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HOW TO DEFINE OCCUPATIONAL CONTENT AND JOB PROFILES

A Dutch Method Applied to Two Finnish Industries

This study is part of the European Union OPAQ-project (Anticipation of Occupational Qualifications), financed by the Leonardo Program. The project was coordinated by the Finnish Board of Education, Opetushallitus, with partners from the Netherlands and Scotland.

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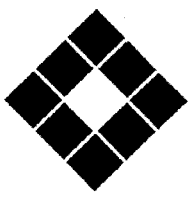

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Hannu **Hernesniemi** and Marja-Liisa **Visanti**, **How to Define Occupational Content and Job Profiles: A Dutch Method Applied to Two Finnish Industries**. Helsinki, 2000. ETLA, The Research Institute of The Finnish Economy, 52 p.. Discussion Papers, Keskusteluaiheita, ISSN 0781-6847; No 710.

There has been no systematic method in Finland to produce information on occupational qualifications. In this study, we test a Dutch method that is used actively in the Netherlands to define work content and job profiles for different branches. This information is used when preparing curricula for vocational education. The social partners are responsible for ensuring that updated information in their fields is made available when these curricula are being made. The government provides the financing as well as consulting services for the research.

We studied the occupational content and job profiles of the personnel working in mobile phone R&D activities and in the assembling of movable machinery – tractors, forest tractors and mine drilling units. These test groups cover most of the Finnish education from the post secondary vocational education and training to the higher level education. First, the most important personnel groups were identified for the sample. Then their different work activities were listed. In the questionnaire, respondents were asked how important each activity is in his or her work and what is the frequency of doing the activity. This information was used to evaluate the different activities. Activities were grouped according to the correlation between activities into broader categories that reflect occupational content. We then sought and selected homogenous groups within the sample to derive the job profiles of the branch. Finally, experts and respondents were asked about possible future changes in the occupational content and job profiles obtained here.

The Dutch method is a serious option for Finland. It systematically provides extensive concrete information about occupational content and job profiles. Industry experts can predict possible future changes by using this information. And finally, those responsible for vocational education can employ the information to improve curricula.

KEYWORDS: Projections, work, occupational content, job profiles.

Hannu **Hernesniemi** and Marja-Liisa **Visanti**, **Kuinka määritellä työn sisällöt ja ammattiprofiilit.** Hollantilaisen menetelmän testaus kahdella suomalaisella toimialalla. Helsinki, 2000. ETLA, The Research Institute of The Finnish Economy, 52 p.. Keskusteluaiheita, Discussion Papers, ISSN 0781-6847; Nro 710.

Suomessa ei ole käytössä systemaattista menetelmää, jolla voitaisiin tuottaa tietoa eri ammattien osaamisvaatimuksista. Tässä selvityksessä olemme testanneet hollantilaista menetelmää, jota Alankomaissa käytetään aktiivisesti työn sisältöjen ja ammattiprofiilien määrittelyssä. Menetelmän tuottamaa informaatiota käytetään, kun valmistellaan ammatillisen koulutuksen opetussuunnitelmia. Niin kutsutut sosiaalipartnerit, työntekijä- ja työnantajajärjestöt, ovat vastuussa siitä, että heidän alaltaan on saatavissa päivitettyä tietoa opetussuunnitelmien laatimiseen. Valtio maksaa suurimman osan tarvittavien selvitysten kuluista ja tarjoaa myös konsulttiapua selvitysten tekemiseen.

Tutkimme työn sisällöt ja henkilöstön ammattiprofiilit matkapuhelinten tuotekehitys- ja tutkimustyössä sekä liikkuvien työkoneiden - traktoreiden, metsätraktoreiden ja kaivoskoneiden – kokoonpanotyössä. Testiryhmien avulla pystyttiin kattamaan suomalaisesta ammattikoulutuksesta toisen asteen ja osittain korkea-asteen koulutus. Ensin selvitettiin tärkeimmät henkilöstöryhmät osuvan otoksen muodostamiseksi. Henkilöstöryhmien työ kuvattiin listaamalla työssä tehdyt aktiviteetit. Aktiviteetit arvotettiin sen mukaan, kuinka tärkeiksi ne koettiin ja kuinka usein ne työssä toistuivat. Keskenään korreloivat aktiviteetit ryhmiteltiin laajemmiksi työn osa-alueiksi, jotka kuvaavat työn sisältöä. Sitten otoksesta etsittiin erilaiset ammattiprofiilit, joissa kunkin profiilin sisällä henkilöiden työ on mahdollisimman homogeenista. Lopuksi alojen asiantuntijoilta ja vastaajilta kysyttiin arviota, miten määritellyt työn sisällöt ja ammattiprofiilit tulevaisuudessa muuttuvat (ns. tulevaisuusanalyysi).

Hollantilainen menetelmä on vakavasti otettava vaihtoehto myös Suomelle. Se antaa systemaattisessa muodossa runsaasti tietoa työn sisällöistä ja alojen ammattiprofiileista. Alan eksperteille se on hyvä pohja muodostaa yhteinen kanta alan työn tulevista muutoksista. Lopulta se on tutkimussuunnitelmista vastaaville hyvä pohja rikastaa työn sisällöt opetussisällöksi - opetussuunnitelmiksi.

AVAINSANAT: Ennakointi, työ, työn sisällöt, ammattiprofiilit

ESIPUHE - FINNISH FOREWORD

EUn Leonardon Surveys and Analyses-osion OPAQ-hankkeen tavoitteena oli saada teoreettista tietoa ja käytännön kokemusta ammattianalyysistä ammatillisen koulutuksen laadullisen ennakointijärjestelmän suunnittelua varten. Projektissa kokeiltiin ja kehitettiin tulevaisuuteen suuntautuvaa ja työelämälähtöistä ammattien kuvausmetodiikkaa. Oivaltavaa ennakointitietoa tarvitaan ammatillisen koulutuksen rakenteita ja sisältöjä uudistettaessa ja valtakunnallisia opetussuunnitelmia laadittaessa. On saatava ote työn muutoksen suunnasta ja siirrettävä tieto jo ennakoivasti koulutuksen suunnitteluun ja toteutukseen.

OPAQissa analysoitiin maakohtaisesti työelämän osaamistarpeita ja ammattiprofiileja yritysten ja työmarkkinoiden edustajien eli ns. sosiaalipartnereiden kanssa. EU-partnerit olivat Hollannista (CINOP-tutkimuslaitos, ent. CIBB) ja Skotlannista (SQA, ent. SCOTVEC). CINOP ja Ms Anneke Westerhuis toimi ammattianalyysin metodisena erityisasiantuntijana. Etlatieto ja tutkimusjohtaja Hannu Hernesniemi toimi kotimaisena tutkijana ja ammattianalyysien laatijana. Opetushallitus koordinoi projektia ja tuotti yhteisen väliraportin ja loppuraportin Leonardon ohjeistamana.

Projektissa testattiin CINOPin innovoimaa klusterimaista ammattianalyysimetodia, jota käytetään Hollannissa ammatillisen koulutuksen uudistamisen työkaluna. Suomessa valittiin tutkimusaloiksi kaksi dynaamista kasvualaa a) liikkuvien työkoneiden asennus ja b) matkapuhelinten tuotekehitys, joille määriteltiin ammattiprofiilit. Skotlantilainen SQA tuotti ammattianalyysin hyvin erilaiselta alalla eli täydennyskoulutuksessa toimivien opettajien työstä. Tämä raportti on saatavissa Opetushallituksesta.

Metodin testaus eteni OPAQssa vaiheittaisena tutkimusprosessina ja kokemuksen kautta oppien. CINOP arvioi välitulokset seuraavaan vaiheeseen ohjeistaen. Ammattiprofiilien tietokonekäsittely tehtiin Hollannissa CINOPin ATK-asiantuntijoiden kanssa. Keskeistä prosessissa oli työelämän edustajien osallistuminen sekä tutkimusaloja edustavissa työryhmissä, yrityskyselyjen yhteydessä että tuloksia analysoitaessa.

OPAQssa valmisteltiin sosiaalipartnereiden kanssa alakohtaiset kyselylomakkeet ja otos yrityskyselyjä varten. Kyselyissä kartoitettiin työn eri vaiheet ja toiminnot (activities) niiden toistuvuuden (frequency) ja tärkeyden (importance) perusteella. Toiminnot ryhmiteltiin eli klusteroitiin työkokonaisuuksiksi tilastoanalyysinä ja lopuksi tehtiin asiantuntijoiden kanssa ns. tulevaisuusanalyysi (Future analysis/Enrichment analysis). Erityisesti tarkasteltiin lisääntyviä ja vähentyviä työtoimintoja. Lopuksi sosiaalipartnerit hyväksyvät ammattiprofiilit.

Ammattiprofiilimetodi osoittautui varsin käyttökelpoiseksi ja havainnolliseksi työkaluksi sekä visuaalisesti että verbaalisesti. Metodi on selkeä ja yksinkertainen myös aloja tuntemattomille. Keskeiset ja toistuvat työkokonaisuudet nousevat esiin koulutussuunnittelun modulaaristen opetussuunnitelmien lähtökohdaksi. Parhaimmillaan metodi on hyödynnettävissä kun on määriteltävä aivan uusien tai laajojen ammattialojen työn sisältöä tai uusien ammattien osaamistarpeita.

Lausumme parhaimmat kiitokset EU-partnereillemme: hollantilaisen CINOPin ammattianalyysin erityisasiantuntijalle Ms Anneke Westerhuisille ja SQAn Mr Rob van Kriekenille. Yhteistyö oli hedelmällistä, luovaa ja sisällöllisesti avartavaa.

Projektin tuloksia ja kokemuksia on levitetty loppuraportteina, tieto- ja koulutusaineistona sekä tietoverkkojen kautta kotimaassa ja EU:n piirissä. Loppuraportin keskeisten osien

suomennos on vireillä edistämään metodin laajempaa käyttöä osana laadullisen ennakoinnin kotimaista työkalustoa.

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Anticipation of Occupational Qualifications

Työelämän osaamistarpeiden ennakointi

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Contents

1 Introduction

1.1 Objectives

One main aims of the Anticipation of Occupational Qualifications Project (hereafter OPAQ project) was to test the Dutch occupational analysis system, procedures and methods (hereafter the OPAQ procedure), in two other participating countries - Finland and Scotland. In the Finnish case this was done in two example branches: 1) in production of mobile machinery and 2) in research and development work of mobile phones.

An important question in this simultaneous test and evaluation process is, whether the institutional framework is similar enough that Dutch occupational analysis is applicable. There are differences in the structure of industries, organization of production and firms' work force needs. Vocational educational systems and their information needs differ from each other. The status of social partners and their role as transmitters between industries and the education system have developed along different trajectories.

1.2. Main characteristics of Dutch occupational analysis – OPAQ procedure

Dutch occupational analysis system is developed by the former CIBB, now part of CINOP. It provides necessary information for development or revision of vocational curricula. Characteristic features of the OPAQ procedure are:

- the analysis of the structure of the branch to be studied. This subdivision has to be based on the most important characteristics of the work done in the branch and it also has to give information on the most important personnel groups.
- the description of work done in the branch. This is based on the concrete activities of the jobholders.
- the clustering of the job activities into activity blocks called activity clusters.
- the grouping of job holders into the work profiles, according to the importance of different activity clusters in their work.
- the use of data and experts to forecast changes in job content
- the involvement of "social partners" in preparation and for interpretation of the analysis.

A crucial part of the analysis is the questionnaire, which should cover all important personnel groups and their work activities. Respondents value the activities according to their frequency and importance at his or her work. Also relevant background information of the respondents is controlled.

Those needing more detailed information about the Dutch method are asked to consult other parts of OPAQ project report or contact CINOP for further information[1]. The method is nevertheless explained later in connection with two test cases.

1.3 Selection of test branches

In Finland test cases were selected so that the *relevant levels of vocational education were covered.* Firms producing mobile machinery get their new workers mainly from the second level vocational institutions. Research and development staff for mobile phones are graduates from third- to fifth-level institutions, mainly from polytechnics and universities.

The branches are among the leading edge industries of Finland. Finnish factories are market leader producers of forest tractors and hard rock drilling equipment. The same goes for the mobile phone production, where R&D activities are of crucial importance. This means *high quality demands for the workforce and occupational education system.* There has been a huge lack of educated researches and designers in mobile phone production.

Technology used in the example branches has got application possibilities in other production too.

- In addition to the above-mentioned mobile machinery Finnish firms produce also farm tractors, loaders, dippers, straddle carriers, trucks, road maintenance machinery, military vehicles etc. All have got the same principle parts (motors, axles, transmissions, hydraulics, electronics etc.). A lot of assembling and testing work is needed. Only the customers and their needs are different.
- Mobile phone technology has got wider application areas although practical solutions are coming in the future. There is a lot of programming and designing work that is partly similar to that in any other electronic industries. R&D projects often also have same phases and human interaction in similar forms independent of the branch.

An important and practical selection criterion was that we knew key work places and firms in both branches. This helped us to make representative samples. This also *facilitated control of the results and made future analysis possible directly with the experts of firms.* These are important advantages when testing the method.

1.4 Work procedure

Finnish Board of Education (Opetushallitus) appointed research director Hannu Hernesniemi from Etlatieto Ltd. to carry out the following two subprojects. The Board of Education also gathered expert groups from the "social partners" of both branches to give necessary guidance to the researcher and comment on the results. Those experts came primarily from labor and entrepreneur organizations. Also many experts of firms were used for checking, commenting and forecasting the future development of branch. Ms. Anneke Westehuis from CINOP gave scientific and methodological

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guidance. Her colleagues Mr. Arie Pieter Veldhoen and Mr. Joop Obeling were responsible for the statistical data processing.

