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### Customization and problem solving - strategic consequences from a competence perspective

In technologically intensive industries among OECD countries during the 1990s, the share within international trade of medium-high and high technology industries increased from 18 to 25 per cent. Knowledge intensive services have emerged as an industry contributing 15 per cent of the business value added in OECD countries.<sup>1</sup> Thus, within the developed economies, technology intensiveness and tasks performed by highly skilled workers are key characteristics of economic development. The importance of technology in association with highly skilled workers can be illustrated for instance by the way that the position of engineers and scientists are related to technology. Approximately 30 per cent of the employment of this group can be attributed to technological change<sup>2</sup> and engineers and scientists can be labeled as knowledge workers<sup>3</sup> and as professionals<sup>4</sup>.

Highly skilled workers is a category that may include the categories of knowledge workers and professionals and often the three are used interchangeably.<sup>5</sup> Highly skilled workers seem to be essential in the production processes of most industries, among them manufacturing<sup>6</sup>. Manufacturing growth can be attributed to human capital, research and, as a consequence, technological change<sup>7</sup>. In turn, manufacturing is a label that can include a wide variety of organizations often classified in association with the output or the type of raw materials that are fundamental in the processes<sup>8</sup>. Similarly as a high degree of technology and highly skilled workers are viewed as increasingly important in general and in the specific area of manufacturing, we find indications of the importance of innovation in manufacturing companies<sup>9</sup>. Innovation as central to achieving economy of scope in manufacturing through flexible systems was predicted by for instance Goldhar<sup>10</sup>. Innovation has in later studies been established to have a positive effect on profitability<sup>11</sup>, and innovation within manufacturing can be seen as stemming from other areas of the business than only within the R&D units<sup>12</sup>. The creation of innovative solutions is increasingly viewed as a process involving activities in many different disciplines, organizations and settings<sup>13</sup>. Of special interest, and importance, is the relationship between innovations and interaction within buyer-seller relationships<sup>14</sup>. In addition, industrial services, that have increased in importance<sup>15</sup>, encompass a wide range of services among them complex problem solving, new product innovation, customization, discretion, distributed location, effectiveness of technology focus, and high requirements on the interpersonal, diagnostic and technical skills of workers, i.e. characteristics of professional services<sup>16</sup>. Furthermore there is also a trend towards integration of goods and services<sup>17</sup> and a trend of similar underlying structural ideas of goods and services<sup>18</sup>.

Windahl et al and Shepherd & Ahmed<sup>19</sup> in their articles emphasize the customer interaction and the requirements on the set of competence areas in association with integrated solutions. Shepherd & Ahmed base their discussions on observations within the computer and electronics sector while Windahl et al extend the ideas into the area of capital-intensive manufacturing. Thus, we may assume that these ideas are relevant to consider for manufacturing firms within the western economical environment. In both of the articles is emphasized the move towards a competence profile consisting of: technical and application

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<sup>1</sup> Parker, 2004 with references to OECD, Science, Technology and Industry Scoreboard: Towards a knowledge based economy, 2001; OECD Science, Technology and Industry Outlook 2002, 2002

<sup>2</sup> Forbes, 1991

<sup>3</sup> C.f. Dove, 1998; Nomikos, 1989; or engineers viewed as knowledge workers in Kim & King, 2004

<sup>4</sup> C.f. Löwendahl, 1997, Bigliardi et al, 2005

<sup>5</sup> C.f. Fuess, 2003; Malott, 1998; White, 1991

<sup>6</sup> Examples on knowledge workers from Canada in Lavoie et al, 2003

<sup>7</sup> Ochoa, 1996; Romer, 1990

<sup>8</sup> OECD, STAN industry list, <http://www.oecd.org/dataoecd/33/19/1830838.htm>, 2005-04-12

