamic systems are limited in their predictability leading to the unavoidable imprecision. Due to the phenomenon of chance, predictability is bound to the probability and hardly deterministic in such systems (Stewart 2002). Yet, the short term predictability is nevertheless feasible (Bousquet 2009), so it makes sense to try to exercise the project management.

Von Foerster introduced 1974 the second order feedback loop: his observer (the system mechanics in the Fig. 1) is a cybernetic system with own loop itself (von Foerster 1974).By deploying a number of such second order cybernetic systems we attempt to view our first order system through the filter of particular second order sensors as shown in Fig. 2. It is a linearization of all other variables beside those, treated by the individual cybernetic system: the project management process e.g. P&S for Planning and Scheduling or L for Leadership.

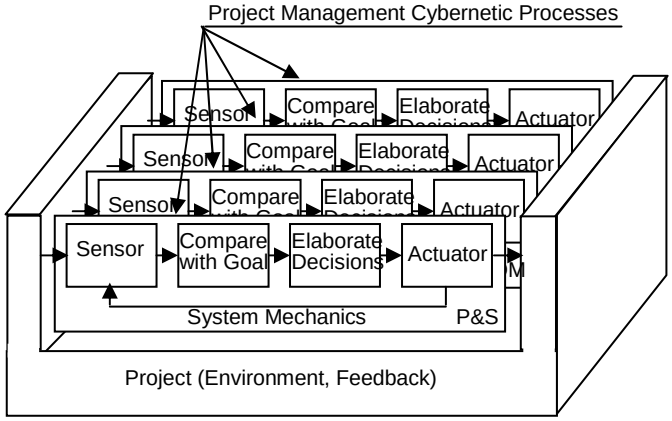

Fig. 2. Cybernetic model of Project management

2. Mental Model of Project Management

In search of mental model we focused on easy mnemonic, which should help to manage the complexity of project management. The time clock with processes assigned to full hours appeared to be the best choice here. There are 12, 18 and 24 options of process assignment.

An evaluation of project manager activities brought the number of up to 800 single actions with numerous linear and non-linear interconnections (Rufenacht 2005). The cognitive relationships indicated the selection of 18 processes to be the best option. The heuristic process selection is based on vast experience, literature study and an analysis of the interactions between the single actions. The results were verified in several studies and practical deployment in project management daily operations since 2003 (Rufenacht 2005).

In this approach the recurrence of daily cycle secures the minimal sensitivity of each process. The mental cycle must not be diurnal: the 24 hours may go through within few minutes of project manager reflections on his activities or stretch over weeks and may occur in coincidental sequence. The key issue is recurrence itself.

L-Timer™ system handles twelve administrative processes during the day time (like working day): each hour one process, in a logical sequence, which base on a macro linear interrelation; and bihourly six human factor processes (Fig. 3).

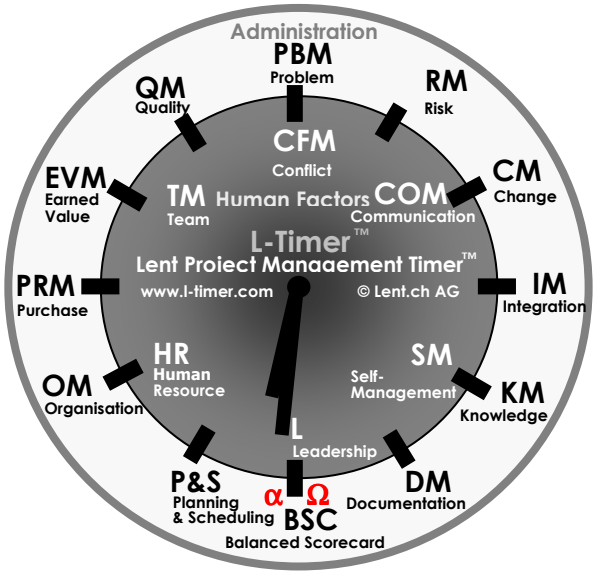

Fig. 3. L-Timer™ cybernetic processes system

The Human Factor processes are aligned with relevant administrative processes with closest links (e.g. 20:00 Human Resource Management is triggered by 8:00 Organisation Management) (Lent 2004). For readability the administrative processes are split into Table 1 and Table 2. Table 3 lists the human factor processes.