Different tasks necessary to fulfil the project was done according to following schedule:

1. The selection of the branches and analyzing their structure was done in spring 1996. It was confirmed at the Glasgow OPAQ General Meeting in May 1997.
2. The preparation of questionnaires was done during summer and autumn of 1996. This was the demanding phase of the project. Detailed information has to be collected from different firms, factories and work places situated far from each other. Questionnaires were discussed and checked at the Amersfoort OPAQ General Meeting in September 1996.
3. Surveys were carried out during December 1996 and January 1997. After data input was completed, the mobile machinery sample was processed in the s'Hertogenbosch OPAQ General Meeting January 1997 and the mobile phone sample later in March 1997.
4. Results (i.e. activity clusters and work profiles) were presented to social partners and companies involved during April – June 1997. Mobile machinery experts and firms were sent an intermediate report (in Finnish)[2] and comments were requested. Mobile Phone R&D experts presented results in two meetings. The first was held (as a videoconference) in NMP Ltd. in order to get comments about primary results and material for future analyses. The final study was presented in a joint meeting of representatives of social partners, firms and educational institutions and universities.
5. Finally the results of the qualification analyses including activity clusters, work profiles and future analysis were presented and discussed at the Helsinki OPAQ General Meeting In October 1997.

The report is organized so that at first we will present mobile machinery study and its results and then the mobile phone R&D study. Then we will evaluate the OPAQ method and its usefulness for Finland based on these two test cases and our knowledge about the Finnish institutional framework. At the end, we will give some concluding remarks.

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[2] Hannu Hernesniemi: Ammattianalyysimenetelmän testaus kohteena liikkuvien työkoneiden asentajien ja testaajien työ, 4.4.1997

2 Application of the OPAQ analysis in mobile machinery production

2.1 Structuring branch and defining personnel groups

Activities of firms in this branch, as in many others, can be divided in research and development, subcontracting and manufacturing of components, production, sales, marketing and financing, maintenance and after sales and planning and managing all above-mentioned activities. We have concentrated only on production and thus focused on the biggest personnel groups.

Mobile machinery production was *structured according to customer area.* We selected the three most important machinery types, namely forest tractors, hard rock drilling automates and farming tractors. Our hypothesis was that the customer area has an effect on the work in the profession studied.

Another structuring criterion was the way in which production was organized. This is of course connected to the size of the production series. We selected factories from all relevant types, namely very customized, nearly individual production of machinery, small serial production and mass production (on a Finnish scale). In customized production one is used to operate rather independently. In small serial production work is done in production cells. In mass production there is the "Henry Ford" style of production line. Again the hypothesis was that the production organization type has an effect on the work content in factories.

Simultaneously we also find out what were the most important personnel groups in production.

- The main group is *assemblers*. In this group we also included fitters who do assembly work on "mass" production lines. They are more specialized in assembling only some parts in the production line, but the workplace as well as the parts assembled might change time after time. Correction assembling after testing the machinery is part of the assembly work in individual and small serial production. In "mass" production there are specialized correction assemblers. Another special group was assemblers, who were fitting axles, transmitters and motors, but their number was rather modest. The trend is to buy more and more ready made components from outsider suppliers.
- Another important group is *testers*. They test machinery in several different ways. They verify whether the machinery fulfils vehicle standards and working standards and of course whether the assembly work is of high quality. Testers are very often the interface of production with customers and service. They advise service men and even customers and pass or filtrate customer and service feedback to production.

There are also minor groups of welders, platters and other metal sheet workers. These groups were omitted from the study, but welding, cutting, drilling etc. as work activities were included, because some assemblers perform those activities.

Another group left out was painters. Many components are already painted by suppliers and part of painting carried out in a factory might be bought from specialized firms. But again there is some painting and finalizing work, which was included as activities because they were a part of assemblers' and even testers' work.

We left out also foremen, because there were so few of them. Nowadays assemblers and testers and their groups (production cells) are self-directing their work.

All this information was used for sampling. In the OPAQ method it is essential to get at least 20 representatives from every subgroup of personnel. Our sample was compiled so that there were enough answers from different customer areas (i.e. production of forest, farming and mining machinery) and from different types of assembling (individual assembling, team assembling in cells and assembling on a conveyor belt), fitter of parts and modules as well as from testers.

Table 1: Sample and Number of Respondents

Factory	Sample	Answers	Professions
Suolahti tractor factory (farming tactors)	45	41	Convey belt fitters, module assemblers, testers
FMG Timberjack (forest tractors)	25	25	Cell assemblers, module assemblers, testers
Ponsse (forest tractors)	25	15	Cell assemblers
Tamrock (mining machinery)	35	31	Cell assemblers, testers
Normet (mining and forest tractors)	25	22	Independent assemblers, testers
Together	155	133	

The high response rate (86,5 %) was possible because of a lottery. The prize for the winner, donated by Metalliliitto (organization of metal workers), was a one-week holiday with a family or friend in Lapland.

2.2. Mapping job activities and questionnaire

The activity mapping was made by interviewing production managers and assemblers. They were asked the following questions:

- What activities are performed during normal working days?
- What activities have to be done during the assembling process of machinery?
- What activities have to be done during the testing of machinery?
- What activities are necessary while starting the production of the new machinery?
- What exceptional activities (training, education etc.) might there be?
- What tools have to be used?
- Are there some other important activities connected to work (work safety, target setting, meetings etc.)

In addition to these, also relevant background information were asked about the firm a respondent was working for and work history and vocational education. The questionnaire is included as an appendix of the report.

Social partners were checking and commenting on the questionnaire. Their input for preparing the questionnaire was much more modest than in the Netherlands for two reasons. First, the social partners have no formal responsibility and financing for this in Finland. Secondly, people working for social partner organizations are mostly engaged as specialists (with a lawyer's, administrator's or social science education), but not an expert of the work itself.

The respondents indicated how often they perform each activity listed in the questionnaire and how important they rate it. These codes have been combined into one code and used for the weight of the activity according to following scheme.

Table 2: Valuing the Activities

		Importance		
Frequency		1	2	3
Never	N	0	0	0
Monthly or more seldom	1	1	4	7
Weekly	2	2	5	8
Daily	3	3	6	9

2.3. Activity clusters and work profiles

Clustering of work activities

Once the weights have been determined, the correlations between activities have been computed. This allowed the original 300 activities been grouped, first into 211 and then further into 38 activity clusters. From these we finally got 16 activity clusters covering all relevant work activities of assemblers and testers in production of movable machinery. These activity clusters are presented in the following Table 3.

The OPAQ clustering method suggests combining the most correlated activities if they also have an internal connection.[3] Combination decisions are based on subjective evaluation made by the research staff together with industry experts. In this analysis the industry expert Mr. Seppo Valio from the National Board of Education was used.

Each activity cluster in Table 3 contains a lot of activities. They are listed in annex 1. After the activity there are reported how many of the respondents are doing that activity at his or her work and the percentage share of those performing the activity.

It can be seen that there are four different kinds of assembling: mechanical, hydraulic, electric and automation assembling as individual clusters. There is of course a clear technical reason for this.

The size of production series or organization of production (assembling customized products, working alone, production line management) reflect the work so much that they form some activity clusters.

Activity clusters are the base material for making curricula. Educational experts can analyze activities and give them educational contents – skills, qualifications, values etc. This is so called enrichment analyses. Sometimes a cluster itself or correlated clusters can form the base for a education module with one or more courses. Skills and qualifications needed to fulfil activities of some clusters can also be gained via training organized at workplaces. Some clusters have to be taken into account another

[3] Rule of a tump is that the correlation should be 0,5 or higher. Some times it would be nice to use a condition that the combination of activities is not internally contradictory. These surprising combinations may give new knowledge about real content of work.

way in education, for example, how to teach i.e. using similar tools and equipment as at workplaces and studying similar ways of doing work.

Table 3: Mobile Machinery Assemblers' and Testers' Clustering of Work Activities

PREPARING ASSEMBLING
MECHANICAL ASSEMBLING
HYDRAULIC ASSEMBLING
ELECTRIC ASSEMBLING
AUTOMATION ASSEMBLING
ASSEMBLING CUSTOMIZED PRODUCTS
PRODUCTION OF NEW MOBILE MACHINERY
METAL WORK
PREPARING MODULS AND COMPONENTS
TESTING WORK
CORRECTING ASSEMBLING
FINALIZING WORK
SERVING CUSTOMERS
WORKING INDEPENDENT
WORK SAFETY
PRODUCTION LINE WORK

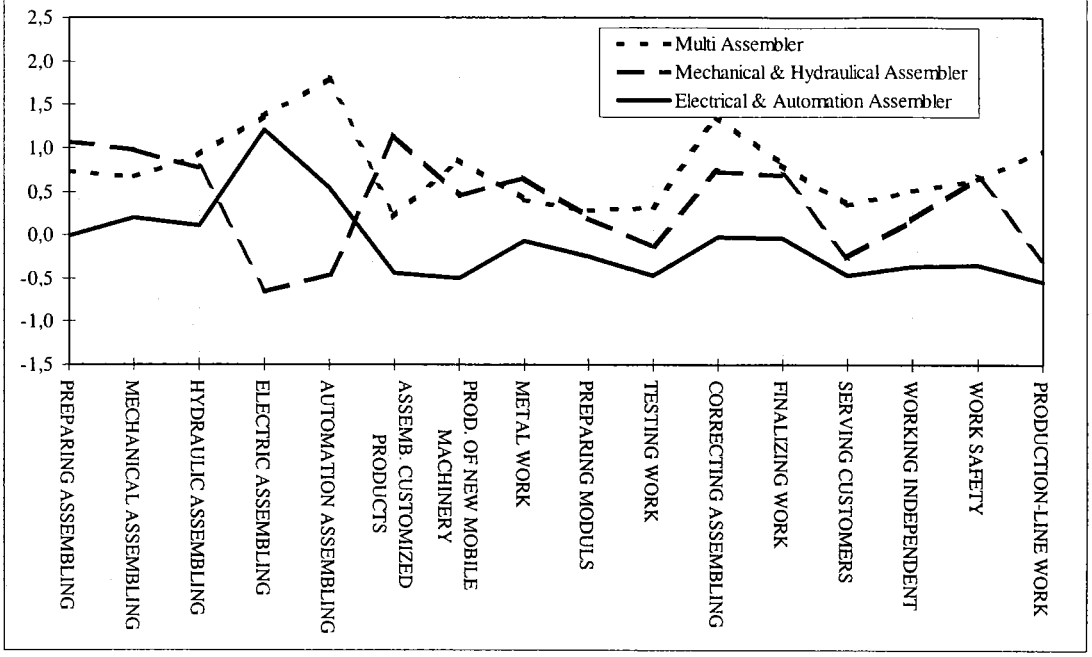
Defining work profiles

Once the activities were grouped into clusters, the cluster scores were computed by taking the average over all the weights a respondent had attributed to the activities within the same cluster. In this way 16 cluster scores were computed for each respondent.

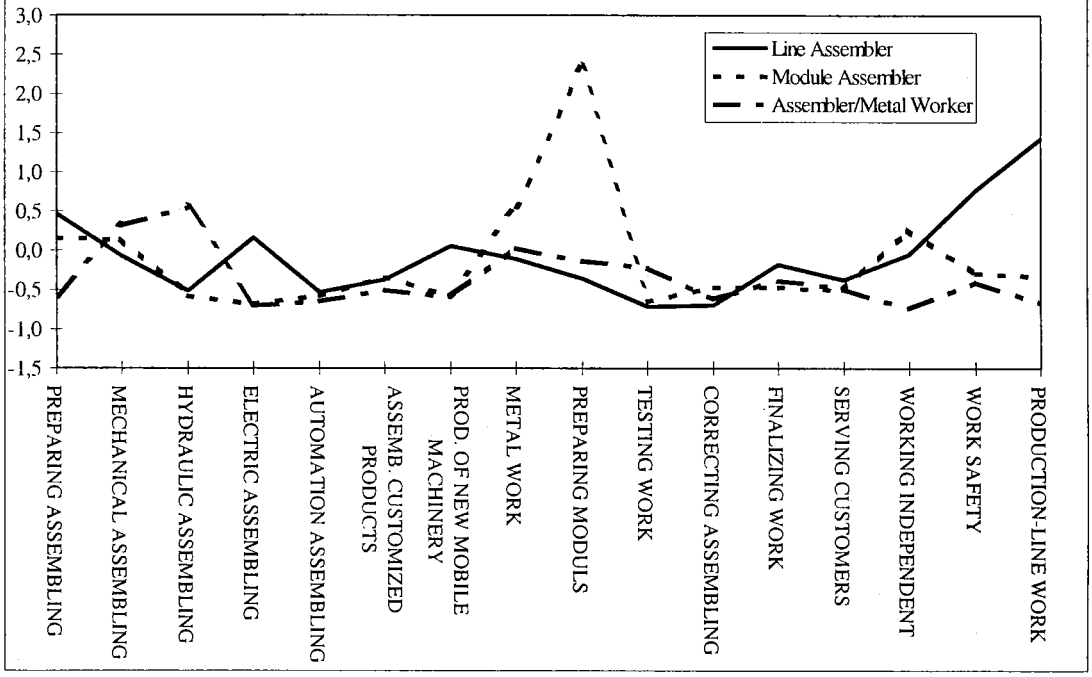
The following step was grouping the respondents into profiles on the basis of cluster scores.[4] The basic idea is to determine the different basic "profession" groups within the sample and in the branch, if the sample is representative. In each profession group the persons' work profiles are rather similar to each other, but profiles differs from each other.

