

Research teams as complex systems: implications for research governance

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I collaborate, therefore I am?

- Increase of **collaboration**, and especially new types of collaboration; episodic, international, interdisciplinary, use of ICTs
- **Problems:** related to coordination/communication and related to information security and cultural differences. What type of governance mechanisms can we use for such teams?
- Very little **theorizing** of how teams operate in interaction to their different contexts. How can we understand the interaction between individuals, team and different contexts?



Objective of the paper...

...is to increase our understanding of appropriate governance mechanisms for distributed collaborations, by introducing a conceptualization of **collaborative teams as complex systems.**

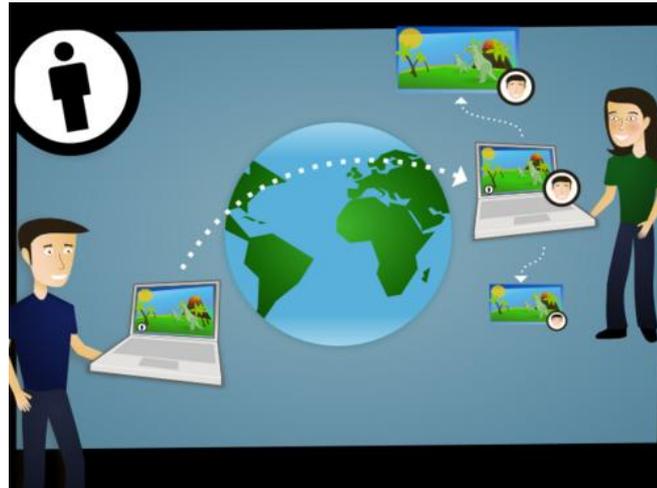
RQ: How can we conceptualise research teams, so that we can gain insight into appropriate governance mechanisms?

Structure of presentation

1. Research teams as complex systems
2. Lesson 1: Teams operating in different contexts; conflicts
3. Lesson 2: Stabilization of communication related to degree of complexity
4. Lesson 3: Additional coordination needs for high complexity teams; ICTs
5. Conclusions: lessons for research governance

Research teams as...

... emergent complex systems, consisting of individual researchers in different contexts, who interact with each other to organise the activities around their common tasks.

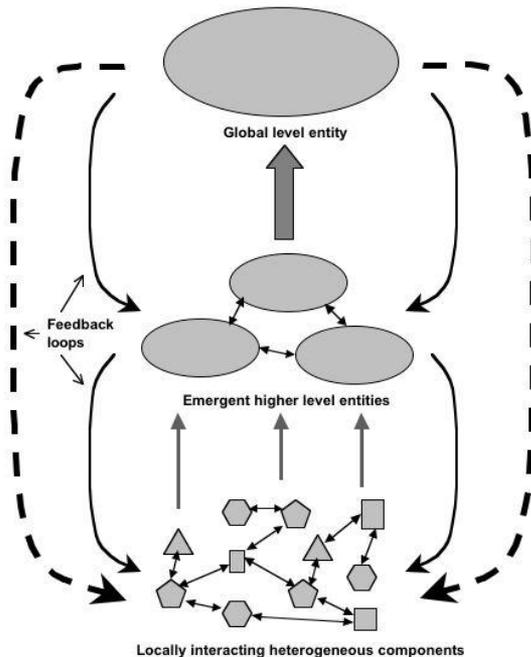


Three levels of dynamics

Local dynamics: the individual researchers in their institutes (e.g. teaching versus research; evaluation methods, individual motivation)

Global (team-level) dynamics: emergence of a collaborative team, history, (communication, coordination, productivity, conflicts)

Contextual dynamics: impact of features in the multiple contexts in which the team belongs to. (scientific context, context for funding, infrastructure)



Degree of complexity in teams

Complexity: “the number and variety of identifiable regularities in the structure and behaviour of the group, given the description of that group at a fixed level of detail”. The structure and behaviour of teams includes both regularities and random elements.

Complexity is low in a team whose behaviour is a collection of random events; but it is also low if the behaviour of the team is highly ordered and adheres to a single rule.

Complexity is high when research teams have many kinds of regularities (e.g. in their communication dynamics, in the ways output is produced) generated by multiple rules, including contingencies and exceptions.

