EARNINGS VERSUS INNOVATION; MEASURING ARCHITECTURAL COMPETENCIES

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Abstract – **Managers in high tech industries often face decisions with the trade-off between increasing operating profits now and investing in innovation in order to allow for profits in the future. We report the case of telephony business unit, which currently sees the convergence of traditional telephony with Internet. Literature suggests that in such situations of innovation on the level of the product architectures success and survival of the incumbent firm depend on their embedded architectural competencies. We propose that architectural competencies can be measured using business process level accounting figures. We illustrate our proposal to operationalize the concept of 'architectural competence' with observation of the effects changing accounting standards in a telecom business unit.**

I. INTRODUCTION

This paper is instigated from the recent listing of the German engineering group Siemens at the NYSE and its associated change from German to American accounting standards (US-GAAP). As we will explore, the new accounting standards have strong impact on external and internal performance criteria for the entire company, its business units, as well as for individual managers. Siemens' NYSE listing took place on October 1st, 2000, while we were studying a business transformation process in one of the business units. In the first two reporting quarters we witnessed the uncertainty of the business unit management and the ups and downs of their company internal perception of their performance.

The objective of this paper is to make explicit that - among other changes - the new accounting standards bring about a shift from more sales-based performance measurement to earning-based performance measurement under US-GAAP. We further focus our interest in this paper on the impact that the changed accounting system has on innovation and new business development. Innovation is difficult to accommodate in any accounting system. This case of a business unit in the telecom industries seems particularly enlightening, because it faces a period of disruptive technological and business changes in its environment.

Innovation is associated with investments on the level of product components as well as on the level of their integration into product architecture [4]. In times of disruptive change numerous radical component innovations emerge with high frequency and are mostly driven by new firms. However, in order to create economic impact such components often need to be integrated into radically new product architectures, in this case for example Internet telephones (VoIP, Voice over Internet Protocol). Incumbents like Siemens would have the advantage of the necessary size and experience to drive such radical economic innovation; however at the same time they face the challenge of overcoming outdated believes in their long-standing organizations as well as existing management systems. In a nutshell, it is not per se decided whether incumbents or new entrants win this innovation competition. Hendersson and Cockburn [6] attribute success or failure to the availability of 'architectural competencies' in the incumbent's organization.

If it were true that architectural competencies lead to competitive advantage in times of disruptive change, it would be equally interesting for academics as for management to be able to observe architectural competencies and predict future business performance. Literature suggests that architectural competencies include the organizational architecture [10], managerial systems [9], dynamic capabilities [3,12,13] and combinative capabilities [8]. However, these conceptual explanations do not yet provide operational measures for larger empirical studies.

Our observation suggest that in comparison to sales-based accounting, earning-based accounting figures give a clearer measurement of the existence of architectural competencies in industries that face a period of disruptive technological change. Earnings are a firm-level performance measure. However, direct costs reduce Earnings before Interest, Tax, Depreciation and Amortization (EBITDA). Earnings, therefore, will increase if the organization is able to quickly integrate component competencies, such as knowledge and skills, or technical systems into firm-level solutions.

We adopt a competence-based perspective of the firm for our analysis and contribute to the academic community a way to operationalize the measurement of organizational competencies through using accounting data. In doing so, we hope to make more empirical work possible, which still is at a preliminary stage [6].

To management practice this paper intends to contribute experience of a transitional situation that other growing firms in the globalized economy will face in the same situation. This will become even more relevant for European firms, when the already for the year 2006 announced Europe-wide accounting standard IAS will be enforced.

The remainder of the paper is structured as follows: based on a theoretical framework presenting a competence-based view of the firm we describe the nature of architectural competencies. From this framework we derive a model of resource and earning measures on a product and operational process level in order to determine the level of architectural competence for a firm. We illustrate our arguments with a longitudinal study.