[4] This was done using the specially developed CINOP program 'Kmeans' as well as with standard SPSS cluster analyses (Ward). Both programs took an initial number of fifteen profiles and gradually reduced this by taking the two most similar profiles together. The Kmeans program then redistributed respondents from other profiles as well, if necessary. Final profiles are selected among the most stabile groupings.

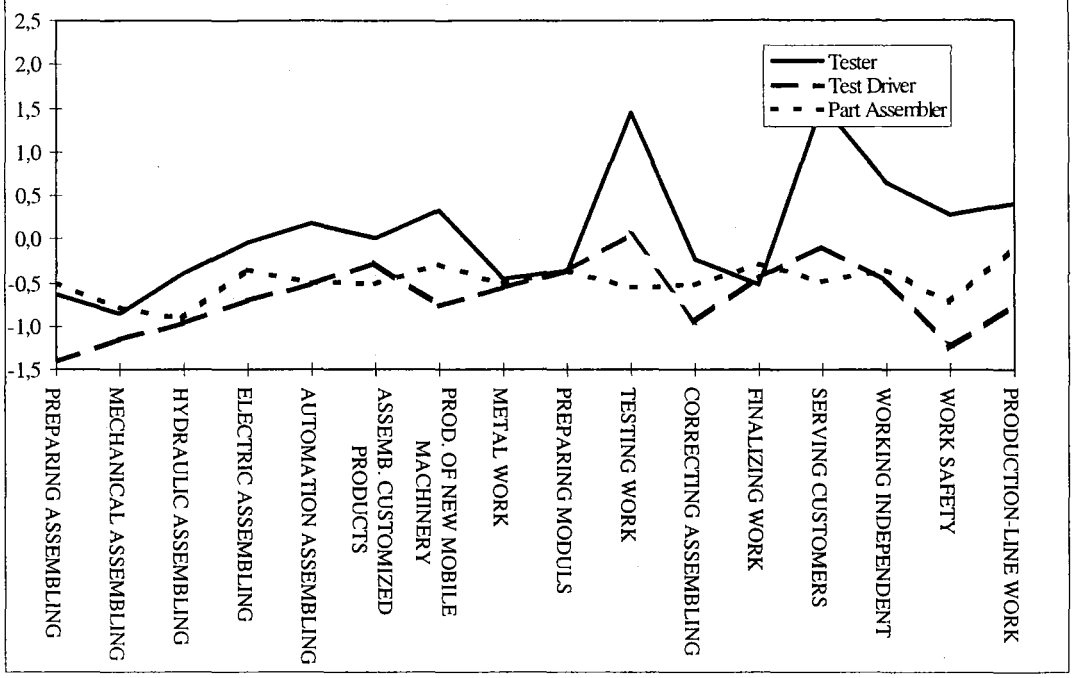
Graph 1a: Assembler's Work Profiles in Mobile Machinery Production



Graph 1b: Assembler's Work Profiles in Mobile Machinery Production



Craph 1c: Tester's Work Profiles in Mobile Machinery Production



We find nine different profiles among assemblers and testers of mobile machinery. These are presented in the adjacent charts 1a-c. Again the final solution was a subjective one made by the researcher and the industry specialist of the National Board of Education, Mr. Seppo Valio.

Multi-assemblers (Graph 1a), often work in production cells, have to have wide skills from all areas of assembling i.e. mechanical, hydraulic, electric and automation assembling. They also take part in the beginning of production of new machinery including the production of proto- and zero series, studying the new machinery and giving training to others and planning the production.

Mechanical and hydraulic assemblers (Graph 1a) do both of these assembly tasks and also teamwork in production cells. They also do all kinds of metal work (welding drilling, cutting), if the machinery produced are customer tailored.

Electric and automation assemblers (Graph 1a) are a special group. They are concentrated on this newest area of assembling. Their profile is rather similar to multi-assemblers, which is preferred by employers because of the flexibility and usefulness in team assembling.

Module and components assemblers (Graph 1b) are fitting axles, gearboxes and motors. The work is mechanical assembling. Often a worker does his or her work independently, taking responsibility also for quality.

Assemblers/metal workers (Graph 1b)are all rounders. They take part in mechanical and hydraulic assembling, all kinds of metal work and also finalizing the machinery i.e. painting, taping, customizing and backing the machinery. These workers are needed in production of individual machinery.

Line-assemblers (Graph 1b) take care of the most demanding tasks and gearing responsibility in conveyer belt type of production. They are preparing assembly work, performing electronic assembling and guiding the production starts of new machinery. They are also taking care of target setting and effectiveness of the production line as well as work safety.

In *part assemblers'* work (Graph 1c) any particular activity cluster has got a special stress. They are doing very defined tasks in different parts of the conveyer belt. The tasks itself are as demanding as in other assemblers' work but each part assembler has got only a few of them. Continuously repeated tasks are easy to learn. Probably that is why even the tasks, which are marked are not ranked important, and the profile is very low in all activity clusters.

Testers (Graph 1c) of course gave high stress to all areas of testing work. They are also the interface of production with customers. They have to know customer demands, give them advice and training as well as filter customer feedback to production and product developers. Effective communication skills are essential in order to get real changes in quality of production and also dealing with customers.

Test drivers (Graph 1c)have got a rather similar profile to that of testers, but their work is not so wide in scope and demanding as that of testers. As the name of the profile tells, test drives are the core of the profile. Test drivers are sometimes taking part in the production of custom tailored machinery. They also help customers in the start-up of the machinery[5] and give advice connected to that.

The above profiles are quite detailed. Some of them are correlated with each other, as can be seen from the charts and explanations of profiles. Depending on the purpose, these profiles can be used separately or combined.

For curricula preparation profiles are basic elements. Curricula experts can consult the profiles when thinking which kind curricula structure is needed based on the profiles. They should bring up the following questions:

- Which profiles are so different that they need their own curricula?
- Which profiles are so similar that common curricula can be used?
- Can there be common modules for those activity clusters which have got high scores for all profiles?
- Do some profiles need special modules because of high stress in some activity clusters?

Again there is full reason to evaluate which part of the skills has to be taught in the vocational education system and which are given by firms and other work organizations. Some activity clusters and even profiles can exist only because of firm or workplace-specified activities based on their core competitions (see chapter 3).

2.4 Future analyses

Future analysis is a crucial part of the OPAQ procedure. One constructive way to make future analysis is to predict the changes in work content (activity clusters) and

[5] Start of the working machines for the first time in production and also by customers might be potentially very dangerous. That is one reason why work safety as an activity cluster got such high emphasis in many profiles. The other reason for that is heavy lifts and hoist of components.

work profiles. This can be done using the best experts of the branch.[6] Because the main aim of future analyses is to develop curricula, the forecasting period should extend from 5 to 10 years so that the implementing period is long enough.

In this study future analyses were made by interviewing production managers who are responsible for developing the production and work done in factories. Interviews were made in the beginning of project so managers have not had an activity cluster or profile results yet as the basis for their future estimations.

Also respondents of the questionnaire were asked to give their estimate about decreasing and increasing work activities. Activities were grouped into work areas for the questionnaire. In the light of the results this grouping seems to be very successful. There are the same elements as in activity clustering. So we can use also these estimations for future analyses[7].

Table 4: Respondents' Estimates of Tasks Whose Significance Will Increase or Decrease in Next 5 Years

Tasks	*Increase*	*Same*	*Decrease*	*No Opinion*
Electrical engineering/automation installation work	*68 %*	*16 %*	*1 %*	*15 %*
Customer relations	*66 %*	*19 %*	*0 %*	*15 %*
Work and cooperation in production teams	*61 %*	*31 %*	*1 %*	*6 %*
Electrical installation work	*59 %*	*26 %*	*1 %*	*13 %*
Testing work	*57 %*	*31 %*	*0 %*	*12 %*
Development of new machinery and starting of production	*54 %*	*33 %*	*0 %*	*13 %*
General business management	*54 %*	*30 %*	*0 %*	*16 %*
Finishing work and delivery to customer	*53 %*	*35 %*	*1 %*	*11 %*
Hydraulic assembly work	*43 %*	*43 %*	*4 %*	*10 %*
Preparation for assembly and assembly-related activities	*38 %*	*49 %*	*1 %*	*12 %*
Occupational safety measures	*37 %*	*53 %*	*0 %*	*10 %*
Assembly of components	*26 %*	*50 %*	*8 %*	*16 %*
Working alone	*25 %*	*48 %*	*15 %*	*13 %*
Manufacturing of customized products and starting of production	*25 %*	*50 %*	*10 %*	*15 %*
Corrective assembly work	*19 %*	*60 %*	*9 %*	*12 %*
Work and cooperation on production lines	*18 %*	*43 %*	*13 %*	*26 %*
Mechanical assembly work	*12 %*	*72 %*	*8 %*	*7 %*
Metalwork	*11 %*	*63 %*	*10 %*	*16 %*

[6] In the Netherlands CINOP experts have found that it is best to ask experts to make their prognosis using results of the OPAQ procedure. Otherwise each person introduces their "king" ideas, which might have a rather loose connection to the actual situation or facts and do not give a common base for discussion.

[7] When interpreting the results one should take into account that there are more increase answers than decrease in all works areas. This is partly because of continuous pressure to increase productivity and partly answering behavior and strategy. Anyhow differences between increase and decrease percentages give valuable information.

Electronic and automation assembly work seems to be clearly expanding. The development of machinery is an obvious reason for that. Information technology is more and more important when automating functions and optimizing the working capacity and value added of the machinery.[8] At the same time there is an increase in the number of analyzers, processors, data machines and telecommunication equipment put into machinery.

Workers estimate also that cell production is increasing compared to working alone and conveyer belt production. Production managers of the cell type of production also prefer team working because of flexibility, quality and productivity reasons.[9]

In production teams assemblers must be multi-skilled doing more than one type of assembling or in optimum case all kinds of assembling. This is also advantage in other kinds of production. Production managers were generally of the opinion that the share of multi-skilled assemblers will grow.

According to the questionnaire and interviews, the production developing rhythm of machinery will accelerate. This means in the work of assemblers and testers more studying of new machinery, more planning of workplaces and more contacts with the R&D department (for example, production of prototypes, exchanging ideas on how to develop easy-to-make machines, etc.)

The role of the customer relationship also increases in assemblers' and testers' work even if it is mainly the business of the marketing department and service organizations. Workers meet more and more customers. They visit factories when purchasing the machinery, consulting about possible customizing details, in order to get training, or simply to become more familiar with the factory. Testers are giving advice by phone and passing customer feedback. Some expert assemblers are visiting customers to help in first starting and giving advice, to make reparation in special cases and to make final assembling. In these kinds of situations more and more foreign language skills and cultural knowledge are needed.

Demands towards high quality will also grow. There are at least two reasons for this: Mobile machinery often is an expensive investment good. Breakdowns make big loses rapidly. Hard competition forces producers to protect their reputation. So according to workers and managers more and better testing work is needed. At the same time the role of correction assembling seems to decrease. This surprising phenomenon has got an understandable explanation. It is much cheaper to take care of quality while assembling than later do repairing assembling where you first have to take the machinery apart and then reassemble it after repair.

According to the interviews of the production managers, the role of mechanical assembling will decrease in importance and especially the needs for assemblers doing only that. The respondents of the questionnaire seem to have a similar opinion if we take into account the bias of the answers.

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[8] For example by computer of a forest tractor driver can maximize incomes to forest owner and at the same time optimize raw material supply to different factories. Mine drilling automate can minimize amount of side stone and so decrease enriching costs

[9] One of the managers made an important remark: when production series are growing there might be more optimal ways to organize production (for example conveyer belt). This change, if it happens, shall have important effects to assemblers work content.

There is also a tendency to externalize metalwork, painting and component production. Mobile machinery firms concentrate on their core competitive areas of R&D and efficient assembling, including testing and international marketing. If no experts are left for these functions, this means that assemblers and testers have to do some of these activities, which are impossible to do beforehand or it is wiser to do it in connection with assembling.

An important aspect is an increase of target setting concerning quality standards, productivity and production targets and meetings connected to these. Workers and production teams take care of tasks of foremen by themselves. Wages are more and more tied up with the targets mentioned, which gives a lot of incentives for effective self-direction.

Table 5: Trends in Future Vocational Education Given by Production Managers

- Multi skilled team assemblers are needed.
- Electric, electronic and automation assembling education has to get more emphasis in vocational education.
- Mechanical and hydraulic assembling is possible to learn by doing.
- Teaching methods and learning results can be improved for example: by increasing contacts to work places (visits, guided training, training) and using videos, computer programs etc. to visualize and concretize the actual work activities in electrical and hydraulic assembling.

3 Application of the OPAQ analysis in mobile phone research and development work

3.1 Structuring branch and defining personnel groups

Mobile phone technology is highly developed in Finland. Mobile phones are the biggest individual export product of Finland measured by export value. In addition to phone production, the planning and construction of the mobile phone networks and production of equipment needed in networks are very important to Finland. We selected production of mobile phones for the focus of the study.

There are two principal personnel groups in mobile phone production - research and development staff and compilers of mobile phones. These two groups are very different from each other. Research and development staff are highly educated - graduated from polytechnics and technical or other universities. Compiling workers are much less educated. They come from different professions (former nurses, dress makers etc.) and from the different vocational institutions not specialized in compiling. They are mainly women with quick hands and a careful, strict attitude toward work.

We focused on the research and development of mobile phones and personnel doing that, and left out compiling work. There are some very good reasons for this. We also wanted to cover higher vocational education in the OPAQ project. There are big challenges in education of these experts too. There is a continuous lack of these experts. This branch is the most R&D intensive among Finnish industries. Nearly 40 percent of employers do product development tasks and product development is a core competence area of this expansive industry.