Process	name	Objectives
PS	Planning and Scheduling	You elaborate, structure and plan the objectives of your project. Project targets are aligned with the overall assignment specified by the customer and the higher-ranking enterprise strategy and are guaranteed over the entire duration of the project.
OM	Organization Management	You define project roles, responsibilities and the form of the organisational structure for the successful realisation of your project.
PM	Purchase Management	Through formal relationship with suppliers over all phases of the project, you secure the proper procedures and optimal results, along the formal laws, regulations and enterprise guidelines.
EVM	Earned Value Management	You control the activities in the project according to the result / deadline / cost stipulations set up in the Planning and Scheduling, with consideration for unforeseen events in the project.
QM	Quality Management	You constantly monitor project results, project processes and the other characteristics for compliance with project target stipulations, project requirements and their implementation planning, and promptly draw attention to deviations.
PBM	Problem Management	Together with your team and the applied methodology you master the technical or organisational problems within the cost and time-frame of your project.

Table 1. L-Timer™ administrative processes, part 1

Not coincidentally also the L-Timer™ hands point at 6:30. With the last working day results closed before at 18:00 (Balanced Scorecard) we recall the project strategy and with Leadership approach we are ready to start the day with 7:00 P&S Planning & Scheduling.

In the cybernetic system's approach the processes are not bound with specific project phases like in most recognized standards PMI (PMI 2004), IPMA (Caupin et al. 2007), but rather continuously work in loop between sensors and actuators. Obviously we distinguish the project phases, which each process passes. The Rubicon model of four phases is the model of choice (Lent 2004).

Process	name	Objectives
RM	Risk Management	You minimise the overall risk to your project by permanent, creative and timely identification of potential risks, their analysis and the development of suitable countermeasures.
CM	Change Management	You ascertain, assess and decide on the implementation of proposed changes with a systematic procedure, introduce them – keeping their effects to a minimum – to the planned project handling and have the updated configuration of the system continuously under your control.
IM	Integration Management	According to the project plan and schedule you ensure that the elaborated solutions are embedded problem-free into the existing environment (organisation, human resources, applications, platforms) and that a high level of client and personnel satisfaction is achieved with its introduction.
KM	Knowledge Management	You acquire and store process experiences gained in the course of the project for its use in the current project and in other projects.
DM	Documentation Management	You ensure the documentation and archiving of project results for ease of access during project realisation, the successful placing in operation of the project results, cost-effective operation and full user satisfaction.
BSC	Balanced Scorecard	You submit the results of your project to an internationally recognised, integral and comprehensive evaluation with the aim of making a permanent, positive contribution to the implementation of enterprise strategy in your company.

Table 2. L-Timer™ administrative processes, part 2

We demonstrate hereafter the feasibility of this approach beyond the conventional project progress control or risk management with the process of the Human Factor group, namely the 06:00 L – the Leadership process.

Process name		Objectives
HRM	Human Resource Management	You select personnel for appointment to the formal and informal project roles best suited to their skills and experience and promote their personal further development according to the enterprise strategy
TM	Team Management	You ensure the best possible efficiency of the complete project team measured against yielded performances, staff satisfaction client satisfaction and process improvement.
CFM	Conflict Management	You promptly identify potentials for conflict in your team and in the overall project environment. You solve conflicts successfully with suitable methods and technologies.
COM	Communication Management	You master the effective communication, including that of marketing, devoted to the achievement of project goals, both in the project and its environment.
SM	Self Management	Your personal satisfaction and performance is very important. You promote it through effective self-appraisal and dealings with your own engaged resources.
L	Leadership	You skilfully and consciously control the behaviour of your team members to guarantee the achievement of the project goals.

Table 3. L-Timer™ Human Factor processes, part 2

3. Second Order Cybernetics of Project Management

The second order loop is composed by the project management cybernetic processes. Exemplary Leadership process is shown in Fig. 4. We have our time-triggered activities (initiated by 06:00) or other process initiates the Leadership, what corresponds to the changed invariants in Leadership non-linear system description. Four phases follows: L (Launch), E (Engage), A (Act) and D (Deliver), LEAD in short. In each phase the results reached are measured and corrective (negative feedback) actions are initiated. Project manager applies his third order cybernetics to aggregate the experiences and act on situation taking his mental model in account. This unpredictability of his decisions, due to the changing mental model may be viewed as the initial values change in non-linear second order

cybernetic loops of the process. It implements directly the system positive feedback: by modifying and adapting the system control mechanics.

