An Exploration of the Concept

Military Self-Synchronization

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Project Description

- **TNO-NLDA program : "Command and Control (C2) in a NEC Environment"**
  - PhD track on 'Self-synchronization'
  - Spring 2005 – Spring 2009

- **Problem:**
  - Defining the concept
  - In what ways can we achieve self-synchronization in C2?
- **Relevance:**
  - Military self-synchronization is a key concept in NEC
- **Contribution:**
  - Measurement tool
  - Building a body of knowledge
  - NLDA & TNO: Training and instruction

Problem

- **Military teams function in a changing environment:**
  - Dynamic, complex environment
  - IC-technology facilitates distributed operations
- **Ideally:**
  - Dynamic adaptation with minimal higher level coordination between teams within overall mission intent : ‘self-synchronization’
- **In what ways can we achieve self-synchronization in C2?**

Relevance

1. **The concept appears to be essential for increasing mission effectiveness:**

Figure 1: The tenets of NCW (Alberts and Hayes, 1999)

2. **"The magic of NCW is the emergence of self-synchronizing behavior" (Alberts & Hayes, 2006, p.2)**

Exploring the Concept

- **Synchronization phenomena studied in: mathematics, physics, biology, and mechanical engineering;**
  - Key issue in modern electronics (*Pogromsky et al., 2002)*

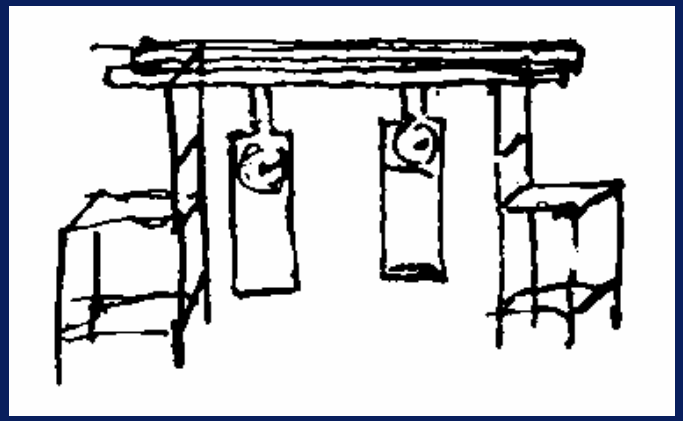


Figure 2: Huygens' drawing of the 1673 synchronization experiment

- **Self-organization ≠ self-synchronization**

Classes of Synchronization*

- **Controlled synchronization:**
  "Synchronization process result from some sort of external input"
  - (Computer) systems
  - Washing machines

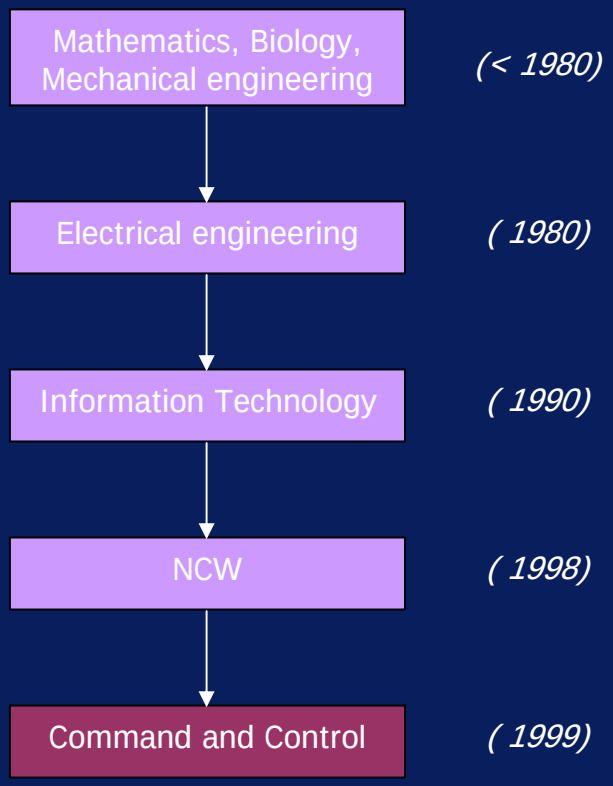
- **Self-synchronization:**
  "Synchronous regime arises due to the natural properties of the processes themselves and their natural interaction"
  - Without external inputs
  - Animal behaviors (Wesensten, Belenky, and Balkin, 1995)

* **Source: Blekhman, I. I., Fradkov, A. L., Nijmeijer, H., and Pogromsky, A. Yu. (1997). On self-synchronization and controlled synchronization, *Systems & Control Letters, 31,* 299–305.**

Military Synchronization

- **Controlled synchronization**
  - Synchronization processes are at the foundation of maneouvre warfare
  - Effects Based Operations (EBO)
  - Synchronization matrix in NL doctrine

- **Self-synchronization**
  - *Force multiplier* in NCW
  - Command and Control issues:
    - Military teams, C2 processes, human dimension



Transfer of concept into social sciences

Transfer of the Concept

- **Knowledge on synchronization phenomena has limited value in alternative scientific research area**

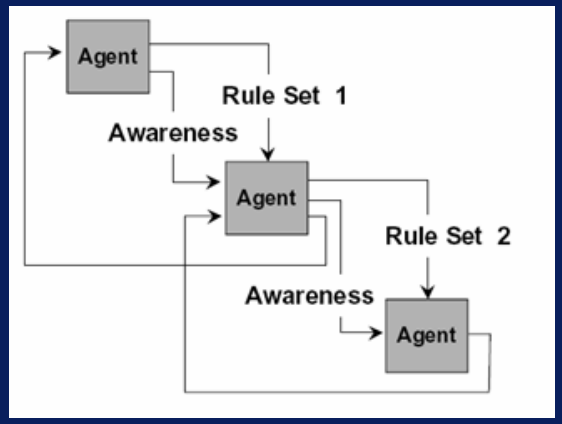


Figure 4: Self-synchronization conceptualized in Alberts & Hayes (1999).

