From Small World to Hierarchic Business Information Networks by Reorganizations – A Real World Study of a Failure

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Abstract:

Business units in large enterprizes are frequently objects of reorganizations. These change the social network of the unit, expressed by the flow of information between the employees that is necessary for performing business processes. Reorganizations usually intend to increase the efficiency of the unit, measured in terms of the speed of business processes performed by the unit. We take a real-world example and investigate the change of the information-flow induced by a reorganization that transformed a small-world type into a hierarchical type network. We show that the robustness, determined in terms of how the business processes are affected by an outage of nodes in the information-flow, is a critical parameter that tends to counteract the intended gain in efficiency. The example demonstrates that reorganizations should not only focus efficiency in terms of classical business studies, but should include an analysis of the robustness of the information-flow network within a business unit as well. Otherwise, theoretically expected gain in efficiency may not be achievable in practice.

Key Words: Reorganization, business unit, information flow, small world network

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1 Introduction

Large companies perform business processes within specified organizational units – business units – in order to create products that are supplied to the market. The business processes are mapped to the units such that the organizational structure of the business unit optimizes production. This optimization of the organizational structure of companies through reorganizations is a primary task of managers [4]. Reorganizations may be driven by external causes, for example due to changed market conditions, or by internal causes, for example due to a reorientation of the strategy of the company. The classic measure to evaluate the effectiveness of a reorganization is efficiency in terms of the time needed to perform business processes [8]. Customarily, the organizational structure of the business unit is grasped by the organization chart, where several different forms can be distinguished (e.g. line organization or matrix organization) [6]. The coaction of the steps associated with a business process is described by the operational structure – e.g. in the form of a flow chart. Usually, a business unit performs more than one business process. The task of the manager is then to find a organizational structure that can be mapped in an optimal way to the different operational structures. A *reorganization* can then be defined as an adaptation of the organizational structure to a new set of operational structures.

In recent times, the sociology of economic systems is increasingly investigated from the perspective of social networks [10]. This perspective emphasizes the importance of the informal structure of business units, expressed by the information flow (e-mails, informal talks etc.) between the members of such a unit. The informal network has a history in the sense that the personality of the individuals involved lead to implicit optimizations of the operational structure that may not be recognized by members of the senior management. This makes reorganizations a challenging task, as they may influence the social network of business units in an unforeseen way [7]. We investigate this phenomenon in a real world example, a reorganization of a business unit of a Swiss IT company [3]. We characterize the social network of the business unit by the "officially approved" information flow associated with the performance of business processes, basically reflecting the operational structure. Our case study focuses a typical example of a top-down-reorganization, intending to map business processes on more explicitly defined sub-units within the business unit. In this way, the (theoretical) analysis promised a more efficient handling of the individual business processes. In reality, however, a large increase of process runtime was observed, even well after the reorganization has been implemented. We explain one possible reason for this phenomenon by introducing the term of robustness of a business unit, that measures the probability of business process interruption as a function of node-outage. We will proceed in three steps: First, we explain the basic concepts in a toy model. Second, we outline the reorganization of the business unit by demonstrating, how the type of the social network changed from a small world into a hierarchic business information network. Third, we calculate the robustness of the network for a specific project management process that is performed by the unit. We conclude by recapitulating the interrelation between efficiency and robustness for real world business units.

2 Toy Example

We define the main concepts and symbols used in this contribution as follows:

- *Social network:* A network of employees (nodes), where the edges represent information transfer that is associated with the performance of a business process.
- *Business process* P: A sequence $\{p_1 \dots p_n\}$ of n processing steps associated with a specific product.
- *Business unit* $B(k)$: A social network of k nodes associated with a class of business processes.
- *Process unit* B_{p_i}: The part of B that performs processing step p_i.
- *Process operating expense* $E_P = \sum_i e(p_i)$: The sum of the times $e(p_i)$, associated which each p_i, needed to perform P.
- *Process runtime* T_P: The total time from initiation to completion of P.
- *Robustness* $R(l)$: Defined as $R(l) = 1 - I_P(l)$, where $I_P(l)$ is the probability of process interruption in dependence of the relative fraction of node outage of a business unit B (l/k, where l is the number of nodes that turned out).