At first our hypothesis was that research and development work is conducted by firms producing mobile phones, by their component subcontractor and by research institutes and departments and faculties of technical and other universities.

It came out that component subcontractors were hardly doing any R&D with respect to mobile phones. The number of these experts was surprisingly modest. They were concentrated on taking care of the technical possibilities of producing new components and the most economical way of producing them. They also made prototypes according to main producers' orders. Some key experts were making 5 year forecasts of the development of mobile phones, so that the firm would be able to invest in the right kind of production technology. Component producers were left out of the study's scope.

Two firms produce mobile phones in Finland. The biggest and the market leader on the world scale is Nokia Mobile Phones Ltd., which operates several factories abroad. Benefon Ltd. is much smaller, but it has large market shares in analog NMT-phones in different countries. These firms took part in the study, but they put a precondition on their participation. We left out technical areas of the work, because they were in the core competence area of the firms. We had to accept this.[10]

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[10] On the other hand core competitiveness areas of specialized firms are the key assets of these firms. It is natural that companies have something to give to schools not the contrary, but very often they are reluctant to share these business secrets.

The next step was to look at the work of research and development staff. Most were developing new phone models and even conducting R&D for new phone generations. We focused on the activities and work profiles of these personnel. Another work area was research and development connected to improvements in production methods. The number of the people involved in these activities is perhaps not more than one tenth of those developing the phones. Often they work in production departments. We left them out of the study.

A lot of subcontracting for producing firms takes place in the State Research Center and in different universities. Often academic researchers make feasibility studies and solve autonomous research tasks, where theoretical knowledge is needed. They also might do some programming subcontracting. Researchers have to underwrite concealment contracts. On the other hand they are independent researchers, who also have to have academic merits. So subcontracting is a vivid link, where two-way technological spillovers occur.

Private programming firms also do subcontracting programming. We had to leave these firms out because of a lack of information in the early phase of the study. Firms producing mobile phones are reluctant to reveal their subcontractors and subcontracting firms carefully cherish their important client relations.

The main personnel groups among research an development personnel are R&D and project directors and managers including head planners, designers engaged in all sorts of designing work (for example hardware designing or radio frequency planning) and programmers, who program software for the mobile phones. In subcontracting units, the number and the role of directors and managers is minor. Personnel doing planning are called researchers because of their academic background.

Most research and development is done in projects. There are certain phases in the research and development projects, which make it systematic and effective. A lot of emphasis is made to coordinate and divide work and to guarantee maximum information exchange to and share the results. A lot of teamwork and meetings are needed between project members and between different projects because findings and solutions might have wide ranging effects. Subcontractors work is more independent, but regular reporting to clients is essential.

This structuring of the branch and its personnel group was necessary for representative sampling. We selected personnel for our sampling from three units of NMP Ltd. and from the R&D-unit of Benefon Ltd.. The State Research Centre, VTT was included as well as departments from five universities. One weakness was that we couldn't cover private programming firms that do subcontracting programming. From all aforementioned relevant personnel groups (different kinds of foremen, designers, researchers and programmers) there were enough representatives in the sample.

Table 6: Sample and Number of Respondents

Organization and location	Sample	Answers
Benefon Ltd., Salo	25	21
NMP Ltd., Salo	25	20
NMP Ltd., Oulu	25	21
NPM Ltd., Tampere	25	17
State Research Center, Espoo and Oulu	29	20
Helsinki University of Technology (Espoo), Tampere University of Technology, University of Helsinki, University of Tampere and University of Turku	24	18

The high response rate (76,5 %) was made possible because of a lottery. The prize for the winner, denoted by Tekniikan Akateemisten Liitto TEK ry (labor organization of academic technologists), was a one week holiday in a cottage in Lapland.

3.2 Mapping job activities and questionnaire

Important things affecting work content are the phases of research and developing process. One has to go through more or less the same phases every time. Work is mostly conducted in teams, which makes communication, negotiation, solution etc. activities important. The nature of work – innovating, developing and their usage – also have important effects on work content.

For mapping mobile phone R&D activities we interviewed a research director and three R&D managers and a researcher. The following questions were asked in order to find out the most important activities of R&D work:

- What are the activities conducted in different phases of R&D-projects?
- What activities are conducted while working in teams?
- What activities are necessary to protect innovations, to update one's own knowledge and work capacity etc.?
- What activities are necessary when selling subcontracting and taking care of these customer relationships?
- What activities are necessary because of international markets for products and international R&D networks (travelling, language skills, knowledge of cultures etc.)?
- What kind of tools, equipment, programs does one have to use at his or her work?
- What activities are needed to maintain work capacity?

Activity listing formed the main part of the questionnaire. Also, relevant background information was asked about the firm, institution or faculty the respondent was working for and work history and vocational education. The questionnaire is an Appendix of the report.

Social partners checked and commented on the questionnaire. Their comments were helpful for structuring the questionnaire but remained on a very general level concerning concrete activities, which were not very familiar to social partners. Here personnel managers of Nokia Mobile Phone, Mr. Elmer Häkkinen and Ms. Katriina

Schrey-Niemenmaa, gave a great deal of help as well as some test respondents from NMP and the State Research Center.

The respondents indicated how often they perform each activity listed in the questionnaire and how important they rate it. These codes have been combined into one code and used for the weight of the activity according to following scheme.

Table 7: Valuing the Activities

		Importance		
Frequency		1	2	3
Never	N	0	0	0
Monthly or more seldom	1	1	4	7
Weekly	2	2	5	8
Daily	3	3	6	9

3.3 Activity clusters and work profiles

Clustering of work activities

There were 230 activities in the questionnaire altogether. Based on the valuing explained above, correlated activities were first grouped into 94 activity clusters. Then correlated clusters were grouped further into 42 clusters and finally into 19 clusters.

Final combination decisions were based on subjective evaluation by research staff together with an industry expert, chief technologist Ms. Pirjo Putila from the National Board of Education. The principle followed was to combine the most correlated (correlation coefficient around 0,5 and higher) activities and later activity clusters, if they have an internal connection or at least are not internally contradictory. These later combinations may give new knowledge about the real content of work.

The final 19 activity clusters are presented in Table 8. These clusters describe the essential content of work made by research and development personnel of mobile phone except those activities connected directly to technology. As mentioned before, that part was left out from the study because it was in the area of business confidentiality.

As one can notice there are two important characteristics of R&D work, namely project and team work. Much emphasis has to be put on managing the project and leading the team as well as communicating and teamwork activities, and the use of the workgroup and project programs.

The position of the workplace seems to also give content to work. Subcontractors of course have to sell their work resources and perform activities related to that. Those having academic backgrounds must build and maintain networks in order to follow the most recent development and have a forum to communicate (advertise) their results and get partners.

Table 8: Mobile Phone Product Development Staff Clustering of Work Activities

MANAGING PRODUCT DEVELOPMENT
PROJECT MANAGEMENT
MANAGING UNIT/TEAM
COMMUNICATING & INFORMATION
TEAMWORK
MANUFACTURER'S R&D WORK
TESTING
PREPARATION OF PRODUCTION
CO-OPERATE WITH PRODUCTION
SELLING SUBCONTRACT R&D PROJECTS
CARRY OUT SUBCONTRACT R&D PROJECTS
TECHNICAL PROGRAMMING
USING WORKGR. AND PROJECT PROGRAMS
SECURITY AND PROTECTION
QUALITY AND STANDARD
MAINTAINING WORK CAPACITIES
IMPROVING TECHNOLOGICAL KNOWLEDGE
DEVELOPING TOOLS & METHODS
BUILDING AND MAINTAINING NETWORKS

Mobile phone technology is in the frontiers of technology development and the tempo of development is rapid. This has got a great deal of influence on work content. Security and protection of the innovations and other R&D results are very important. Other aspects are maintaining work capacities and improving technological knowledge.

Each cluster (in Table 8) contains a lot of activities. They are listed in annex 2. After the activity we report how many of the respondents do that activity at his or her work and the percentage of those performing the activity.

There are also activities, which nearly everybody seems to do at their work. These activities were excluded while making profiles, because they didn't separate the profiles. From an educational point of view these activities are extremely important. The skills needed to execute successfully those activities are must skills concerning an industry.

In Table 9 we compiled ten must skills of mobile phone R&D from those activities which 70-100% of the respondents announced to perform. It is more than obvious that these skills have to be taken into account in the vocational education. They can be called key core competencies, which everybody has to posses in order to manage their work. After running this type of analysis in several industries the education system can gradually obtain a key core competence portfolio, where those common (inde-

pendent from industry) and general key core competencies are valid and necessary to manage in working life. Of course these are in a continuous changing process dependent on mega trends like increases in information technology, globalization of businesses and increasing networking.

Table 9: Ten Must Skills of Mobile Phone R&D Work

1.	ABILITY TO USE MODERN COMMUNICATION CHANNELS
2.	COMPUTERS SKILL
3.	PERSONAL COMMUNICATION SKILLS
4.	LANGUAGE SKILLS
5.	DISCUSSION, NEGOTIATION, ANALYTICAL AND SOLUTION SKILLS
6.	SKILLS TO MAINTAIN WORK CAPACITIES
7.	TEAM WORK SKILLS
8.	QUALITY KNOWLEDGE
9.	KNOWLEDGE OF MOBILE TECHNOLOGY
10.	ABILITY TO REPORT ONE'S OWN WORK

Activity clusters and lists of their activities, as well as general core competence activities are important input materials for enrichments analyses. By enrichment analyses experts of an industry and officials responsible for educational standards and qualifications define contents of education to offset the needs of industries, in this case electronic industry developing and producing mobile phones.

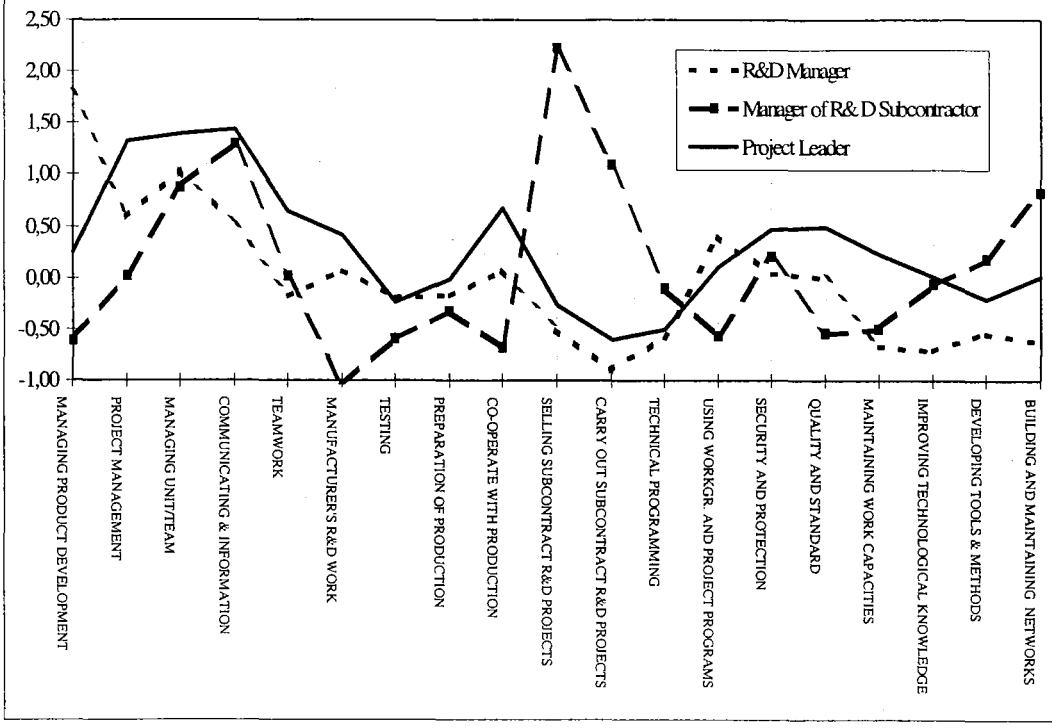
Often an activity cluster can be a base for an element – module - in curricula. In some cases, it is wiser and more effective to teach the skills and even knowledge needed to fulfil the activities in a cluster in other ways. For example teaching how to use computers, electronic mail, and even languages can be byproducts of other modules. Also pupils can form and study in groups and acquisition of knowledge and learning can be a process similar to working in teams.