II. THEORETICAL FRAMEWORK

A. Architectural Innovations

High-technology industries show patterns of alternating periods of incremental innovation and subsequent dominant designs, and periods of radical change. The difference between radical and incremental change is well established. New technologies for example change the existing knowledge base in the industry. Incremental innovation extends existing knowledge and therefore sees incumbents in a favorable competitive position. Radical innovation on the other hand contradicts existing knowledge and consequently sees new entrants to the industry in a favorable position that do not have to overcome the outdated knowledge. In some cases, however, new products can be assembled from existing components that qualify as radical innovation, despite the incremental innovation on the component level. Organizations often face this architectural innovation [1,2] with limited ability to react due to limited financial or managerial means.

The challenge of architectural innovation is the changing links and coordination on the product level. In the case of VoIP, for example, transmission without time delay is essential for good audio quality, but is less crucial in the transmission of text or graphics of an Internet web page. Several studies have extended the concept of architectural innovations by examining on which level the innovation occurs in a product. At the core of this research stream is the notion that, while firms may possess or could develop the competencies required to develop a new product architecture, they often fail to recognize the way in which organizational competencies must be reconfigured to successfully sustain it on a business level. Existing organizational structures and routines operate to preserve current component linkages and thus raise cognitive barriers to the development of new architectures [5,11]. In short, in the case of architectural innovation it is much less clear-cut whether incumbents or new entrants are in strategically favorable position.

B. Architectural Competencies

We take a competence-based view of the firm to identify what organizations require in order to deal with architectural innovation. Organizational competencies are acknowledged as a source of sustainable competitive advantage to firms [10]. For the purpose of our paper we distinguish between component competencies and architectural competencies.

Component competencies are characterized by a firms local abilities and knowledge fundamental to the day-to-day problem solving. This can be tacit knowledge developed by skilled engineers [9]. Such local capabilities can provide a firm with a competitive advantage, though limited to the life cycle of the component specific innovation. Component competencies are therefore related to component innovations that can either be incremental (better component) or radical (new component).

Architectural competence basically refers to the ability to acquire and use component competencies for integration in new products and solutions [6]. Architectural competencies thus become visible in time of architectural innovation, when component knowledge within the firm or from other firms in the industry needs to be reconfigured. The telecom industry in our eyes is a good laboratory to study architectural innovation. It is in a phase of disruptive change, where there is a high frequency of

component innovations, combined with a limited time frame for the development and exploitation of new products and solutions.

Architectural innovation is an effect on the level of the product and the changes needed on the organizational level on the other side. For our purpose it is useful to distinguish the achieved degrees of architectural integration at each given point in time and for each product. This 'static' part of architectural competence has been referred to as architectural knowledge [4], managerial systems and values [9], or organizational architecture [10] and describes problem-solving strategies, coordination and communication channels between different units in the organization. Business processes are being designed in many organizations to enhance organization-wide integration and therefore seem to us a useful proxy for architectural integration, especially where accounting systems have been adapted to them.

Complementary to architectural integration are dynamic capabilities, which is the organizational competence of creating architectural innovation. This is the ability to re-deploy existing knowledge [7,8], the ability to systematically update routines dynamically, or simply dynamic capabilities [3,12,13]. Hence a measure of dynamic capability on a business unit level can be derived from comparing measures of achieved architectural integration over time.

C. Measuring Architectural Integration and Dynamic Capabilities

The next step in developing a measurement model for architectural competencies is to allocate specific parameters to both the level of architectural integration as well as the relative dynamic capability level.

The apprehension that the level of architectural integration can be measured by looking at the operational processes and product level allows to further precise the parameters of this model. We take the stance that the ability to co-ordinate, build, and recombine operational processes, is the key for determining the level of architectural integration. Measuring the process resource allocation to a specific product determines the marginal direct process costs as part of the EBITDA of a specific product.

Products can be measured in terms of costs of the resources allocated to the specific processes used for a specific product over a specific point in time. If R_1 is the resource cost allocation to process 1 as a percentage of the total resources, at a certain point in time (t), and the process portfolio has n processes than the total resource allocation to product i can be described as:

$$R_{producti}(t) = R_1(t) + R_2(t) + R_3(t) + \ldots + R_n(t)$$

The total process resource allocation can be equally measured for all products. Now the total resources used for all products should equal 1 (since we take a relative measure in percentages). If a product portfolio has n products, this can be described as:

$$R_{product1}(t) + R_{product1}(t) + \ldots + R_{productn}(t) = 1$$

Using these measures in conjunction with the specific earnings (before interest, tax, depreciation and amortization - EBITDA) of a product over a certain time period (t), it is possible to make statements concerning the level of architectural integration, for each of the products.