<sup>9</sup> Wolff, 2005

<sup>10</sup> Goldhar, 1986

<sup>11</sup> Cefis & Ciccarelli, 2005

<sup>12</sup> Panchak, 2005

<sup>13</sup> Leonard-Barton & Sinha, 1993

<sup>14</sup> Sivadas & Dwyer, 2000; Millson et al, 1996; Roy et al, 2004

<sup>15</sup> C.f. the discussions related to after-sales services in Johansson & Olhager, 2004; Wise & Baumgartner, 1999

<sup>16</sup> Johansson & Olhager, 2004

<sup>17</sup> Johansson & Olhager, 2004

<sup>18</sup> Sanchez, 2002; Anderson & Narus, 2004; Meyer & DeTore, 2000; Meyer & Mugge, 2001

<sup>19</sup> Windahl et al, 2004; Shepherd & Ahmed, 2000

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competence, integration competence, market/business & consulting competence and (customer) partnering competence<sup>20</sup>. Similarly Nyhan states that an overall general competence feature is “the capacity to understand and handle social/organizational and technological complexity in an integrated manner. This kind of worker is able to relate the specific tasks in which he or she is engaged, at any moment in time, to the overall task being carried out by other members of the organization... These attributes were traditionally seen as ones which only management required.”<sup>21</sup> He further specifies this central feature by claiming that it is an integration of four different kinds of competences: Cognitive, technological, business (entrepreneurial) and social (organisational)<sup>22</sup>. Common for these authors is the mentioning of qualities related to consulting/business/entrepreneurial competence and (customer) partnering/social competence, that through their relation to customer interaction and the demands for customization we may associate with firms where highly skilled workers are central, such as professional service firms<sup>23</sup>. In professional service firms competence development is based on the interaction with clients and the learning takes place as a result of the client interaction<sup>24</sup>. But the implications of an increased degree of highly skilled work on competence development in manufacturing organizations are far from obvious. For instance:

- An increasing degree of highly skilled workers in the manufacturing organization may imply organizational and managerial changes. Of interest is for instance the management of knowledge workers in association with innovative activities<sup>25</sup>.
- Some authors have indicated that, in accordance with a continuous view on highly skilled work, it can in manufacturing organizations be attributed to other categories than those associated with a particular educational or professional background. Consequently highly skilled work would permeate all of the business and the tasks of different labourers, although to a varying extent<sup>26</sup>.
- In some studies within manufacturing, services are largely treated as complementary activities, labelled for instance “after sales”, and do not thoroughly include activities that create innovation with the customer, although industrial services and goods are increasingly integrated in the offerings<sup>27</sup>.

A manufacturing organization is closely related to its production and its tangibles, but utilization of qualities such as customer partnering and problem solving, usually associated with highly skilled workers and professional services seems increasingly important. How is a move towards offerings based on an increased utilization of qualities associated with highly skilled workers, in a manufacturing organization, reflected in the competence set of the organization?

### Customization of deliveries

The two in-depth cases in this study are based on two organizational units, being parts of the Trelleborg Group, a global industrial corporation, headquartered in Sweden. Close access is made possible through a research collaboration between the Trelleborg Group and the School of Economics and Management at Lund University, Sweden. Unit RD works towards a specific niche and primarily within a specific industry whereas unit VG works towards a set of niches within several industries, but the most complex deliveries are focused on one specific industry. Both organizations rely on concepts on various levels of specificity that are utilized in order to primarily deliver small series of customized solutions. Each new delivery requires problem solving efforts and the flexibility of the concepts or the subparts utilized. When it comes to manufacturing it is worth noting that the automatization degree is seen as relatively low but that the flexibility is seen as rather high. In VG the distinction between various levels of development i.e. applications development and underlying development is rather clear formally but the underlying development staff is heavily involved in application development through direct project support. In both units technological development is highly customer project driven.