Defining work profiles

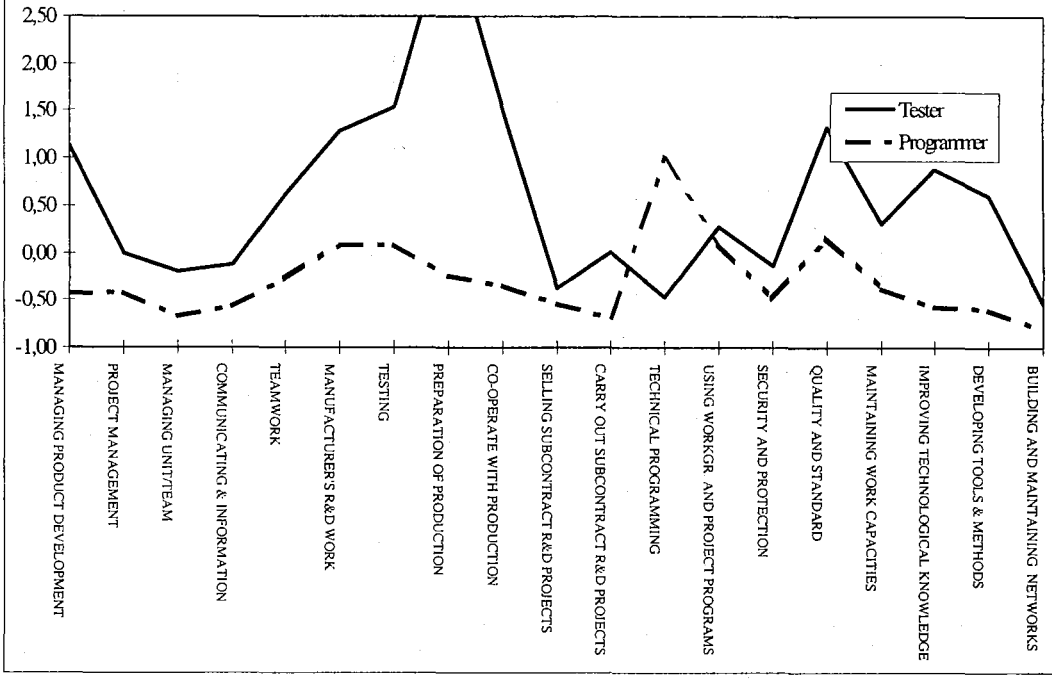
The following step in the OPAQ procedure, after forming clusters, is grouping the respondents into profiles. The fundamental idea here is to determine the different basic "profession" groups within the representative sample and consequently in the branch. In each profession group the persons' work profiles are rather similar to each other but profiles differ from each other.

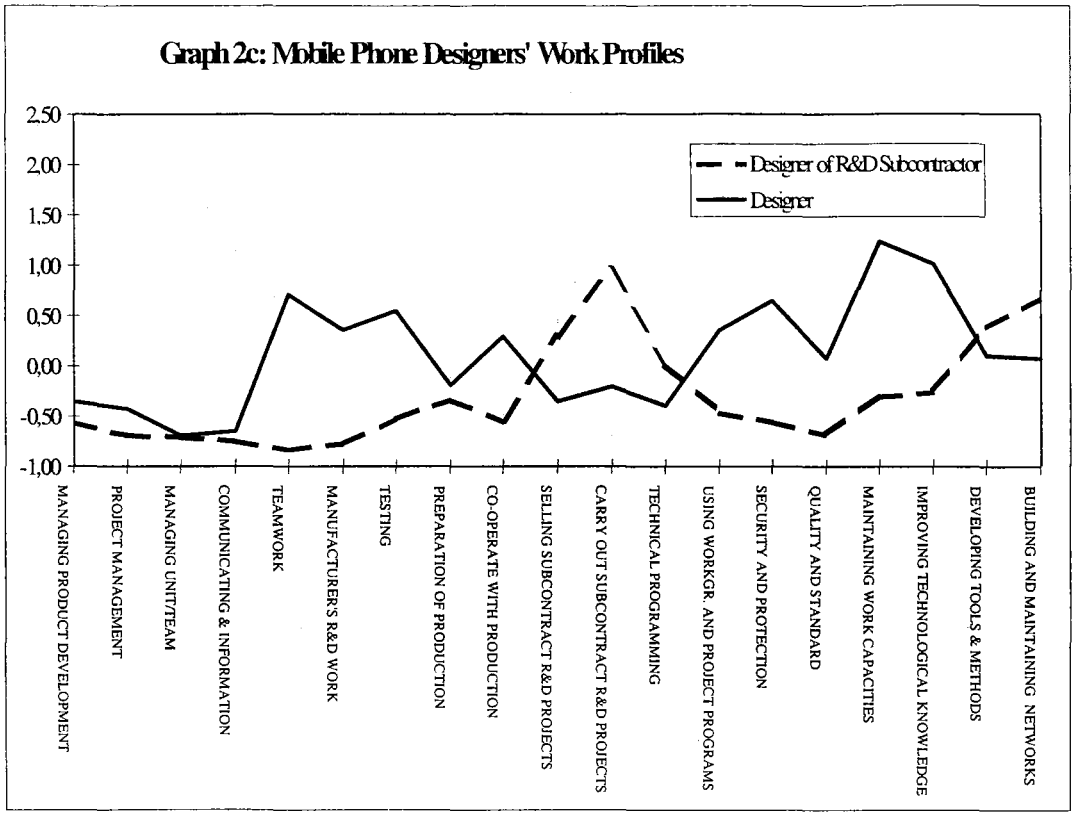
The programs used in the OPAQ procedure took an initial number of fifteen profiles and gradually reduced this by taking two similar profiles together. Final profiles are selected from the most stabile groupings. We find seven different profiles among research and development personnel of mobile phones. These are presented in the adjacent charts 2a-c. Again, the final solution was a subjective one made by the researcher after consulting the industry specialist of the National Board of Education, Ms. Pirjo Putila.

Graph 2a: Mobile Phones R&D Managers' and Leaders' Work Profiles



Graph 2b: Mobile Phone R&D Testers' and Programmers' Work Profiles





R&D managers' and project leaders' work profiles (Graph 2a) were rather similar. In R&D managers' work there is more stress on activities related to managing product development and using workgroup and project management programs. Project leaders do more social activities like managing the unit or team and communication. He or she also manages innovations and their protection (included in security and protection) as well as quality and standard issues. R&D managers of subcontractors have to put more emphasis on selling and carrying out subcontracting projects. Instead they don't need to manage project development, which is under the responsibility of a client company. Often subcontracting tasks are small, requiring only one or a few researchers. That is why project management activities are not so important. Developing tools and methods and especially building and maintaining networks and communicating are among the core areas of subcontractors' R&D manager work.

Testers (Graph 2b) are naturally responsible for testing the R&D work done i.e. components, modules containing several components and sub programs and programs included in the mobile phone concerns and final product. Tests are made as simulation tests and as tests for the prototypes and the final products. Managing the product development and of course quality and standards issues are important for them. Helping to start the production and co-operation with production seems to be an essential part of their work.

Programmers (Graph 2b) are an important group and their number is growing because programs are replacing mechanical solutions, and the new services can be created 'simply' by programs. Here programmers got higher scores only in technical programming and in quality and standards issues. If the technical side had been included in the study, there would certainly have been more relevant clusters. In any case,

teamwork and project management skills do not seem to be as important as they are for many other profiles. This might be the result of a rather strict labor division as well as other groups being more responsible for coordination.

Designers and researchers (designers of R&D subcontractors) (Graph 2c) are basic personnel groups:

- Maintaining work capacities and improving technological knowledge are stressed in designers' work activities. This is natural since technology and its applications are in a fast developing process and at the same time education cannot give any superior or long lasting knowledge about them. In this situation the capability and skills needed to adapt to new knowledge are essential. One other aspect is the improvement of creativity, which is needed in this innovative work. The third important aspect is the ability to avoid and tolerate stress. Innovation management, protection and other connected security activities were done frequently and ranked important. Designer work is mainly teamwork. Workgroup and project programs are actively used.
- Subcontractors' designers (researchers) carry out subcontracting activities, which often are feasibility studies, theoretical modeling, making limited programming tasks etc. They work more independently. Nevertheless, they often also obtain their own projects, which demands selling activities. The competitive edge of this group comes from science and the scientific community. Developing tools and methods as well as building and maintaining networks are important.

3.4. Future analyses

In the study the future development of mobile phone R&D work was anticipated by two different methods:

- Respondents were asked to list ten activities, whose importance will increase the most during the next 5 yeas, and correspondingly ten activities, whose importance will decrease.
- The results were presented to a group of Nokia Mobile Phone Ltd R&D managers and personnel managers. Later, future development analysis was discussed in the meeting, where there were also attendants from social partners and educational institutions.

The respondents' answers were incomplete in the sense that lists were not fully completed. Normally, tasks whose importance will increase were mentioned considerably more compared to tasks whose importance was supposed to decrease. A short summary table of answers given by respondents is presented below in Table 10.

The two first points are interesting. So far the primus motor of mobile phone development has been development of technology itself. Now R&D staff expect that users' needs and application possibilities will become more important. So they are even mentally ready to change from technology push to need pull or some kind of interactive product development, which in any case may be the trajectory of development. One other significant change is that R&D staff have learned that technology development also has economic prerequisites. Firms' profit prospects and optimal use of value added change in use has to be taken into account.

Table 10: Increasing and Decreasing Areas of Work by Importance

Increasing areas

- Taking account of user needs and application possibilities of technology
- Taking account of R&D effects on the value added change and firms' profit prospects
- Improving quality and sensitivity of communication and teamwork
- Developing work methods and tools
- Improving quality responsibility
- Protecting innovation and copyright protection and the right to use them
- Better utilization of communication and information technology
- Managing R&D activities
- Maintaining and improving work capability and capacity

Decreasing activities

- Using old fashion communication (letter, fax)
- Using old programming languages (assembler-programming)
- Taking part and giving presentations in exhibitions, meetings of industrial organizations, conferences
- Archiving of R&D documents
- Research work financed by grants

R&D and personnel experts partly expressed the same things. They also stressed the business view of product management as well as taking into account customers' needs and managing them. On the other hand, they see that there is a need to improve technological knowledge connected with the foresight of technological development. Also, innovation management (including identification, evaluation, resource investment, introduction into the product and finally protecting by patents etc.) will become more important.

Table 11: Experts Future Analysis Based on Study Results

Increasing activities

- International teamwork and networking
- Innovation management
- Buying and managing R&D subcontracting
- Business view of project management
- Effective use of communication and information technology (new equipment, programs, media)
- Improving technological knowledge with the foresight of technological development
- Taking into account customer needs and managing them

Decreasing activities

- Analog technology design activities
- Hardware design activities

According to experts, teamwork is becoming even more important and networking within and between companies. Both will become international because of globaliza-

tion of business and R&D activities of companies. Externalization of tasks together with globalization make buying and managing of R&D more important and demanding in the future. A list of experts' future trends is in the Table 11.

Firm experts were also asked to comment on present education. They emphasized that technical education is at a high level in Finland. There is only a huge shortage of an educated workforce. However, the situation is better here than in countries where they have subsidiaries.

The Biggest developing need is in skills and knowledge needed to fulfil "social activities" included in this study. They also stressed the importance of the correct teaching and learning methods.

Table 12: Some Notes on Vocational Education

- Technical education is at a high level in Finnish universities and polytechnic institutions but the numbers of graduates is too modest
- The biggest development needs are connected to work activities included in the questionnaire (see activity clusters and ten must skills)
- Some activity clusters do not need to form a module in education. It is more a question of how to teach. Teaching methods and learning results can be improved by:
  - > using computers, programs, communicating methods and surroundings similar to actual workplaces
  - > using teamwork and networks for gathering information, analyzing it, solving problems, making reports etc.
  - > familiarizing students with work of international teams and networking via international contacts, students and teacher exchange, visits etc.

4 Evaluation of OPAQ analysis method from the Finnish perspective

4.1 General advantages of the OPAQ method

The OPAQ methodology, as sampling research, can be applied to research effectively work contents and profiles in industries with plenty of work places and large numbers of employees. In these cases, it is impossible to cover all employees or places of business within the study. The cost/quality relationship of the sampling research is good if central questions are asked from a minimum sample that describes the population being researched well.

The OPAQ method provides a precise description of job content. It lists the key job performances (activities) of the branch being researched and groups them separately into job blocks, or activity clusters.

The OPAQ method divides personnel into groups, with the help of job content, which have different work profiles. Within each group, the job content, or work profile, is homogenous. The job blocks, or activity clusters, are weighted in the same fashion across personnel belonging to the same profile. It can be said that the method illustrates what the true professions of a branch are, as determined by job content.

The activity clusters, and the activities they comprise, along with the information on the branch's different work profiles – the true professions – are of utmost importance when preparing curricula. In addition, a precise picture of today's job content and different work profiles provides a good basis for making estimations on the future changes of work. These estimations can be taken into account in curricula.

The OPAQ method can also be used as a tool by researchers who are not familiar with the branch. With the assistance of experts from that branch, it can be ensured that the work activities of the branch are covered in the questionnaire and that the sample questions therein provide a good picture of the branch. The results are generated using standard advanced statistical methods. Finally, the social partners accept the work results (activity clusters and professional skill profiles).

Due to the formality of the OPAQ method, the researcher is given the opportunity to develop the cost efficiency and quality of the work within the framework of the method. When the method is repeated in more or less the same fashion, its routines can be refined so as to be more efficient. The activities of different branches can, in addition, be collected in databases, which help in making confirmations and which provide lists of potential activities (generic activities) when research is conducted across many branches. Naturally, they provide a good base for repeated research in the same branch.

4.2 The general requirements of the OPAQ method

The OPAQ method requires strong commitment and input from the representatives of the branch being researched. In the Netherlands, this commitment is ensured via an agreement settled between the government and the social partners (employer and employee groups). According to this agreement, social partners are responsible for

timely occupational analysis for purposes of preparing educational standards and curricula. The analysis of occupations itself is generally given to the specialized research unit to conduct, but the groups must provide expertise to the researchers and the social partners have the final say in the results. As a counterweight, the government funds a significant part of the costs of analysis.

In the Netherlands, the social partners are apparently able to assist the researchers well. They have a strong vocational grasp on firms and their employees as well as a substantial knowledge of job content.

The rather technical OPAQ method also requires that the research be concentrated on specialized personnel and organizations. If analyses were requested here and there, the costs of learning the method would be unreasonable and the persons and corporations involved would not reach the needed level of learning. There is a clear benefit from specialization.

The method is applicable to large branches and, on the other hand, it requires large branches for cost reasons. For small branches, the costs prove to be too high. Therefore, the method cannot be used to cover all sectors of the economy. The problem is more serious, the smaller the economy.