What could be expected is that in cases of older more established products, architectural integration is better than in cases of 'newer' or innovative architectures. This should be reflected in the process resources allocated to these 'older' products, which should be lower in comparison to 'newer' products. Good integration should show low process resource allocation costs, associated with high EBITDA. Alternatively for 'newer' products the resource cost allocation will be higher (more effort is needed for these products), whilst EBITDA will be lower (the overall earnings will not be as good as for the established products). Hence the degree of architectural integration is expected to be lower in cases of innovations in comparison to more established products.

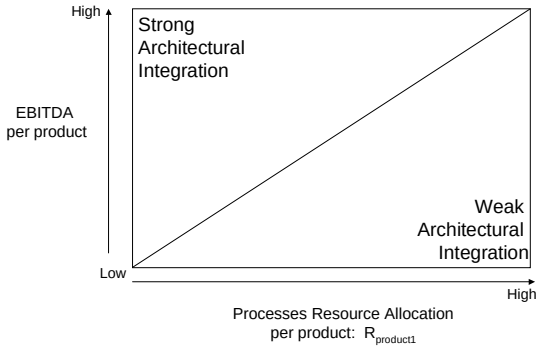

Table 1: Scale for Architectural Innovation

The above assumptions define various levels of architectural innovation per product, and relate to the

static components of the concept of architectural competence. This status, however, is only an indirect measure for dynamic capabilities of the business unit, or how good the unit is in changing the business to support architectural integration.

Improvements of architectural integration over time are the effect of dynamic capabilities. The specific measure can be defined as a proxy for the dynamic capability of the firm. This relates to how well the organizations can reconfigure and change their process base, and therefore decrease their resource allocation to the processes of a particular product as part of the EBITDA. In order to determine the level of dynamic capability of the firm it could be expected that innovative products show stronger effect of dynamic capabilities. The evaluation of a firm's dynamic capability based on the relative increase of EBITDA of the innovations (innov) and the relative decrease of the process cost allocations. This can be described as:

$$\Delta R_{innov1} = R_{innov1}(t) - R_{innov1}(t+1)$$

and

$$\Delta EBITDA_{innov} = EBITDA_{innov1}(t+1) - EBITDA_{innov}(t)$$

An organization with strong dynamic capabilities should show for innovations, rapidly decreasing resource allocations to the products processes ($\Delta R_{innovation1}$) and increasing product EBITDA ($\Delta EBITDA_{innovation1}$) within a short period of time.

In order to draw conclusion on data describing dynamic effects, of course longitudinal studies are necessary. The effectivity of the firm's dynamic capability can be derived from changes of architectural integration over a time series measurement (for example measured monthly, over a period of 6 months time). We expect measures to be positive or negative. Positive measures would show that the firm's dynamic capability is stronger than the competitive necessity from the changes in the industry. Negative measures would indicate that the organization is loosing ground.

Organizational competencies need time to develop. Based on this information a firm can develop statistical prognoses on whether or not it a certain innovation will be successful for the firm. Our model provides information based on its product architecture (knowledge) its architectural integration, its operational process architecture, resulting in a measure for the embedded dynamic capabilities of the firm, how quick the firm will be able to adapt its architecture in order to predict its EBITDA in a certain period.

When this information is set off against other management information such as the expected life cycle of the innovation and the market expectations, decisions can be made in the range of make or buy, investments in resources and capabilities and pre-investments for future innovations. The model provides complementary measures for a firm in order to determine its architectural competencies.

Furthermore, it has to be noted that the measures from this model can only be used in a specific industry, for the changes in the market and customer requirements define the level of architectural competency a firm should possess in order to compete in this market.