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<sup>20</sup> A combined version of the model developed by Shepherd & Ahmed, 2000 and the model as modified by Windahl et al, 2004

<sup>21</sup> Nyhan, 1998

<sup>22</sup> Nyhan, 1998, p 271

<sup>23</sup> Compare with Liedtka et al, 1997; Löwendahl, 1997

<sup>24</sup> Löwendahl, 1997 and for business services Sivula et al<sup>24</sup>

<sup>25</sup> Compare with Amar, 2004

<sup>26</sup> Cusimano<sup>26</sup>, 1995; Ahanotu, 1998; Estrada, 1995 (In the text I prefer to use highly skilled work instead of the “knowledge work term” as used by the authors referred to in order to be able to include work associated with professional services.)

<sup>27</sup> Johansson & Olhager, 2004; Windahl et al, 2004

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One of the key features of RD and VG is the high degree of professionals and staff not directly related to the production line relative to “blue-collar” workers and consequently the high degree of fixed personnel costs involved in development relative to manufacturing costs. In both firms the idea of cross-functional ways of working seems to be central and it is also important to involve production early in the process or at least in the final stages of development in order to anticipate problems. In RD a prototyping group that may traditionally be classified as “blue-collar” utilizes craftsmanship abilities and problem solving in order to find new solutions and tailored versions of existing concepts for specific customer problems. The prototyping team may then be viewed as attaching to the qualities of highly skilled workers in the sense that they to some extent are central to customer problem solving based on their long-term experiences. Within VG the craftsmanship abilities of the production “line” appeared to be most apparent in the most technologically complex part of the business (which constituted 80% of the revenue). Here delivery relies upon craftsmanship in order to apply the solutions to the customer parts. Thus the deliveries are also physically customized through the mounting. This was referred to as “project manufacturing”, by interviewees. The cross organization way of working is particularly apparent in RD as the unit often needs to deliver a prototype within very short periods of time from the request.

When it comes to sales and marketing this is almost entirely a task of people who have long-term experience of design projects within the organization or in the same business. For both units it appears that a sales and entrepreneurial ability needs to be paired not just with a social character suitable for the interaction with the customers but also with a long term in-depth experience of the technical realities of the business and of the technical problems of the customers, paired with a problem solving ability. Organization RD had performed a development project with the aim of supplying a prototype but no serial delivery. This may indicate the high level of competence within the specific problem area that the organization acts within. For both of the organizations the local presence to the buyers was indicated to be of importance. For organization RD the establishment of sales offices on another geographic market was not unproblematic. One of the reasons appeared to be the lack of direct interaction with production. For VG the local market penetration is high but reaching other geographical markets at a corresponding level has been problematic.

### Problem solving and customer interaction

As Shepherd & Ahmed and Windahl<sup>28</sup> et al conclude, central competence areas when working in a solution oriented fashion are related to problem solving and customer interaction. Problem solving can be said to be depending on the combining of competence, knowledge and information of various types and resident in various sources. As resourcing becomes more open to external acquisition and accessing ideas such as the “extended firm” appear where suppliers and users collaborate more closely<sup>29</sup>. When viewed from a service perspective we can compare such activities with those of a professional service firm considering the degree of customization. The need for collaborations are the results of the complexity, novelty or scarcity of the technologies that need to be utilized in order to solve complex problems that are related to direct usage of the firm itself or due to the market and customer needs of the buyer<sup>30</sup>. For the buyer, the accessing<sup>31</sup> and/or acquiring of technology related to these collaborations are sources of learning and competence development. It complements the internal R&D and is related to diversification of technology towards more and more technologically complex solutions<sup>32</sup>. The complex technological reality requires collaboration in many forms and the buyer-supplier collaboration is one of the key collaborations.