Note that we distinguish E_P and T_P, because employees can be absent (due to illness etc.), possibly leading to an interruption of P if no redundance is implemented in the network. T_P is an estimate of the efficiency of P. We have $T_P \geq E_P$, as a temporary outage of a B_{p_i} increases T_P. Thus, T_P also accounts for the robustness of the network.

Robustness refers to the ability of a network to avoid malfunctioning when a fraction of its constituents is damaged [2]. The problem can be encountered in two different ways: *Static robustness* refers to the influence of deleting nodes without redistribution of information flow. *Dynamical robustness* takes the latter into account. In our case, dynamic robustness is related to the informal networks that are formed in the business unit *within the boundaries given by the organizational chart.* In other words, dynamical robustness is usually given only *within* a process unit B_{p_i} that is formed by a sub-set of employees

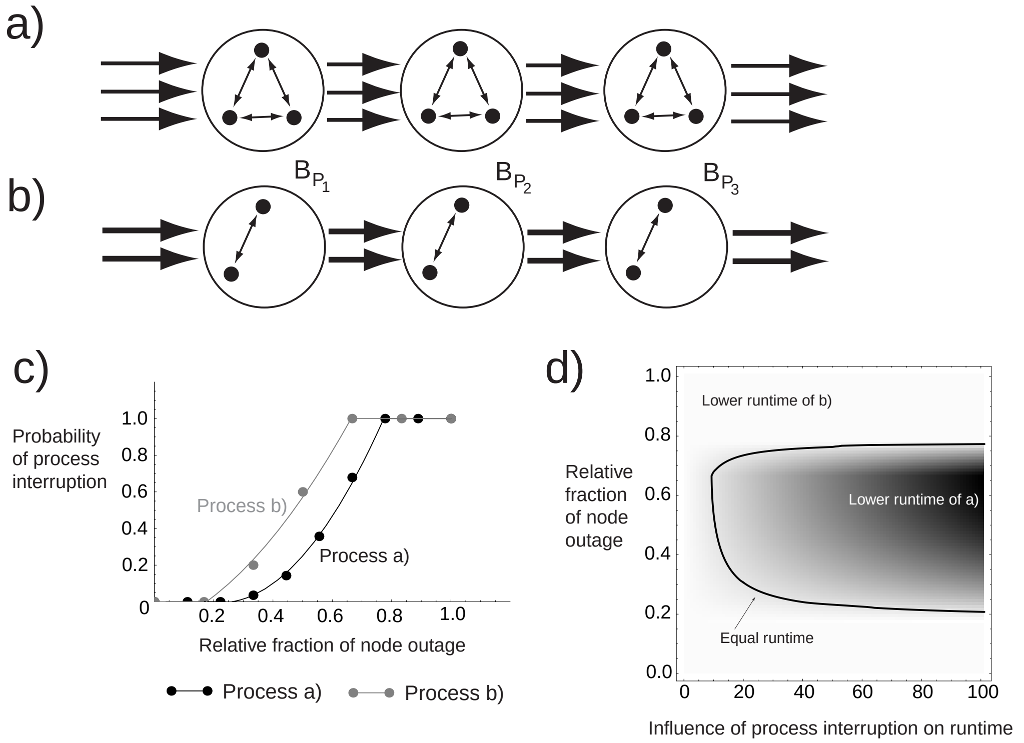

Figure 1: a) Three business processes P incorporated in a business unit B consisting of three process units B_{P_i} of three employees each. b) B after reorganization: the number of business processes has been reduced from three to two and in each B_{P_i} an employee has been released. c) Robustness before and after reorganization for a single P. The increase of interruption probability (= decrease of R) is approximated by quadratic fit-functions. d) Process runtime in dependence of the weight of process interruption and the relative fraction of node outage (the darker region identifies the parameter space where P in the organizational structure of a) is processed faster compared to the structure of b).

of the business unit. We then calculate the robustness of our business unit as the static robustness of the network of process units. This probability is calculated according to the hypergeometric distribution. We consider each process unit (r members) in a business unit (k members) separately. We have to calculate the probability that from a number l of nodes that fail in the network those x nodes fail that interrupt the process. As $x = r$ in our case (i.e. the complete process unit has to fail), the effect of a single B_{p_i} on the probability of process interruption caused by an outage of l nodes is calculated as

$$I_{B_{p_i}}(l) = \frac{\binom{r}{x}\binom{k-r}{l-x}}{\binom{k}{l}} \stackrel{x=r}{=} \frac{\binom{k-r}{l-r}}{\binom{k}{l}} \tag{1}$$