III. Architectural Competence measured at Siemens

The model is developed instigated on a longitudinal study at a business unit of Siemens, which subsequently provides a first illustration of how the model can be put to practice.

A. Background Siemens Enterprise Networks.

Siemens Switzerland head office is located in Zürich and employs 3900 people. The annual turnover of Siemens Switzerland is 1.1 Billion Euro, with the Enterprise Networks department accounting for an annual turnover in 1999 of 160 Million Euro. The Enterprise Networks department employs approx. 350 people. The department provides tailor made information and communication solutions are in 5 major areas: Voice networks, Data Networks, Application (Hardware and Software) Services, and recently Converged Networks (Voice over Data Networks).

At the beginning of 1998, the telecommunication market was opened up to competition. A normal effect of privatization is that besides Swisscom, the Swiss incumbent, new operators enter the market, bringing previously high telecommunication prices for households and enterprises down. Especially taken into account the dropped earnings on products, the liberalization increased the turbulent nature of the local market drastically.

In addition an internal analysis of the average product life cycle for innovations in the telcom industry showed a profound change in the pattern of innovation. Based on the 1995 figures, this curve shows a product life cycle of 3 years, with investments of approx. 10 million Euro per product. Compared with the 1995 curve, in 2000 the market-

life cycle has shortened to 9 months, and the required pre-investments have more than doubled. It became clear that the division had to be able to quickly switch from innovation to innovation, rather than to rely on cash cows.

B. EBIT orientation

The globalization drive of the holding company resulted in the listing of Siemens on the NYSE. Subsequently financial reporting had to be converted from the German GAAP to US GAAP. This implied a change from turnover oriented reporting, to EBIT reporting. While Turnover reports volumes, EBIT is based on margins. Sales revenues are diminished by the process cost and therefore link revenue growth with process efficiency gains. In several press releases von Pierer, the CEO of Siemens Group made it clear that improvement of profitability is top priority.

Consequently the targets for the local businesses changed and new EBIT margin targets have been set. The EBIT margin targets are in the range of a 20% increase per annum from operations.

C. Innovations: Components and Architectures

From an innovation point of view, complexity of the products of the department increased dramatically. The traditional component innovations such as the PBX, Internet, ATM etc. showed a high frequency. In addition the mixture of these component became more and more important. Telephone networks and IP-based networks and the stronger penetration of applications increased complexity, which became visible in converged products where Voice is digitally routed over Data networks such as Internet Protocol (VoIP) and ATM. These typical architectural innovations led to the increased importance of architectural competencies of the business unit.

D. Architectural Integration

Turbulence in both, the environment and the innovation pattern, required changes in the process architecture of the organizations. The operational processes previously geared up to support the PBX business did not support the new architectural innovations.

In order to cope with these challenges management decided to embark on a department wide effort to get a new level of architectural integration. Hence the department introduced a new and process framework in order to support innovations such as Voice over IP. The re-deployment of architectural knowledge within the department required a flexible coordination mechanism, which allowed for the integration of new processes. In short, the mechanism allowed for new architectural innovations and subsequent processes to be integrated in the main operational processes of the company, based on rational, internal market decisions, trading architectural knowledge (innovators) against operational result (sales).

We have observed this as a combinative capability to rapidly integrate new operating processes as a result of new architectural innovations. However, management realized that only changing the processes was not enough.

E. Measurement control systems

The department introduced a new management information system that measured the detailed process and product performance. Through a monthly inquiry to all staff, resources where divided over the process and product portfolio. Hence, the allocation of the resources became visible.

In addition the system integrated strategic information from the administrative systems and marketing databases. By doing so the department could re-allocate the resources to the products and processes required. Furthermore the monthly measurements provided valuable information on product and process performance. This information can subsequently been evaluated to initiate new process changes. This managerial system added considerably in the mentality of both staff and management to change. We have interpreted this as the development and deployment of dynamic capabilities within the firm.