4.3 The problems associated with the OPAQ method

The OPAQ method concentrates on the importance of a selected branch's job duties and measuring their frequency. It is based on analysis of activities, or concrete job performances. *It does not collect information on the skills and knowledge needed to accomplish the activities or the possible attitudes, values and ethics that affect the accomplishment of the activities.* Information on these could be collected simultaneously.[11] On the other hand, this part is accomplished in connection with the so-called enrichment analysis, where the activities (by experts of working life and schooling) are translated into teaching content, educational goals and curricula.

Measurement of the activities is more justified and provides a good description of job duties when the branch is established. Job duties change slowly and they are relatively the same in different places of work. *When the branch in new or its jobs experience strong periods of transition, or development of the branch takes place rapidly, the activities are likely to change quickly and diverge across firms and places of work.* In this situation, it is better to find the skills, knowledge, attitudes, values and ethics that can overcome new challenges posed by changing job duties.

The OPAQ method emphasizes those activities that appear to be clearly distinctive activities and which produce some sort of apparently concrete output. *Many jobs that require "invisible" activities are thus in jeopardy of being left unnoticed.* One form of invisible activity is quality control, which is constantly conducted in connection with job performances. Many mental activities can be left out, such as the thought process related to work planning, carrying the responsibility for the productivity of work or the timeliness of activities, etc. These may be most visible when looking at how systematically work is being done and how quickly it is completed.

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[11] For example, the content of jobs in Nokia Mobile Phones are interpreted by dividing them into separate roles, within which are various activities, which require different skills, knowledge and attitudes, as well as possibly values and ethics. The critical aspects of these, from the point of view of competitiveness, could be found and subsequently strengthened with the aid of schooling.

The OPAQ method is overly extensive in small branches due to cost factors. In these branches, it is more efficient for the researcher to interview those persons responsible for work development and employees to attain a sufficient overview of the job blocks and work profiles and, in addition, to efficiently take into account future elements. Alternatively, the analysis can proceed in a team framework by experts and researchers in the branch. Here too, the OPAQ method can be used in structuring the branch and to determine the activities performed in a specific type of work, and later to enrich the results and future analysis. Thus, expert estimates replace the costly questionnaire process.

4.4 The applicability of the OPAQ occupational analysis in Finland

Finnish and Dutch institutional conditions diverge significantly from each other. The most significant differences, which affect the applicability of the analysis method, are perhaps the following:

1. Vocational education in the Netherlands is clearly industry-based. Only university education is based on science and subjects. Also, the occupational analysis method is built so that the point of departure is the line of business and the work conducted there - the activities and activity clusters as well as the different work profiles. In Finland, vocational education is a mixture, where the education is partly based on science and subjects and partly on the traditional professional titles. The necessities of the industries influence part of the education as well and, in the end, the structure of vocational education is determined by decisions made by the administration. In addition, much of the education has focused on general requirements. To achieve maximum benefit of the occupational analysis method in Finland, vocational education should be clearly based on industries.
2. In Finland, the main social partners (employee and employer groups) are first and foremost interest groups. They negotiate wages and working conditions and ensure that their interests are upheld in relation to those of the government. Only recently have they begun to promote education in their lines of business. A significant number of the organizations' employees are, due to the nature of their work, lawyers or persons having attained an education in administration or the social sciences. In order to cope with their new role, the social partners should hire professionals that are familiar with the sector's firms and the work conducted at work places. In addition, the social partners should engage in more occupational analyses, as is occurring in the Netherlands for example.
3. Also, the thinness of Finnish industries restrains current usage of the occupational analysis method. Many lines of business are so small that it is not profitable to conduct large-scale occupational analyses. In addition, many industries are constantly going through changes. From the perspective of a future employee, it is risky to attain an education which is specific to a certain industry if there is a danger that the industry in question will no longer exist after that education is attained, or if that type of work will totally change. The small size of the lines of business and the constant process of change pose a serious challenge to the entire educational system. Vocational education should produce a labor force that is competent overall, flexible and willing to learn, and which can be placed in many industries instead of just one.

However, many factors favor the usage of the OPAQ occupational analysis method:

1. It is a systematic, transparent method to determine job content and work profiles in different lines of business and its results can be used relatively easily for purposes of teaching content.
2. When the results are combined from analyses of different lines of business, it provides information on general job duties and their required skills, knowledge, values and attitudes that are requested from all employees no matter what their occupational profile and line of business (see the Ten must skills of mobile phone R&D work, Table 9). These represent the educational system's core competence information.
3. The method provides an excellent basis for future estimation concerning the lines of business and the work conducted in them. As such, educational goals, curricula and teaching content can be altered accordingly so as to meet the requirements of working life.
4. This method combines education to working life and bonds the social partners and the educational authorities to develop their own field.

The Finnish educational system can benefit from the present format of the OPAQ occupational analysis method in large branches. For example, the occupational profiles of construction work, restaurant work, elementary school teachers, grocery store merchants, banking personnel, etc. can be determined with the help of the OPAQ method.

The occupational profiles of small and dynamic sectors can be determined in cooperation with educational authorities or the researcher representing the educational institution and the branch's leaders and firms interested in work development. The appropriate way to proceed would include interviews and teamwork as well as even participating in observation and the hiring of firm experts to conduct analysis. For the most part, the OPAQ method can be used in these sectors too.

In the future, the analysis method could be developed to reveal more explicitly what activities and their knowledge and skills are a) general – needed in all or most fields, b) necessary in certain lines of business and c) specific to a particular firm.

A second aspect is to recognize the relatively stabile and, on the other hand, the constantly changing job duties. The present method provides the preconditions for mainly recognizing the teaching content and educational goals of the former. The knowledge and skills required by constantly changing job duties (learning to learn, creativity, boldness, etc.) should also be defined.

A third element for development is the effect of education on the competitiveness of the branch. In the present method, an attempt is made to match education with the activities and work profiles of the line of business. Could education change the activities and work profiles so as to improve the competitiveness of the branch? This means that firm-specific know-how and the generalization of activities would have to be transferred to other firms in the branch or, via education's core competence, to other areas besides the development of firm-specific know-how.

The applicability of the method requires training of the expert research group and securing that the organizations (the firms and the units of the education administration) engaged in the analyses have a sufficient number of orders. The social partners should also emphasize personnel resources. Persons in charge of the development of education in organizations and, on the other hand, representatives with occupational backgrounds similar to employers and employees could participate in the occupational

analysis of large branches. In small and dynamically developing branches, persons responsible for work development in leading firms and employees wanting to develop professionally could be involved. Teachers in the best educational institutions are also an excellent resource.

5. Concluding remarks

There has not been systematic method to produce information for preparing occupational qualifications and standards in Finland. Most of the work done has focused on finding out general skills and knowledge needed. Concrete information about work in different areas has been provided by sector experts, based on their familiarity and contacts with the branch. Branch committees named by the Ministry of Education have supported this work.

The OPAQ-method is a serious option for Finland. It systematically gives a lot of concrete information about work content and profiles. This would optimally complete the intensive work done to define general qualifications.

The OPAQ method could be used as such in bigger branches. It is a cost-effective way to collect information in these branches. For smaller branches, lighter procedures have to be developed. Nonetheless several practices of the OPAQ procedure can be used here as well. Also, the perspective should be different than in bigger branches. More stress has to be put on activities and work situations (and skills and knowledge needed) which are common to several branches and which improve the flexibility to place oneself in different branches depending on the current employment situation.

Another principal question to be solved is on what element we will base our vocational education. Is there a need for more industrial orientation? If so, the OPAQ method or some similar tool is definitely needed.

Annex 1: Clustering of Work Activities of Mobile Machinery Assemblers and Testers

(Number of activity refers to numbering of questionnaire. %-share from 134 respondents.)

Preparing assembling

No.	*Activity*	*Pers.*	*%-share*
10.01	I familiarize myself with information about the machinery to be assembled	74	55,2 %
10.02	I check the order information	83	61,9 %
10.03	In review the quality standards of the factory	68	50,7 %
10.04	I check if there are enough components at my work station	83	61,9 %
10.07	I clean my work station	101	75,4 %
10.08	In use lifts and hoists in my work	88	65,7 %
10.09	I use a forklift in my work	66	49,3 %
10.10	I use transport and loading equipment in my work	48	35,8 %

Mechanical assembling

No.	*Activity*	*Pers.*	*%-share*
1.05	I install the chassis	53	39,6 %
1.06	I install the power device (the motor)	58	43,3 %
1.07	I fit the gearbox	43	32,1 %
1.08	I fit the clutch	39	29,1 %
1.09	I fit the axles	52	38,8 %
1.10	I install the wheels or the caterpillar track	51	38,1 %
1.11	I install the cab	59	44,0 %
1.12	I install the engine hood	62	46,3 %
1.13	I install fastenings for the machinery	47	35,1 %
1.14	I install the machinery assembly	49	36,6 %
1.17	I fit the plates and other markings	75	56,0 %
5.01	I cooperate closely with my co-workers in my team	94	70,1 %
5.02	I divide the work with my co-workers in the team	89	66,4 %
5.03	I move from one job to the next within the team	74	55,2 %
5.04	I move from one production team to another	55	41,0 %
5.05	I install several machine models	80	59,7 %
5.06	I do various types of assembly work in the team (mechanical, hydraulic, electrical or automation)	78	58,2 %
5.07	I correct work done by my co-workers if I discover incorrect parts or poorly carried out installations	85	63,4 %
5.08	I participate in testing of machines after faulty assemblies are repaired	85	63,4 %
5.09	I learn from my co-workers about new components and work methods, etc.	86	64,2 %

5.10	I teach my co-workers about new components and work methods, etc.	79	59,0 %
5.11	I participate in setting efficiency targets for my team	58	43,3 %
5.12	I participate in planning ways of achieving the efficiency targets set for the team	57	42,5 %
5.13	We discuss the targets and significance of our team in relation to the performance of the whole company	47	35,1 %
5.14	I take part in setting quality targets for the team	46	34,3 %
5.15	I take part in discussing the reports concerning the work quality in our team	46	34,3 %
5.16	I discuss with my co-workers how the quality standards for the team can be reached	71	53,0 %

Hydraulic assembling

No.	*Activity*	*Pers.*	*%-share*
1.01	I familiarize myself with the drawings of the machine to be assembled	100	74,6 %
1.02	I read the product/work card of the machine to be assembled	98	73,1 %
1.03	I read the instructions from the component suppliers	91	67,9 %
1.18	I check that the parts to be installed are the correct ones and in good condition	68	50,7 %
1.19	I replace incorrect or faulty parts	83	61,9 %
1.20	I check that the machine is assembled according to the drawings	69	51,5 %
1.21	I correct faulty installations	82	61,2 %
1.22	I file a report on the incorrect or faulty parts	93	69,4 %
1.23	I file a report on faults and faulty work carried out in previous work phases	69	51,5 %
1.24	I file a report on the faults left unrepaired in my own work	50	37,3 %
2.01	I familiarize myself with the hydraulics chart of the machine to be assembled	82	61,2 %
2.02	I read the product/work card of the machine to be assembled	89	66,4 %
2.04	I install the hydraulic hoses	73	54,5 %
2.05	I install the hydraulic pumps	50	37,3 %
2.06	I install the hydraulic valves	63	47,0 %
2.07	I install the hydraulic cylinders	56	41,8 %
2.08	I fill the hydraulic system of the machine	57	42,5 %
2.09	I check that the installed hydraulic parts are correct and in good condition	72	53,7 %
2.10	I replace incorrect or faulty parts	69	51,5 %
2.11	I check that the parts have been installed properly	78	58,2 %
2.12	I repair poorly carried out installations	74	55,2 %
2.13	I check that installations are carried out in accordance with the hydraulics chart	67	50,0 %
2.14	I rectify incorrectly carried out installations to ensure they confirm with the hydraulics chart	65	48,5 %

2.15	I do a preliminary check on the functioning of the hydraulic system	72	53,7 %
2.16	I file a report on incorrect or faulty parts	66	49,3 %
2.17	I file a report on faults and faulty work carried out in previous work phases	51	38,1 %
2.18	I file a report on the faults left unrepaired in my own work	47	35,1 %

Electric assembling

No.	*Activity*	*Pers.*	*%-share*
3.01	I familiarize myself with the electrical diagram for the machine	64	47,8 %
3.02	I read the product/work card for the machine to be installed	61	45,5 %
3.03	I read the instructions from the component suppliers	55	41,0 %
3.07	I make sure that the electrical equipment to be installed in the machine complies with regulations	34	25,4 %
3.08	I install the machine's electrical leads	45	33,6 %
3.09	I install the lights	36	26,9 %
3.10	I install the electrical adjustment and control devices	32	23,9 %
3.11	I use electrical measuring equipment in my work	46	34,3 %
3.12	I check that the installed electric parts are correct and in good condition	47	35,1 %
3.13	I replace incorrect or faulty parts	51	38,1 %
3.14	I check that the parts have been installed correctly and in accordance with the electrical diagram	48	35,8 %
3.15	I repair installations carried out poorly and those not performed according to the electrical diagram	52	38,8 %
3.16	I check the functioning of the electrical system	46	34,3 %