$I_{B_{p_i}}(l)$ is calculated for all l up to a value where at least one B_{p_i} fails definitely (i.e. the probability of process interruption is one – this depends on the network topology) and for all B_{p_i}. Basically, $I_P(l) = \sum_n I_{B_{p_i}}(l)$ applies – but one has to take into account that specific constellations of node-outage may possibly be counted twice (this, again, depends on the network topology). These cases have to be identified and incorporated when calculating $I_P(l)$. In this way one obtains – for each given $l = 1 \dots n$ – the probability of process interruption $I_P(l)$ and thus the robustness $R(l)$. Due to the dependence of R on the network topology, no general analytic formula for $R(l)$ can be provided

The robustness alone does not account for the relevance of process interruption for process runtime. For example, longer downtime of a node may have cumulative effects on runtime. To model this effect in a simple way, we weight the probability of process interruption by a factor that accounts for the additional time that prolongs process runtime. By changing this weighting factor we can assess the parameter space spanned by this factor and the relative fraction of node outage.

To demonstrate our approach, we investigate a reorganization in a toy example intending to concentrate B on its core business, by reducing the number of P from three to two and by releasing one employee in each B_{p_i} (Fig. 1.a/b). We assume that $e(p_i)$ for a specific P is reduced from 3 to 2, as the number of p_i that have to be processed in parallel by each B_{p_i} decreased, which reduces friction losses. Thus E_P decreases from 9 to 6. However, when the decrease of robustness of the social network (Fig. 1.c) is taken into account, depending on the weight of process interruption, the reorganized B may be less efficient than before (Fig. 1.d). In the bright region of parameter space, the business process in the organizational structure b) is better in terms of efficiency, whereas in the darker region, the process performed in structure a) is superior to b).

3 Business Reorganization

We investigate the IT division of a Swiss telecommunication company (the division had 1400/1250 employees before/after reorganization) that develops products for telecommunication and insurance companies. We focus on an business unit within this division. Before reorganization, B (23 employees) was organized as profit center and acted autonomously on the marked in terms of client relations, budgeting and accounting (mean