Case studies



Framework Programme
collaborations

3 publications, combination of
results

Conceptualising teams as
complex systems: What can
we learn about team
governance?

1. Different contexts

Vasileiadou E. (2009), Working Apart Together: using ICTs in research collaboration, PhD thesis, UvA

Complex systems have fuzzy boundaries that separate them from and connect them to their embedded contexts.

Conflicts as a result of mismatch of: local regulations; team-level regulations; regulations in the context (funder)

E.g.: The employment regulations at a local site (local level), were in clash with payment regulations of the funding agency (context), causing delays and conflict between the members and content change (team level).

2. Stabilisation of communication

Vasileiadou E. (2009), Stabilisation operationalised: Using time series analysis to understand the dynamics of research collaboration, Journal of Informetrics 3(1): 36–48

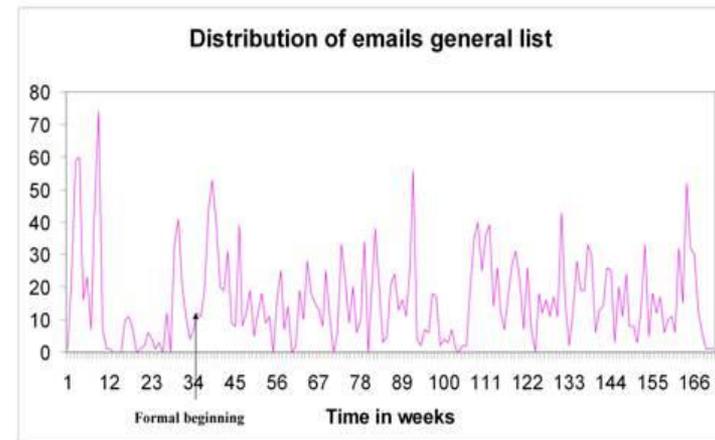
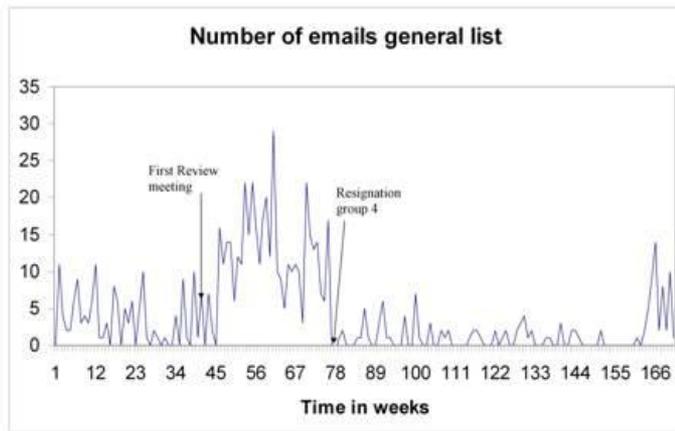
Question:

How can we use informal communications of researchers to understand dynamics of research collaboration in a systematic way?

By ARIMA modelling of online communication data

- DELTA: relatively stable communication patterns (frequency, media and type) over time
- ERICOM: communication patterns changed substantially over time

Frequency of emailing lists



Operationalisation of complexity

Operationalisation of the level of complexity of an (emergent) system

- Stationary ARIMA models (AR- or -MA) with negative coefficient values describe low complexity systems
- Non-stationary ARIMA models (logged/ I) with positive coefficient values in the AR/MA components describe high complexity systems

-Longitudinal designs for the study of collaborative teams are necessary: ARIMA modelling, advantageous in such designs

-Low complexity team with stable media and types of communication

-High complexity team with changing communication

ARIMA modelling in a nutshell

- Set of observations at regular intervals of time (min. 50)
- Memory of a variable/ Random shock
- Stationarity
- Autoregression (AR), memory of all preceding values (diminishing)

$$\text{Value}(t) = \text{shock}(t) + \varphi \times \text{Value}(t - 1)$$

- Moving averages (MA), memory of preceding shock (short-term)

$$\text{Value}(t) = \text{shock}(t) + \theta \times \text{shock}(t - 1)$$

- Integrated models (I), perfect memory, sum of past shocks

$$\text{Value}(t) = \text{shock}(t) + \text{Value}(t-1).$$

ARIMA modelling for CAS

Integrated models [e.g. ARIMA (0,1,0)] to operationalise path dependence of the initial conditions (shocks) of a system.