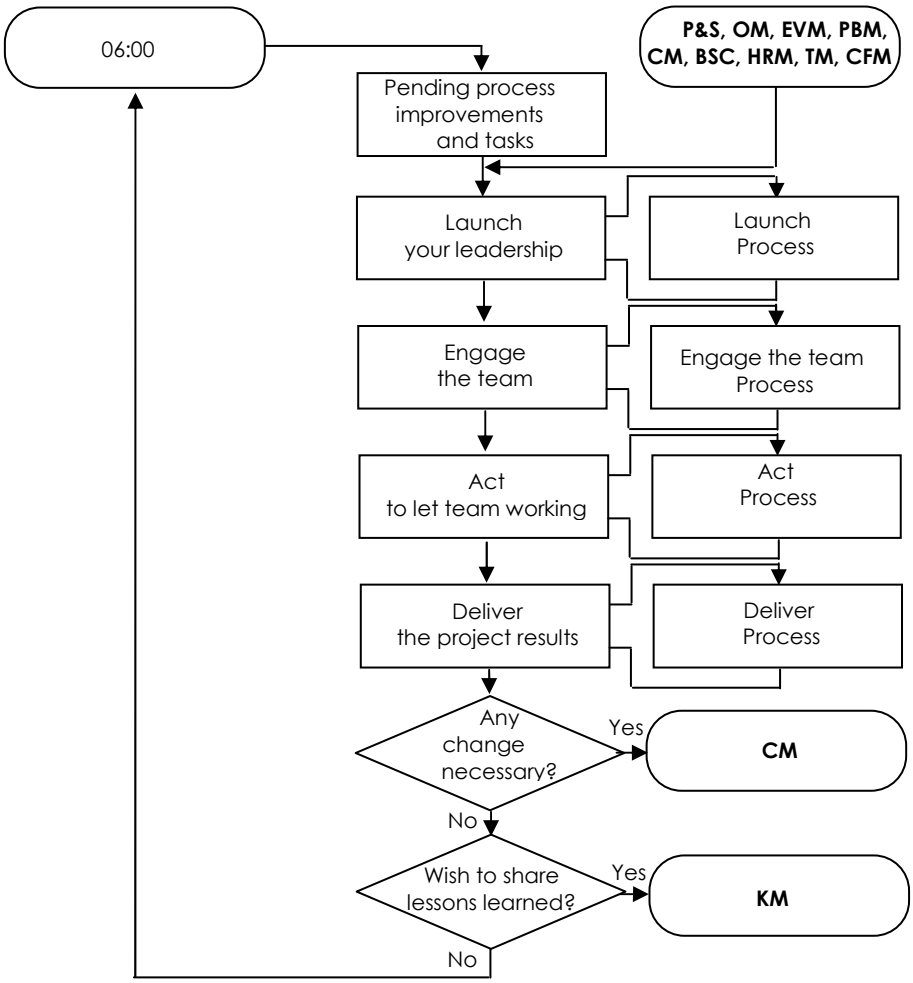

Fig. 4. Leadership process in project management

The interaction with the environment (project in this case) was evaluated a.o. by Kinicki et al. (Kinicki et al. 2011). In this model the team member (subordinate) behaviours are feedbacks to the leadership action. The reflecting awareness (Lee and Roberts 2010) allows for analysis and interpretation leading to the corrective actions which close the cybernetic loop (see Fig. 5). The situational (environmental) variables impact the goals and expectations as well as the feedbacks of the team members.

The individual project management cybernetic processes remain complex issues. For the purpose of these considerations the Gell-Mann definition of complexity is

used. In his view, the simpler the system, the shorter is it's description (information content). Opposite, the longer the description, the more complex it is (Gell-Mann 1994). Systems highly ordered (perfectly linear) and chaotic (fully non-linear) have short description, in-between lays the complexity. As we can not assume that the environment (the project) behaves along the logical rules or as expected, we face rather the complexity at the verge of chaos.