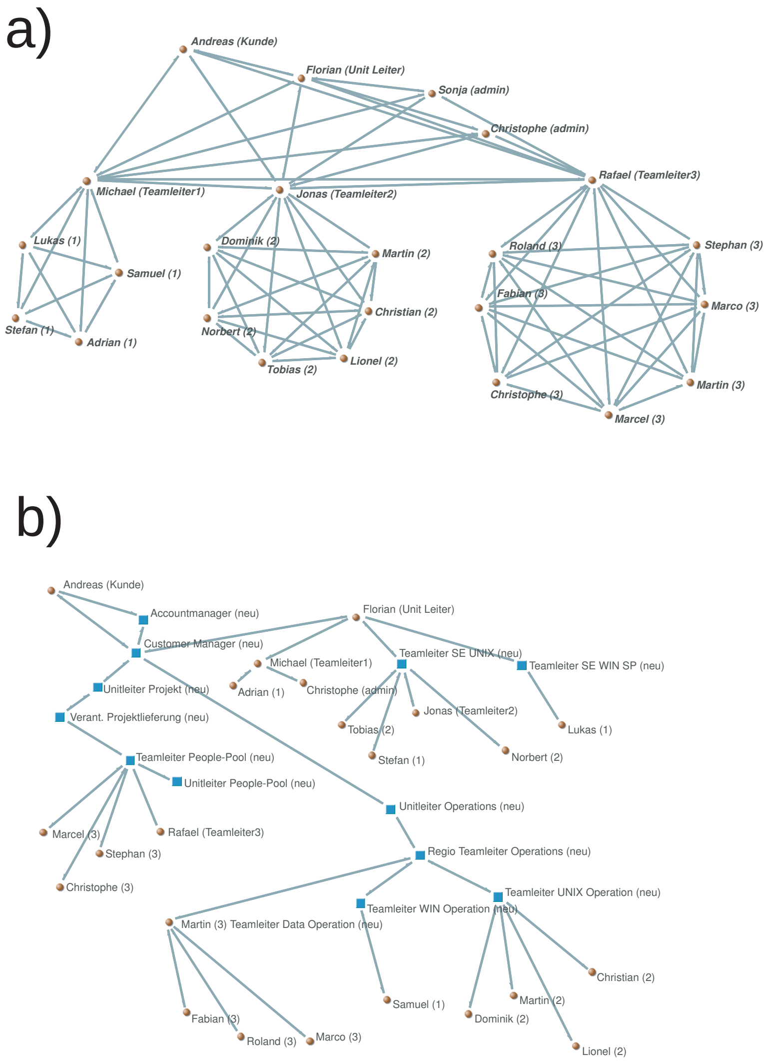

Figure 2: Social network of a business unit before (a) and after (b) reorganization. Quadratic nodes in b) indicate new members of B. The names are fictive due to privacy issues. We used the freeware tool AGNA for network analysis [1].

turnover: 16.5 Mio. CHF, profit: 2 Mio. CHF). Four classes of P were performed by the unit: project management, application development, operations and maintenance of IT services. When investigating the information flow network, this large degree of autonomy of the unit led to a small-world social network (low characteristic path length and high clustering coefficient [9]), with three main B_{p_i} emerging (Fig. 2.a).

The reorganization, performed in 2002/2003, intended to separate the different P more clearly and to map them on more precisely defined B_{p_i} in order to increase efficiency in terms of E and T_P. Furthermore, the reorganization aimed to increase the control on the beforehand more autonomously acting business units, as competition between the units within the division sometimes led to the situation, that external customers obtained different tenders for the same product and could choose for the best solution within the division. Thus, after the reorganization, the information flow was much stronger restricted compared to the situation before reorganization, leading to a hierarchical type social network (Fig. 2.b). Just by looking at the two graphs it is apparent, that the characteristic path length is much longer in b) compared to a) and that the clustering coefficient in b) is much smaller (i.e. close to zero) compared to a) – the network changed from a small world type to a more hierarchical type.

Day-to-day experiences of the employees of B aroused the suspicion that T_P increased significantly after reorganization. We investigated this phenomenon for several classes of P performed by the unit by determining E and T_P empirically [7]. Although both parameters could not be measured precisely due to comparability issues, valuable estimations could be gained. In the following, we focus on project management processes, where the most trusted results have been obtained.

4 Results for a Project Management Process

Project management processes are performed according to general procedures. In the IT company we investigated, the procedure emerged out of the so-called Hermes-method – a standard procedure that has been implemented in the late 1970s in the large public enterprizes of Switzerland [5]. This widely distributed standard has been used by the business unit before and after reorganization, so that basic comparability is given. One task of the unit was to develop tender offers for large IT projects. Whereas realization and implementation of such projects largely depend on the individual character of each project, the tender phase was much more uniform, allowing to compare process operating expense

	E_P	T_P
Before reorganization	88 hours	19 days
After reorganization	86 hours	35 days

Table 1: Mean process operating expense E and process runtime T_P before and after reorganization for a project management process.