MA-models with negative θ coefficient describe variables in systems of lower complexity (negative feedback loop);

MA-models with positive φ coefficient describe variables in systems with higher complexity (positive feedback loops)

... turning complexity into a research question, and investigating the degree of complexity of a system.

3. Additional coordination needs

Vasileiadou E. and Vliegenthart R. (2009), Research productivity in the era of internet revisited, Research Policy 38(8): 1260-1268

Is there a positive link between communication and research productivity in collaboration?

Data

- Productivity: FRACTIONAL books, articles, presentations, deliverables
- Communication: emails, meetings
- Other variables: Gender, PI, Effort



Are you lonely? Hold a meeting!

1. Meetings important predictor of all types of productivity, irrespective of degree of complexity
2. High complexity teams face additional coordination and communication needs. These needs can be addressed with ICTs (email, blackboard etc)
3. Email a predictor for productivity only for the high complexity team



	Deliverables		Book chapters		Articles		Conference presentations	
	I	II	I	II	I	II	I	II
Constant	.203 (.161)	.138 (.171)	.157 (.189)	.184 (.204)	-.281 (.168)	-.265 (.158)	-1.327** (.643)	-1.175 (.576)
Female	.015 (.144)	.038 (.146)	-.192 (.169)	-.203 (.173)	-.132 (.150)	-.164 (.135)	-.183 (.574)	-.343 (.490)
Principal In.	-.138 (.171)	-.029 (.191)	-.137 (.201)	-.195 (.227)	-.066 (.178)	-.276 (.176)	.010 (.682)	-.991 (.642)
Team Delta	-.118 (.151)	-.058 (.218)	-.090 (.178)	-.092 (.260)	-.141 (.157)	.190 (.202)	-.228 (.603)	1.049 (.733)
Effort	.008 (.012)	.011 (.012)	-.004 (.014)	-.005 (.014)	.036** (.012)	.031** (.011)	.101* (.047)	.078 (.041)
Meetings	.070*** (.017)	.085*** (.020)	.058** (.020)	.051* (.024)	.075*** (.018)	.057** (.019)	.324*** (.068)	.228** (.069)
Emails	.000 (.001)	-.003 (.003)	.000 (.001)	.001 (.003)	.000 (.001)	.006* (.002)	.003 (.004)	.034*** (.009)
Team * meetings		-.044 (.050)		.015 (.059)		-.038 (.046)		-.100 (.167)
Team * emails		.004 (.003)		-.002 (.003)		-.007* (.003)		-.032** (.009)
F-value full model	4.599***	3.660***	2.506**	1.857	8.033***	9.291***	9.185***	12.158***
Adjusted R-squared	.289	.286	.146	.115	.443	.556	.481	.627

Conclusions

The conceptualisation of complex systems provides unique insights into the individual-team-context interaction in a research team. For research governance it helps us:

1. Distinguish between **different contexts** of the team, and understand how conflicts are conditioned by mismatch of governance structures at each context
2. Utilise dynamic methodologies (ARIMA modelling) to trace **evolution** of a team
3. Distinguish between teams with low complexity, where **communication stabilises** (frequency, media and types), and teams of low complexity with no such stabilisation.
4. Expect additional **coordination needs** in high complexity teams, and be able to address them with ICTs (emails, blackboard, intranet etc)

Future research agenda

Agent-based modelling using individual researchers as agents, and starting from known rules of behaviour (e.g. motivation to collaborate with renowned scientists) could explore how **interactions at the local level bring about team-level phenomena** (How does research evaluation at the local context shape team productivity?), and **how contextual developments can influence research teams** (e.g. How do new funding mechanisms influence task allocation in teams?). Data from thick descriptions could help **calibrate** it.

ARIMA: multivariate analysis at the team level;

How is socio-emotional communication linked with coordination?

To what extent do conflicts affect productivity?

A team is more than the sum of its researchers

As collaboration among researchers is increasing, and governance structures become the bottleneck, understanding research teams as complex systems, which are more than the sum of their parts, which connect to their environment through their porous boundary, which emerge from the local interactions between researchers, which strive to achieve their aims, and maintain themselves as systems, provides a unique advantage.