Automation assembling

No.	*Activity*	*Pers.*	*%-share*
3.04	I keep a record of the completed phases as I am working	16	11,9 %
3.05	I read the electrical safety regulations	40	29,9 %
3.06	I familiarize myself with the electrical standards used for the machine	26	19,4 %
3.17	I file a report on incorrect or faulty parts	47	35,1 %
3.18	I file a report on defects and faulty work carried out in previous work phases	33	24,6 %
3.19	I file a report on the faults left unrepaired in my own work	34	25,4 %
4.01	I familiarize myself with the electronics diagram for the machine	28	20,9 %
4.02	I read the product/work card for the machine	35	26,1 %
4.03	I read the instructions from the component suppliers	26	19,4 %
4.04	I keep a record of the completed phases as I am working	9	6,7 %
4.05	I install the vehicle's steering automation system	18	13,4 %
4.06	I install the automation system for the machinery	21	15,7 %
4.07	I install the automation system for the seats	17	12,7 %

4.08	I check the condition of the automation system components	27	20,1 %
4.09	I replace faulty components	34	25,4 %
4.10	I check that the parts have been installed correctly and according to the instructions	25	18,7 %
4.11	I repair faulty and poorly carried out installations	26	19,4 %
4.12	I do a preliminary check on the functioning of the automation system	25	18,7 %
4.13	I make initial adjustments for the automation systems	25	18,7 %
4.14	I file a report on incorrect or faulty electronic components	29	21,6 %
4.15	I file a report on faults and faulty work carried out in previous work phases	18	13,4 %
4.16	I file a report on the faults that have been left unrepaired in my own work	19	14,2 %
15.06	I do corrective assembly work of electrical parts	43	32,1 %
15.07	I do corrective assembly work of automation / electronics	31	23,1 %
15.10	I train the other mechanics in the corrective work of electrical parts	30	22,4 %
15.11	I train the other mechanics in the corrective work of automation systems	23	17,2 %
15.14	I assist the other mechanics in the corrective work of electrical parts	43	32,1 %
15.15	I assist the other mechanics in the corrective work of automation systems	31	23,1 %

Assembling customized products

No.	*Activity*	*Pers.*	*%-share*
8.01	I take part in production of customized products	33	24,6 %
8.02	I design machinery parts for customer-specific orders	12	9,0 %
8.03	I make new kind of components and installations using my own initiative	24	17,9 %
8.04	I make drawings of the new components and installations that I have designed and made myself if no previous drawings are available	11	8,2 %
8.05	I make alterations to the product in the middle of assembly in order to comply with revised needs of the customer	33	24,6 %
8.06	I devise new working methods for unique items of machinery	12	9,0 %
8.07	I design the assembly site for unique items of machinery	7	5,2 %
8.08	I use instructions and drawings prepared in the customer's own language	13	9,7 %
8.09	I pass on information to be included in users' and service manuals	22	16,4 %
8.10	I disassemble parts of the machinery for transportation to or starting at the working location	26	19,4 %

Production of new mobile machinery

No.	*Activity*	*Pers.*	*%-share*
9.01	I participate in production of prototypes of new mobile machinery	54	40,3 %
9.02	I familiarize myself with new mobile machinery by participating in first production series	61	45,5 %
9.03	I participate in design of assembly stations for new mobile machinery	36	26,9 %
9.05	I participate in routine development of serial production	34	25,4 %
9.06	I attend courses about new machinery organized by the factory	45	33,6 %
9.07	I participate in courses on components organized by manufacturers or importers	27	20,1 %
9.08	I learn assembly routines of new machinery while working	61	45,5 %
9.09	I observe the work of co-workers when learning assembly routines of new machines	57	42,5 %
9.10	I teach co-workers the assembly routines of new machinery	52	38,8 %
9.11	I participate in checking of production targets	23	17,2 %
9.12	I participate in setting of hourly wage and salary targets related to production	20	14,9 %

Metal work

No.	*Activity*	*Pers.*	*%-share*
12.03	I do metal arc welding in my work	37	27,6 %
12.04	I do MIG/TIG welding in my work	41	30,6 %
12.05	I use a wafering machine	8	6,0 %
12.06	I use a drill in my work	53	39,6 %
12.07	I use an edging machine in my work	4	3,0 %
12.08	I use a grinding machine	39	29,1 %
12.09	I use a flame cutter	38	28,4 %

Preparing modules

No.	*Activity*	*Pers.*	*%-share*
11.01	I assemble transmissions	15	11,2 %
11.02	I assemble axles	12	9,0 %
11.03	I assemble motors	11	8,2 %

Testing work

No.	*Activity*	*Pers.*	*%-share*
14.01	I familiarize myself with defect reports from production	55	41,0 %
14.02	I familiarize myself with maintenance data on the most common problems in the machines	53	39,6 %
14.03	I familiarize myself with maintenance data on the most fragile parts of the machines	40	29,9 %

14.04	I use information on the machine's operating mechanisms in my testing work	48	35,8 %
14.05	I use information on the causes and effects of various defects	51	38,1 %
14.06	I locate faults by observing the machine in operation	56	41,8 %
14.07	I use fault finding devices when locating defects	52	38,8 %
14.08	I utilize the skills of a production mechanic to locate defects effectively	58	43,3 %
14.09	I utilize the experience of a maintenance mechanic to locate possible faults	38	28,4 %
14.10	I give the vehicle a test drive	45	33,6 %
14.11	I test the operating characteristics of the machinery in a working test	35	26,1 %
14.12	I check the work safety characteristics of the machinery	42	31,3 %
14.14	I check the quality of the mechanical assembling	43	32,1 %
14.15	I check that there are no oil or other leaks	58	43,3 %
14.16	I check the quality of functioning of the machinery	47	35,1 %
14.17	I check the functioning of the hydraulic system	55	41,0 %
14.18	I check the functioning of the electric system	44	32,8 %
14.19	I check the functioning of the automation systems	41	30,6 %
14.21	I check the quality of finishing work (painting, tape etc.)	42	31,3 %
14.22	I check that the outfit of the machine is made according to the order of the customer	61	45,5 %
14.23	I carry out repairs on the machinery that I test	45	33,6 %
14.24	I supervise the mechanics carrying out repairs	33	24,6 %
14.26	I adjust the automation system values to better suite the operator	33	24,6 %
14.27	I send written reports on defects to production	29	21,6 %
14.28	I report orally about faults to production	49	36,6 %
14.29	I participate in the handling of reports on defects	33	24,6 %
14.30	I ensure my information on defects is understood and used for make improvements	40	29,9 %
14.32	I receive customer feedback on machinery defects	36	26,9 %
14.33	I analyse customer feedback on defects	23	17,2 %
14.38	I offer suggestions for product development on the machines that I have tested	38	28,4 %
14.40	I see to the safety precautions in testing	26	19,4 %
14.41	I check safety precautions in initial start-up and preliminary testing in production	16	11,9 %
14.42	I participate in the planning and development of testing operations	25	18,7 %

Correcting assembling

No.	*Activity*	*Pers.*	*%-share*
15.01	I read defect reports issued by testing unit	65	48,5 %
15.02	I plan the required corrective work	52	38,8 %
15.03	I do the required disassembly	66	49,3 %
15.04	I do corrective assembly work of mechanical parts	68	50,7 %

15.05	I do corrective assembly work of hydraulic parts	60	44,8 %
15.08	I train the other mechanics in the corrective work of mechanical parts	37	27,6 %
15.09	I train the other mechanics in the corrective work of hydraulic parts	33	24,6 %
15.12	I assist the other mechanics in the corrective work of mechanical parts	62	46,3 %
15.13	I assist the other mechanics in the corrective work of hydraulic parts	54	40,3 %
15.16	I assemble the machinery after the defect has been corrected	64	47,8 %
15.17	I wash and clean the machinery after it has been repaired	41	30,6 %
15.18	I file a report on the corrective repairs made	50	37,3 %
15.19	I make suggestions for production improvements to reduce defects in the machines	64	47,8 %

Finalizing work

No.	*Activity*	*Pers.*	*%-share*
1.15	I apply primer to parts of the machinery or chassis	29	21,6 %
1.16	I cover machine parts before painting	27	20,1 %
13.01	I participate in painting of machinery	13	9,7 %
13.02	I participate in taping of machinery	54	40,3 %
13.03	I participate in equipping machinery to order of customer	73	54,5 %
13.04	I participate in covering and packaging the machine for delivery	32	23,9 %

Serving customers

No.	*Activity*	*Pers.*	*%-share*
7.17	I deal with customers directly on matters concerning my special field (e.g. by giving maintenance advise and answering complaints)	21	15,7 %
13.06	I provide practical training to customer	12	9,0 %
13.07	I provide safety instruction to customer	8	6,0 %
13.08	I assist customer in initial use of machinery	10	7,5 %
14.20	I check is the machine ready for the vehicle inspection	14	10,4 %
14.25	I wash and clean the machinery that I test	27	20,1 %
14.31	I give personal advise to customers on searching for defects and repairs	20	14,9 %
14.37	I advise maintenance on correct ways to undertake repair and maintenance work	17	12,7 %
17.01	I explain the properties of the machinery to customers	27	20,1 %
17.02	I advise customers on how to use the machine efficiently and effectively	16	11,9 %
17.03	I advise customers on handling possible defects	19	14,2 %
17.08	I use an interpreter when talking with foreign customers	16	11,9 %
17.15	I emphasize good service in my contacts with customers	29	21,6 %
17.16	I give customers a reassuring picture of my work	39	29,1 %

17.17	I try to sell our factory's products when dealing with customers	14	10,4 %

Working independently

No.	*Activity*	*Pers.*	*%-share*
7.04	I plan how to carry out my work and how to achieve the output targets	63	47,0 %
7.07	In situations where new skills are required, I ask specialists of the factory (foreman, planner, supervisor) for help	72	53,7 %
7.08	I situations requiring new skills I obtain information from handbooks, courses, etc.	50	37,3 %
7.09	In situations where new skills are required, I ask specialists from outside the factory for help	39	29,1 %
7.12	I take part in setting quality targets for my work	28	20,9 %
7.13	I am solely responsible for the quality of my work	77	57,5 %
7.14	I correct the faults in my work myself	69	51,5 %
7.16	I make suggestions for product development connected with my own field	43	32,1 %
7.18	I do maintenance work related to my special field	17	12,7 %

Work safety

No.	*Activity*	*Pers.*	*%-share*
16.01	I familiarize myself with occupational safety norms (occupational safety laws, regulations, instructions on use of equipment, etc.)	67	50,0 %
16.02	I familiarize myself with occupational safety instructions given by the company	101	75,4 %
16.03	I use the correct tools for work	74	55,2 %
16.04	I use the correct work methods	71	53,0 %
16.05	When lifting heavy objects I check the lifting equipment and fastenings and that the way is clear	93	69,4 %
16.06	I try to prevent dangerous situations	105	78,4 %
16.07	During initial start-ups and after malfunctions, I make sure that precautions have been undertaken	73	54,5 %
16.08	I use personal protective equipment	110	82,1 %
16.09	I participate in investigating dangerous situations	49	36,6 %
16.10	I participate in investigation of accidents	17	12,7 %
16.12	I advise my co-workers about occupational safety	43	32,1 %
16.13	I make proposals to my employer about matters related to occupational safety	53	39,6 %
16.14	I participate in occupational safety planning in my company	26	19,4 %
16.15	I find out the correct occupational safety measures for new work phases	59	44,0 %
16.20	I participate in activities an occupational safety organization	10	7,5 %

Production-line work

No.	*Activity*	*Pers.*	*%-share*
6.01	I work on the line independently according to the previously defined division of labor between myself and other mechanics	27	20,1 %
6.02	I participate in planning how the work is divided	19	14,2 %
6.03	I repeat the same assembly work phases regularly in my work	29	21,6 %
6.04	In problem situations I turn to a co-worker for assistance or to a supervisor	27	20,1 %
6.05	I alternate between different jobs on the production line	21	15,7 %
6.06	I do various aspects of the assembly work (mechanical, hydraulic, electrical or automation)	29	21,6 %
6.07	I participate in repair of machines assembled on our line after testing	30	22,4 %
6.08	I receive guidance from the supervisor and from my co-workers when I start a new installation task	32	23,9 %
6.09	I train new workers on the line	32	23,9 %
6.10	I work with care and make checking to ensure that the quality of my work stays high	35	26,1 %
6.11	I report immediately to the foreman or the supervisor about any work phases that I do not manage or have time to do	28	20,9 %
6.12	I report to the foreman on faulty parts left in the machine and on incorrect installations	33	24,6 %
6.13	I take part in assessing the efficiency of my work	17	12,7 %
6.14	I take part in assessing the quality of my work	19	14,2 %
6.15	I take part in setting output targets for the production line	13	9,7 %
6.16	I discuss with my co-workers how the set output targets can be reached	18	13,4 %
6.17	I take part in setting quality targets for work on the production line	17	12,7 %
6.18	I participate in meetings where we discuss what our line can do to improve company profitability	14	10,4 %
18.01	I participate in meetings where we discuss profitability developments of our company	47	35,1 %
18.02	I participate in meetings where we discuss what should be done to improve customer satisfaction	37	27,6 %
18.03	I participate in meetings where we discuss how to develop quality targets for the whole company	46	34,3 %
18.04	I participate in meetings where we discuss improvement of working conditions	43	32,1 %

Annex 2: Clustering of Work Activities of Mobile Phone Product Development Staff

(Number of activity refers to numbering of questionnaire. %-share from 116 respondents.)