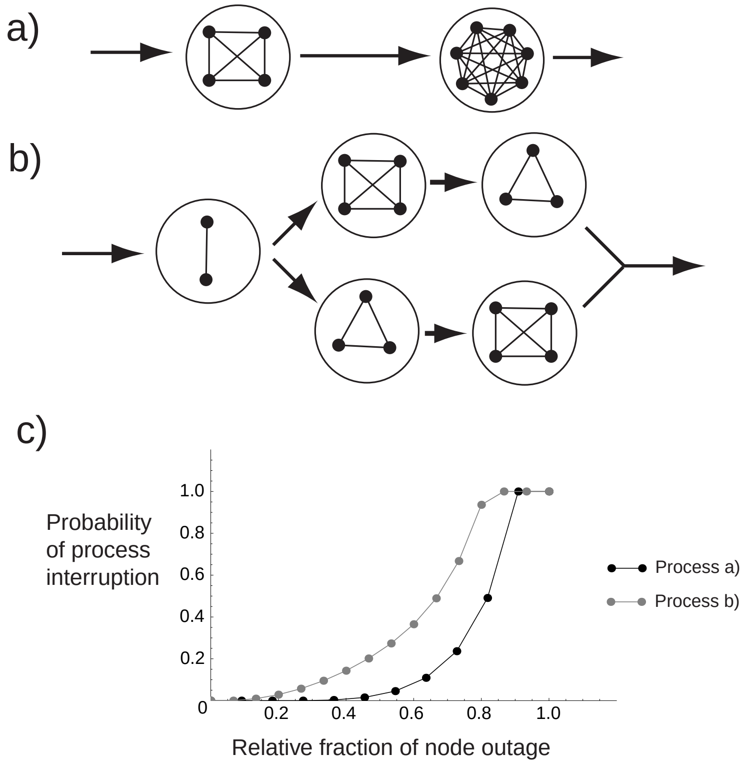

Figure 3: Project management process before (a) and after (b) reorganization of the business unit performing a project management process. c) Decreased robustness of the network after reorganization (grey) that elucidates the empirically measured decrease in process runtime.

and process runtime before and after reorganization. In the following, we concentrate on the result – the details of the measurement process are outlined in Ref. [3].

We find that, in the mean, E_P slightly decreased after reorganization, whereas T_P considerably increased (Table I) – confirming the general impression of the employees that T_P increased significantly after reorganization.

This observation becomes explicable when determining the change in robustness of the social network (Fig. 3). Before reorganization, basically two B_{p_i} with in total 11 employees were involved in the process. After reorganization, the project management process was separated into a system engineering branch and an application development branch, where five B_{p_i} with in total 16 employees were involved. As Fig. 3 demonstrates, the project management process after reorganization is much less robust compared to the process before reorganization. Interestingly, even the larger number of employees involved in the process after reorganization (16 instead of 11) does not increase the robustness –

independent whether the relative fraction of node outage or the absolut number of turned out nodes is taken as reference (x-axis). Not until nine turned out nodes will the process before reorganization outperform the process after reorganization in terms of robustness (graph not shown).

5 Summary and Outlook

We have shown that robustness, determined in terms of how business processes are affected by an outage of nodes in the information-flow, can be a critical parameter that tends to counteract the intended gain in efficiency by reorganizations. The example demonstrates that reorganizations that focus on efficiency by optimizing the division of labor may have the effect, that the network looses small-world properties in terms of information flow networks associated with business processes. Although we have to admit that our analysis did not include a complete survey of other aspects that may have influenced process runtime (e.g. sustained opposition against the reorganization by the employees), we propose that reorganizations should include an analysis of the robustness of the information-flow network within a business unit. In our real world example, the management acknowledged, after some time, the negative effects of the reorganization by pooling separated process units and thus by increasing the robustness of the information flow network, that underlies business processes.

Acknowledgments

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References

[1] Agna: freeware application designed for social network analysis, sociometry and sequential analysis. (e-print `http://www.geocities.com/imbenta/agna/`).

[2] Boccaletti S., V. Latora, Y. Moreno, M. Cavez, & D.-H. Hwang, 2006, Complex Networks: Structure and Dynamics, *Physics Report* **424**(4/5), 175–308.

[3] Bongard, G., 2005, *Der Einfluss von Reorganisationen auf Robustheit und Effizienz von Business-Einheiten* (Master Thesis, Donau Universität Krems, Austria).

[4] Burgstahler, H., 2004, Change Management in Organisationen, (e-print www.burgstahler.biz).

[5] Hermes: an open standard within Swiss public administration (e-print http://www.hermes.admin.ch/internet/hermes/hermes/index.html?lang=de).

[6] Kosiol E., 1968, *Einführung in die Betriebswirtschaftslehre* (Gabler, Wiesbaden).

[7] Sydow J. (ed.), 2003, *Management von Netzwerkorganisationen* (Gabler, Wiesbaden).

[8] Thommen J.-P., 2000, *Managementorientierte Betriebswirtschaftslehre* (Versus, Zürich).

[9] Watts D.J., & S.H. Strogatz, 1998, Collective Dynamics of 'small world' networks, *Nature* **393**, 440–442.

[10] Weyer J., 2000, *Soziale Netzwerke* (Oldenbourg Verlag, München).