Nickerson and Zenger<sup>33</sup> discuss types of problems related to their degree of decomposability and the possibility of solving the subproblem from few or several sets of knowledge. The need for an integrated competence profile among the staff doing sales interaction with the customers indicates that the sales process requires in-depth technical problem discussions. If we compare this with the ideas of how decomposable<sup>34</sup> the problems are it might be interesting to view the process as pending between two

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<sup>28</sup> Windahl et al, 2004; Shepherd & Ahmed, 2000

<sup>29</sup> Tidd et al, 1997 with references to Lamming, 1993

<sup>30</sup> Tidd, 1997

<sup>31</sup> Grant and Baden-Fuller, 2004

<sup>32</sup> Tidd, 1997 and Granstrand et al, 1992

<sup>33</sup> Nickerson and Zenger, 2004

<sup>34</sup> Nickerson & Zenger, 2004

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states: The internal and the external state of problem solving. In the external state (in direct interaction with the customer) the problem is at a less decomposable level as it requires more consideration taken into areas such as overall business concerns (although cost awareness of the customer may appear as important in designer interaction too), direct technical problems of the customer and external social interaction. When the problem is defined and requirements set on this level the internal problem solving becomes more narrowed and thus drawing on a smaller but probably deeper set of specialized competences. Note that this is a generalisation as also internally the competence utilization varies depending on at what stage the organization has broken down the problem into pieces and set requirements. As Henriksen<sup>35</sup> states, the redefinition of the problem is likely to be done iteratively as various sources are utilized and work progresses. Thus it seems as the project is under way the problem solving oscillates between the utilization of a wider set of competence and information sets and a more narrow specialized one.

The concerns that the manufacturing staff should be involved in the earlier stages of the process and the profile of the individuals in RD's prototyping team, where many have a manufacturing background, indicate how closely related everyone in the organization is to the problem solving and that the customer problem affects everyone. Consequently we may have to raise the question whether focusing on formal education levels and the alike in order to identify a group such as highly skilled workers or knowledge workers<sup>36</sup> is beneficial. Formal education does though seem important from an overall point of view. In both the RD and VG case it seemed that higher education was increasingly sought for when recruiting.

When we look at the competence profiles that Shepherd & Ahmed, Windahl et al and also Nyhan discuss a few common traits stand out as particularly interesting: The social interaction competence (internally and externally), the entrepreneurial competence, and problem solving. As we see, when we take into account Henriksen's article on engineers and problem solving, these are interdependent as the complex problem solving is dependent on being able to access and interaction with people, internally and externally in order to use them as sources for problem solving. We could perhaps also view the internal supply of "services"<sup>37</sup> as something that contains a varying amount of problem solving and with a varying "closeness" to the customer problems. Thus the services supplied by human resources within the organization vary according to the amount of problem solving and the degree with which it is connected to the customer problem (or through the number of steps that it has been distanced from the customer problem).

### Competence development

Individuals interviewed in the organizations explicitly mention the focus on one or several niches in their market approach. A common feature also appears to be customization on rather high levels (depending on the deliveries). The focus on niches and customization appears to be a response to problems of competing with mature products where the competition with price levels makes it difficult to maintain sites (and especially manufacturing) in the specific geographic regions. The ability to deliver customized solutions that are technologically complex requires, as discussed above, an integration of the sales and technical competences, especially in the individuals that work interactively towards suppliers and especially towards customers. According to interviewees in the cases, staff that need to take on project management and sales positions need the technical engineering experience but simultaneously need to have social and entrepreneurial abilities and a will to pursue personal development. This may be compared with Nordhaug<sup>38</sup> who mentions issues of autonomy and entrepreneurship as important in order to utilize competence. Nordhaug in addition tend to view individual competence as the basic building block of competence on the organizational level.