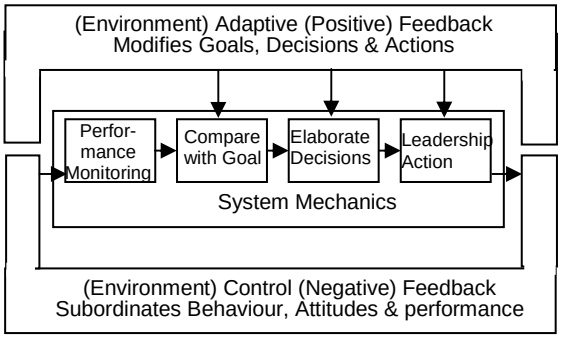

Fig. 5. Cybernetic Model of Leadership of Kinicki et al (Kinicki et al. 2011)

4. Third Order Cybernetics of Project Management: The Project Manager

Project Manager himself is the Von Foerster Observer (third level loop) in this second level project management processes' loop (von Foerster 1974). Project Manager cybernetic loop is shown in Fig. 6. It holds true for all decisions taken by project manager in any project management process.

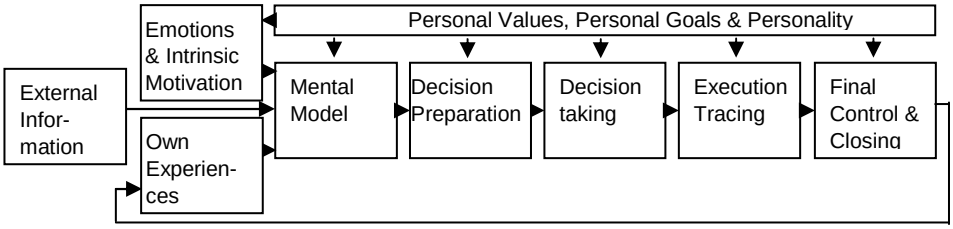

Fig. 6. Decision process

Managers see the system as linear one and try to master the negative feedback loop (e.g. by increasing the frequency of project progress control) imposing order. (Fig. 7).

The leaders, oriented towards dealing with the uncertainty of nonlinear systems, focus on positive feedback. They let the system to certain degree freely float or even intentionally destabilize, to learn the equilibriums and the resistance to change around those points. This adaptive learning let leaders to develop the cognitive intuition (Bousquet 2009). This operation on the verge of chaos is viewed

by several authors as the most successful strategy to deal with the non-linear systems (Bousquet 2009), (Kaufmann 1955), (Singh and Singh 2002). The right approach is that of manager and leader: to keep balance between positive and negative feedbacks (Bousquet 2009).

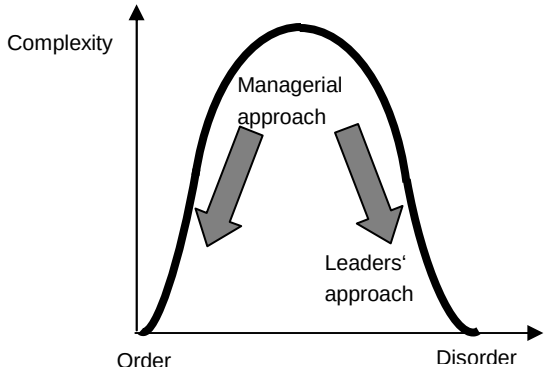

Fig. 7. Complexity adapted from (Gell-Mann 1994)

The profiles of those positive (leader) and negative (manager) feedbacks illustrate Table 4, modified from Verma (Verma 1996).

Project Manager	Project Leader
Planning and budgeting	Setting vision and direction
Organizing team	Inspiring team work
Staffing the roles	Aligning the team members
Controlling the results	Motivating and supporting
Sustaining the structure	Adapting the structure

Table 4. The roles of project manager and leader modified from Verma (Verma 1996).

We lend credibility to Singh and Singh (Singh and Singh 2002), who conclude that project managers have to balance between linear (management) systems and non-linear systems, effective in chaos and complexity management. The high degree of the complexity at the edge of chaos is simultaneously the biggest chance: the management systems handling these situations are most flexible and creative, best suited to adapt for a contingent operation and handle the unpredictability (Bousquet 2009) To handle the last, an awareness of context and relations, even anticipation of their possibility, may be crucial to project success. Linear systems focus on quantitative analysis and project controls limiting the capability of the perception of deviations or stochastic occurrences with impact on the project fate, what may explain, why today's project are not better managed than 10 and 20 years ago.