Research questions on:
– leadership
– team processes
– team collaboration
– implicit coordination
– distributed teams
– decision making

Concept Understanding

- **… our understanding of the concept seems to linger:**
  1. Only few studies take military self-synchronization explicitly in account:
     - Dekker (2005); Fewell and Hazen (2003); Kruse and Younger, (2005); RAND (2005); Warne, Ali, Bopping, Hart, and Pascoe (2004).
  2. Measurement issues:
     - Operationalization

> "The concept of "self-synchronization" is another excellent example of a concept that is difficult to operationalize."
> From: *Alberts and Hayes (2005). Campaigns of Experimentation.*

Experiences with self-synchronization

- **Interviews:**
  - NL, April 2006
  - All three forces
  - Exploratory; n = 4
  - Interview approx. 1 hour

- **Concept was not related to NCW**

Figure 5: Model for identifying factors

- **Qualitative findings indicate that:**
  1. Military personnel grasp the concept
  2. Military personnel link the concept to incidents and situations not anticipated for

Literature study

Studies that explicitly address self-synchronization from a human factors perspective:

- Goals:
  - Collect knowledge on military self-synchronization
  - Research methodology

- 16 articles (NEC literature, ScienceDirect)
  - Information on:
    - Definition
    - Input, process, outcomes
    - Benefits
    - Research design, measurement

Results

Level of agreement in conceptualization:

Element	Level	Agreement on:
Definition	-	**Deciding and acting in concordance with command intent**
Input variables	-	**Trust, leadership, mental models**
Process variables	-	**Command intent, coordination**
Outcome variables	+	**Speed of command, adaptability**
Benefits	++	**Operational tempo, effectiveness**
Research design	+	**(quasi-) experiments, case studies**
Measurement	--	**Performance, qualitative**

Subconclusion

- **Self-synchronization is well-researched in technical sciences**
- **Military self-synchronization is considered important (academic and practical perspective)**
- **Limited understanding of the concept**
- **Experimentation is required to elicit self-synchronizing behaviors**
  - What are the antecedents, conditions ?
  - What are the process characteristics?

Experimentation

- Need for Experimentation:
  - COPB for C2 Assessment (2002)
  - Campaigns of Experimentation (Alberts and Hayes, 2005)
  - The Logic of Warfighting Experiments (Kass, 2006)

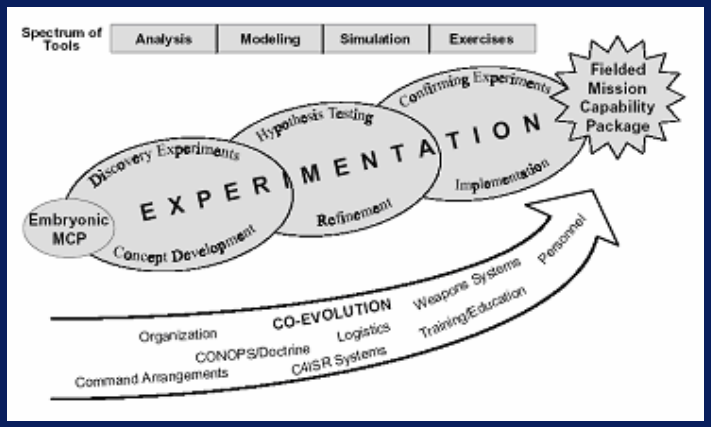


Figure 6: Role of experimentation (From: Alberts & Hayes, 1999)

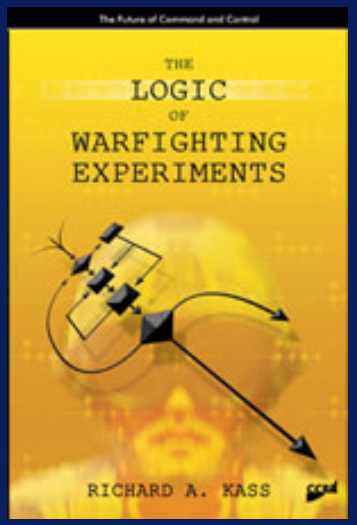


Figure 7: Kass (2006)

- Experimentation on military self-synchronization:
  - Dekker (2005); RAND (2005)

Research approach

- ✓ **Literature study (2006)**
  - Exploration
- ✓ **Qualitative exploration (2006)**
  - Exploration
- **Development of measurement tool (2006)**
  - Research methodology
- **Laboratory experiments (2007)**
  - Knowledge on antecedents and processes
- **Field experiments (2008)**
  - Validation of knowledge
  - TNO & NLDA: Training and instruction

Experiment 2006

- **Goals:**
  1. Determining antecedents of self-synchronizing behavior:
  2. Validating measurement tool;
  3. Validating manipulation.

Figure 8: Classes of factors

Measurement tool

- **Setup:**
  - Experimental design
  - December 2006
  - Joint scenario
  - Manipulation: command intent

Figure 9: Experimental setting

- **Measurement:**
  - Performance measures
  - Questionnaires (validated scales)
  - Observation protocols
  - Interviews, group discussions

Questions?

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