New solutions that are generated are highly dependent on the human resources of the organization and the competence that has evolved through delivering customized solutions to customers. Löwendahl in her work on professional service firms has chosen to adapt to the view of Nordhaug: "Competence may be seen as the overall concept covering all aspects affecting the ability to perform a given task, and exists

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<sup>35</sup> Henriksen, 2001

<sup>36</sup> C.f. Cusimano, 1995; Ahantou, 1998; Estrada, 1995; Kelloway & Barling, 2000; Choi & Varney, 1995; Dove, 1998

<sup>37</sup> Borrowing the label of Penrose, 1959

<sup>38</sup> Nordhaug, 1993

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both at the individual level and at the collective or organizational level.”<sup>39</sup> She combines it with the idea of competence development as being dependent largely on the customer interaction and thus attaches to an idea of competence as dynamic such as the one by Lei, Hitt & Bettis<sup>40</sup> which also resembles the ideas of dynamic capabilities<sup>41</sup>.

The fact that unit RD had performed development aiming at delivering a prototype and no serial production indicates the high level of development ability in the area and how the development service can be either internal or external<sup>42</sup>. As for services and goods, professional services can be integrated with goods or services and similarly the ideas of substitutability, as presented by Quinn, should be applicable not only to services and goods but also to goods and knowledge intensive services and services and professional services. Quinn<sup>43</sup> indirectly relates to professional services since he is discussing how development predominantly is seen as an internal manufacturing activity but may also be viewed as an external service when considering substitutability. In professional service firms competence development is based on the interaction with clients and the learning taking place as a result of the client interaction<sup>44</sup>. The cases indicate that central to the competence development of the organization are the projects that the unit is involved in. Customer projects set the direction for future solutions since very little R&D activity outside of customer projects is possible. The comparison with professional services reminds us that they are performed in close interaction with clients and often includes complex problem solving that renders the value creation firm to have cyclical characteristics<sup>45</sup> that include the output and input market of the firm<sup>46</sup>. I.e. value creation is continuously a matter of getting the most suitable (for future needs) clients and employees that certify individual and organizational knowledge and competence development that provides value to clients which in turn enables suitable employee and client recruitment etc. But it is also essential to recognize that in the manufacturing setting the competence development is related to and constrained by the deliveries that compared to professional services concepts require a much higher degree of investments in machinery, plant equipment etc as well as input of physical resources. Thus the degree of costs and investments related to non-human resources is higher and concepts used in deliveries require changes in the material resources that might be costly if the conceptual changes affect several aspects of the physical manufacturing resources.

### Preliminary findings

This study is still in progress but among the preliminary findings it seems appropriate to mention:

- The way of working is highly integrated and utilizes competences “vertically” across the organization. Since the integrated competence profile for customer interaction appears to be a prerequisite for the delivery of customized technologically complex solutions other functions need close interaction with the manufacturing function.
- That the organizations seem to utilize the high level of skilled technical staff in the unit to develop new concepts within the limits of the flexibility of the production capacity. This way of pursuing innovation usually means small investments in tangible resources such as machinery but a high degree of problem solving and design ability. It appears that the niched, customization focus and the competence configurations that follow with it provide abilities to establish new innovative, valuable concepts with relatively small investments in production resources.
- The occurrence of “craftsmanship” in the deliveries and their central position for customization also indicates that a problem solving ability stretches beyond the responsibility of engineers to staff working closely to the tangible production.
- The need for integrated sales and technical competence in customer interacting staff and the cross competence utilization in projects seem to generate some drawbacks when it comes to pursuing business opportunities over geographical distances without local development and production facilities.

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<sup>39</sup> Löwendahl, 1997, p 81

<sup>40</sup> Lei, Hitt & Bettis, 1996

<sup>41</sup> C.f. Teece et al, 1997

<sup>42</sup> Thus a service can both be external and internal which attaches to the way that Penrose, 1959 used “service” in order to describe internal activities.

<sup>43</sup> Quinn, 1992

<sup>44</sup> Löwendahl, 1997 and for business services Sivula et al<sup>44</sup>

<sup>45</sup> Liedtka et al, 1997; Löwendahl et al, 2001

<sup>46</sup> Maister, 1982; Morris et al, 1998

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