When we consider stress situations, typical in any project day life, we observe, that our approach is rather that of problem solving than the systematic development of understanding, evaluation of alternatives, and risk analysis. We act mostly instantly and spontaneously, without questioning assumptions or implications of our action. This reaction comes from our sense making capability in view of non-linear system encounter, paired with the intuition (Thomas and Mengel 2008).
The key issue in sense making intelligence plays mental model of the situation (Fig. 8) (Lent 2009).

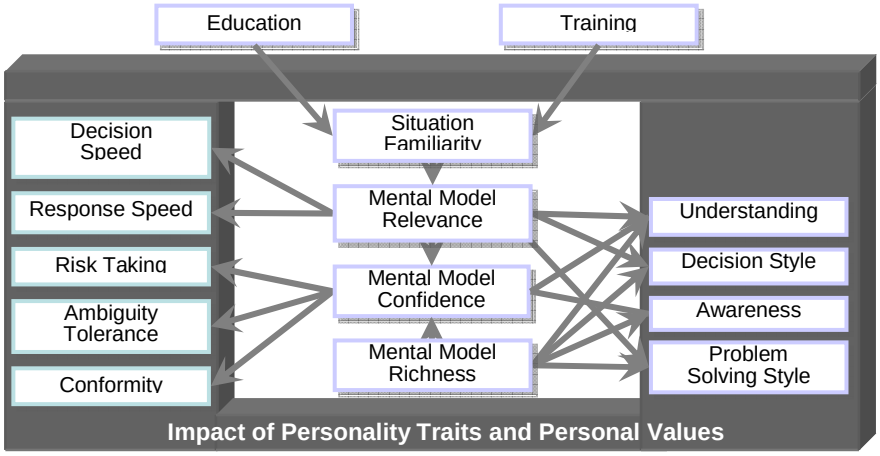

Figure 8. Mental Model adapted from (RTO 2007)

The confidence, thus capability to develop the decision base, particularly in complex situations, depends on mental model richness and it's relevance (RTO 2007). Relevance is impacted by situation familiarity which in turn is modified by education and training. As non-linearity predominates project manager decisions, the associations training and best case education might be better choice here.
The capability to modify the mental model based on experience (training) is a positive feedback systems mechanics modification. It counterbalances the negative feedback (performance monitoring in Fig. 5). Yet the model itself is the necessary prerequisite to set the measures, wherewith the primacy of positive feedback over negative feedback is demonstrated.

5. Conclusions

Projects with specified goals and the project management tracing these goals build together the first order cybernetic system. The complexity and non-linearity of this system exclude the reasonable mathematical modelling and limit the predictability of such systems to certain probability. Only within a short time period certain predictability is achievable, thus negative feedback control might be effective.

On a long term run the balance of positive and negative feedbacks seems to be more effective. To handle it, the second and third order cybernetic systems are conceived. In the proposed mental model of project management (system mechanics in Wiener first order cybernetic model) all activities are spilt into 18 in parallel operating closed loops of second order cybernetic systems. Each of them deals with the specific issues of the process, which constitute the second order cybernetic system mechanics, treating the other project issues as invariants. Still remaining complexity and non-linearity calls for project manager abilities to act as a manager as well as a leader. Project manager is perceived as a third order cybernetic system with both the negative feedback loop (manager, striving for short term feasible control) and the positive feedback loop, bound to the leadership qualities and sense making intelligence. By handling the systems on the verge of chaos leader can better enrich his mental model identifying hidden patterns in project course and possible multiple equilibriums. Through this he wins the confidence to handle the uncertainties in project. The theoretical considerations and practice confirm overall better performance of this qualitative approach as compared to negative feedback quantitative management only.

As each project by definition differs from the others, the positive feedback loop provides the necessary adaptability and cybernetic systems evolution towards better match to project behaviours. The third order system of human handling of the project needs to tilt towards leadership positive feedback loop to be effective. Knowledge Management process KM collects and redistribute the adaptations in the second order cybernetic system - the project management. This secures the second order system evolution. The better adapted project manager and the continuously adapted project management processes are promising approach to cause also the first order cybernetic system positive evolution: this of a project and it’s project management.

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