F. Architectural Competencies at Siemens

All these elements put together, including the concrete measurements towards ongoing developments on both organizational architectural level as well as the process and resource allocation level resulted in emerging architectural competencies. The necessity to invest in, what we interpret to be, architectural competencies became visible to the organization by their ability to better predict process and product performance based on prognoses in sales and marketing, and resource consumption of the underlying process portfolio. Subsequently, strategic direction and change initiatives were guided based on future insights rather than mere past data.

Driven by the globalization drive of the holding company, the EBITDA focus enabled them to deliver the real time reporting of the processes for each business and allowed managers to act upon this information. The system contributed considerably for

the management to reach the new EBIT targets. The capability to transform the business rapidly enhanced quick decision making and choosing which businesses and opportunities would be most profitable in the coming months, and what this implied for the architectural structure of the business.

After an intensive period of change, the department was able to come in on target set by the board, where other similar departments were not. The success of the approach and the organizational impact were apparent, and are currently under further development.

This can be interpreted as clear an illustration of the how the measurement of architectural competencies can effect the overall business performance. Managers have been able to use these new measures to enhance the architectural integration of the business, introducing innovations in the portfolio but remaining on target in terms of EBITDA performance.

IV. Conclusion

To conclude we have found architectural competencies are essential to organizations that deal with a wide range of concurrent product architectures. In order to change the organizational architecture to support such new innovations we have seen that measurements that move to the level of product and processes make the level of architectural integration visible, and allows predictions and subsequent improvement actions in real-time.

Furthermore we have observed that an earnings oriented measures are a good proxy for dynamic capabilities. By evaluating the measures of product specific process resource allocation against the EBITDA of these products as a series of measures over a period of time indicates the relative dynamic capabilities embedded in the organization. These measures are however relative to a particular industry for the industry and its environment drive the architectural integration requirements.

Finally we have seen that such measures only become relevant when taken over a longitudinal study. The measures need to be compared with measures of the past in order to make predictions and judgements on future requirements.

The model suggested in this paper provides a first attempt to operationalize the concept of architectural competencies. Further empirical research is required in order to study the potential results of the measurements. In addition further research should focus on multiple longitudinal studies in order to enhance the model and establish industry specific parameters for dynamic capabilities.

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VI. References

[1] Clark, Kim B. (1985), The interaction of design hierarchies and market concepts in technological evolution„ Research Policy, 14, 235-251

[2] Christensen, Clayton M., and Richard S. Rosenbloom (1995), Explaining the attacker’s advantage: technological paradigms, organizational dynamics, and the value network, Research Policy, 24, 233-257

[3] Eisenhardt, K. M., Martin, J. A. (2000), *Dynamic Capabilities - What are they?*, Strategic Management Journal, 21 (Nov/Dec), 1105-1121

[4] Henderson, R., Clark, K. B. (1990), *Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms*, ASQ, 35, 9-31.

[5] Henderson, R. (1993), Underinvestment and incompetence as responses to radical innovation: evidence from the photolithographic alignment equipment industry, RAND Journal of Economics, 24 (2), 248-270.

[6] Henderson, R. and Cockburn, I. (2000), *Measuring Competence? Exploring Firm Effects in Drug Discovery*, in “The Nature and Dynamic of Organizational Capabilities” , G. Dosi, R.R. Nelson, S.G. Winter eds., Oxford University Press

[7] Itami, H., Roehl, Thomas W. (1987), *Mobilizing Invisble Assets*, Cambridge, Harvard University Press.

[8] Kogut, B., Zander, U. (1992), *Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology*, Organization Studies, 3, 383-397.

[9] Leonard-Barton, D. (1995), Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation, Boston (MA), Harvard Press.

[10] Nelson, R.R. (1991), Why do firms differ, and how does it matter?, Strategic Management Journal (12), 61-74.

[11] Nelson, R. R., Winter, S. G. (1982), An Evolutionary Theory of Economic Change, Cambridge (MA), The Belknap Press of Harvard University Press.

[12] Teece, D. J., Pisano, Gary (1994), The dynamic capabilities of firms: An introduction, Industrial and Corporate Change, 3 (3), 537-556.

[13] Zollo, M., Winter, S.G. (1999), From organizational routines to dynamic capabilities, INSEAD Working paper series, 99/48/SM.