Managing product development

No.	*Activity*	*Pers.*	*%-share*
1.01	I manage preliminary studies for product development projects	19	16,4 %
1.03	I am responsible for assessing product development requirements	19	16,4 %
1.04	I analyse customer feedback for assessing product development requirements	15	12,9 %
1.05	I analyse other marketing feedback for assessing product development requirements	19	16,4 %
1.06	I familiarise myself with research related to product development projects in order to identify development possibilities	28	24,1 %
1.10	I am responsible for formulating product development requirements and objectives (writing product specifications)	25	21,6 %
1.12	I take part in deciding product development objectives	37	31,9 %
1.13	I am involved in decisions on 'content' objectives (what needs are being met)	40	34,5 %
1.15	I am involved in appointing the project manager and principal designers	19	16,4 %
1.16	I am involved in making decisions about the project timetable and resources	53	45,7 %
1.17	I am responsible for implementation stage of product development projects	25	21,6 %
1.26	I determine the cost implications of project development	27	23,3 %
1.28	I am responsible for testing the product being developed	13	11,2 %
1.35	I am responsible for documentation of the development project	15	12,9 %
1.41	I cam responsible for conveying the results to production	9	7,8 %

Project management

No.	*Activity*	*Pers.*	*%-share*
1.24	I determine tasks and objectives for other projects	22	19,0 %
1.25	I determine the repercussions of project development for technology	19	16,4 %
1.27	I am responsible for co-ordinating the work of those engaged in the project	41	35,3 %
3.01	I analyse the goals set by the group	67	57,8 %
3.03	I try to integrate new co-workers firmly into the team	71	61,2 %

4.32	I monitor the costs of the project	26	22,4 %
4.33	I am responsible for improving product development work	24	20,7 %
4.34	I assess developments in technology	28	24,1 %
4.37	I initiate reforms in product development work	32	27,6 %

Managing unit/team

No.	*Activity*	*Pers.*	*%-share*
4.01	I am responsible for recruiting new staff	36	31,0 %
4.02	I take into consideration the needs and characteristics of my subordinates in my supervisory work	43	37,1 %
4.03	I am responsible for planning product development	35	30,2 %
4.04	I define the product development objectives	34	29,3 %
4.05	I plan the timetable for product development	31	26,7 %
4.06	I plan the use of resources in product development	35	30,2 %
4.07	I try to promote my staff's enjoyment of work	35	30,2 %
4.08	I set objectives for staff	44	37,9 %
4.09	I explain the reasons for the objectives	44	37,9 %
4.10	I give feedback to staff regarding their work	45	38,8 %
4.11	I reward staff for good work	36	31,0 %
4.12	I ask the opinions of my subordinates before making my decision	47	40,5 %
4.13	I include my subordinates in decision making	47	40,5 %
4.15	I make sure my decisions are carried out	46	39,7 %
4.16	I support my staff within the organisation	45	38,8 %
4.17	I support my staff outside the organisation	33	28,4 %
4.18	I try to recognise the problems met by the team/unit I manage	36	31,0 %
4.19	I find solutions to meet the problems	46	39,7 %
4.27	I am responsible for achieving the objectives of the team/unit	43	37,1 %
4.28	I make sure deadlines are met	44	37,9 %
4.29	I am responsible for the use of resources in the project	35	30,2 %
4.30	I make sure that resources are used efficiently	39	33,6 %
4.31	I make sure the designers have a reasonable workload	38	32,8 %

Communication & information

No.	*Activity*	*Pers.*	*%-share*
4.20	I am responsible for communications within the team/unit	38	32,8 %
4.21	I also use unofficial channels in communications	42	36,2 %
4.22	I obtain the relevant information from the organisation	38	32,8 %
4.23	I acquire information via unofficial channels	40	34,5 %
4.24	I use my technical expertise in managing	41	35,3 %
4.25	I present alternative solutions to the technical problems met by my staff	41	35,3 %
4.26	With my technical expertise I am able to direct the work to	41	35,3 %

meet the relevant goal

Teamwork

No.	*Activity*	*Pers.*	*%-share*
3.02	I evaluate my own contribution in achieving the objectives of the team	92	79,3 %
3.04	I maintain the team spirit	100	86,2 %
3.05	I confer with my co-workers	108	93,1 %
3.06	I listen and ask opinions of co-workers	108	93,1 %
3.07	I analyse different viewpoints of co-workers and alternative solutions	105	90,5 %
3.08	I make proposals for joint decisions	103	88,8 %
3.09	I define boundary lines between other people's work and my own	79	68,1 %
3.10	I make proposals for dividing the work	93	80,2 %
3.11	I try to help	106	91,4 %
3.12	I try to be flexible to the needs and requirements of the group in my work	105	90,5 %
3.13	I support opinions and proposals of others	106	91,4 %
3.14	I ask the expectations of others and make proposals on the basis of their needs	95	81,9 %
3.15	I try to improve my ability to cope with pressure	81	69,8 %
3.16	I try to improve my knowledge of quality	99	85,3 %
3.17	I try to develop the team's awareness of and responsibility for quality	78	67,2 %
3.18	I try to develop independent working skills as part of team-work (peaceful work environment, objective setting)	87	75,0 %
10.05	I use non-verbal communication skills of interpretation and expression	97	83,6 %

Manufacturer's R&D work

No.	*Activity*	*Pers.*	*%-share*
1.02	I participate in planning of preliminary studies for product development projects	51	44,0 %
1.09	I sift through my earlier research for ideas and research possibilities that could facilitate product development	47	40,5 %
1.11	I take part in defining the critical factors in product development (key stages and influential factors in product development)	41	35,3 %
1.14	I am involved in making specifications for different product development levels (product level, interface and sectoral specifications)	48	41,4 %
1.18	I take part in project planning	61	52,6 %
1.19	I take part in inspection of design work	69	59,5 %
1.20	I contribute to supplementing the product development objectives and defining them in more detail	55	47,4 %

1.21	I look over my earlier product development work and check for anything that can be made use of in the project	58	50,0 %
1.22	I investigate the R&D work of others and the possibilities for using any of it in the project	60	51,7 %
1.23	I do my own new innovative product development work	65	56,0 %
1.36	I maintain and supplement product development documentation as the project progresses	54	46,6 %
1.37	I draft notes of meetings etc.	63	54,3 %

Testing

No.	*Activity*	*Pers.*	*%-share*
1.29	I plan the testing	44	37,9 %
1.30	I perform the tests under simulated conditions	42	36,2 %
1.31	I perform the laboratory testing	39	33,6 %
1.32	I perform the testing of prototypes	18	15,5 %
1.33	I take part in field testing of equipment	50	43,1 %
1.38	I document testing and test results	52	44,8 %
1.40	I am responsible for archiving documents about product development	31	26,7 %
1.43	I produce documents for use in production	18	15,5 %

Preparation of production

No.	*Activity*	*Pers.*	*%-share*
1.34	I specify the production of trial equipment required for the testing	15	12,9 %
1.44	I produce documents for use in marketing	10	8,6 %

Co-operate with production

No.	*Activity*	*Pers.*	*%-share*
1.07	I investigate the suggestions of component and part suppliers and the possible contribution to product development	32	27,6 %
1.08	I investigate suggestions from production and the possible contribution to product development	31	26,7 %
1.42	I am involved in co-operation with production concerning the start of production of the product	36	31,0 %
9.03	I use information on the financial aspects of mobile phone production (e.g. the cost impacts of changes in different parts)	54	46,6 %
9.04	I use information on the value-added chain of mobile phones (e.g. the impacts for subcontractors and production caused by changes in parts and components)	36	31,0 %

Selling subcontract R&D projects

No.	*Activity*	*Pers.*	*%-share*
2.01	I take responsibility for clients' tender invitations	11	9,5 %
2.02	I find out needs of clients	23	19,8 %
2.03	I prepare project tenders requested by clients	16	13,8 %
2.04	I prepare project tenders for clients based on own research	18	15,5 %
2.05	I negotiate with clients about project tenders	21	18,1 %
2.06	I agree with client about research and development projects	22	19,0 %
2.17	I determine with client additional product development work on basis of preliminary study	17	14,7 %
2.31	I define areas of priority for own research facilitating sub-contracting projects in research and development	22	19,0 %
2.34	I gather together parties for research projects	16	13,8 %
2.35	I take care of obtaining financing for joint research projects	11	9,5 %
2.36	I take care of publishing results of joint research projects	16	13,8 %
8.01	I make presentations showing my expertise to clients	31	26,7 %

Curry out subcontract R&D projects

No.	*Activity*	*Pers.*	*%-share*
2.07	I gather necessary information for projects	58	50,0 %
2.08	I familiarise myself with research material related to projects	59	50,9 %
2.09	I clarify demands set by project clients	36	31,0 %
2.10	I perform preliminary work for product development projects	41	35,3 %
2.11	I carry out research for research projects	42	36,2 %
2.12	I participate in project meetings organised with clients	46	39,7 %
2.13	I report to clients about progress in project	40	34,5 %
2.14	I report to clients about results of project	41	35,3 %
2.15	I carry out preliminary studies of product development projects and their results	27	23,3 %
2.16	I produce research reports for clients about research projects	31	26,7 %
2.21	I transform product development results into understandable form for client	21	18,1 %
2.28	I make reports about product development project to client	19	16,4 %
2.29	I present results of product development work to client	18	15,5 %
2.32	I carry out my own research facilitating subcontracting projects in research and development	28	24,1 %
2.33	I carry out research as a basis for product development work sold externally	18	15,5 %
7.01	I do research related to my own special field	73	62,9 %
8.03	I make presentations at conferences	36	31,0 %
8.09	I write articles for scientific journals	35	30,2 %
8.10	I write articles for professional publications in my field	21	18,1 %
8.11	I publish studies and research reports about my work	40	34,5 %

Technical programming

No.	*Activity*	*Pers.*	*%-share*
9.07	I use different design systems (such as object-based design)	59	50,9 %
11.07	I use different programming languages, programs and tools	67	57,8 %
11.08	I use the language C+ or C++	46	39,7 %
11.09	I use other programming languages (assembler level programming)	24	20,7 %
11.10	I use object-based programming	21	18,1 %

Using work group and project programs

No.	*Activity*	*Pers.*	*%-share*
11.04	I use project programs	71	61,2 %
11.05	I use programs for time and resource planning and for cost control and planning	55	47,4 %
11.06	I use work group programs	53	45,7 %
11.12	I use data documentation programs	70	60,3 %
11.13	I use storage and retrieval programs	73	62,9 %

Security and protection

No.	*Activity*	*Pers.*	*%-share*
6.01	I ensure that there is legal protection for innovations and intellectual property rights	28	24,1 %
6.02	I ensure my inventions receive patents, trademarks and other legal protection	36	31,0 %
6.03	I ensure that the results of my product development work are protected also internationally	23	19,8 %
6.04	I present initiatives and product development ideas for internal registration in the company	34	29,3 %
6.05	I make sure the results of product development work are continually documented	54	46,6 %
6.06	I familiarise myself with patents, research, etc. in order to avoid infringing the rights of protected innovations	38	32,8 %
6.07	I check that there is no infringement on my innovations	14	12,1 %
6.08	I make sure that information is physically protected in various ways	57	49,1 %
6.09	I make sure that property security systems function and that they are supervised (passes, locks, etc.)	33	28,4 %
6.10	I make sure that the computer network and valuable data are protected properly (use of user rights, passwords, virus detection programs)	47	40,5 %
6.11	I see to information security on business trips and visits	63	54,3 %
6.12	I see to the archiving of product development documentation	35	30,2 %

Quality and standard

No.	*Activity*	*Pers.*	*%-share*
9.05	I use a knowledge of different quality systems (such as the company's quality systems and quality inspection, and the requirements of inspection bodies)	63	54,3 %
9.06	I use a knowledge of national standards and approval procedures applying in different countries	55	47,4 %

Maintaining work capacities

No.	*Activity*	*Pers.*	*%-share*
5.01	I make an effort to maintain a healthy state of mind at work	81	69,8 %
5.02	I regularly evaluate my own working capacity and workload	96	82,8 %
5.03	I try to improve my ability to cope with stress (I plan my work rationally, concentrate on one task at a time, etc.)	94	81,0 %
5.04	I try to think of refreshing counterbalances to work	104	89,7 %
5.05	I keep in contact and avoid isolation from my supervisor and co-workers	112	96,6 %
5.06	I maintain my physical condition for work in various ways	106	91,4 %
5.07	I make sure the equipment I use at work is appropriate and ergonomic	102	87,9 %
5.08	I suggest ways to improve conditions in the workplace (heat, light, ventilation, cleanliness, etc.)	74	63,8 %
5.09	I practise preventive exercise in the workplace (e.g. wrist cramp from using computer mouse)	34	29,3 %
5.10	I try to improve my knowledge of first aid equipment in the workplace	28	24,1 %
5.11	I try to improve my knowledge of occupational health services	44	37,9 %
5.12	I familiarise myself with the occupational safety regulations issued (e.g. travel regulations)	69	59,5 %
5.14	I study and familiarise myself in advance with new working conditions (such as foreign cultures, customs and norms)	66	56,9 %
5.15	I learn new work methods	82	70,7 %
5.16	I try to improve my ability to learn new things	78	67,2 %
7.09	I study and develop my creative thinking	73	62,9 %
7.10	I apply creative methods to come up with ideas	63	54,3 %
9.02	I use information on the structure and content of product systems (service package, products, modules, components)	68	58,6 %

Improving technological knowledge

No.	*Activity*	*Pers.*	*%-share*
5.13	I take part in continuing and further vocational education	93	80,2 %
7.04	I try to broaden my knowledge of new applications for mobile phone technology	97	83,6 %
7.05	I try to broaden my theoretical knowledge of mobile phone technology	93	80,2 %

7.06	I acquire additional information on the needs of different (and potential) users and their operating environments	59	50,9 %
7.07	I try to increase the user-based influence in product development alongside that of technology	67	57,8 %

Developing tools and methods

No.	*Activity*	*Pers.*	*%-share*
2.18	I plan theoretical product development work	33	28,4 %
2.19	I build simulation models on product development matters	29	25,0 %
2.20	I develop methods necessary in product development	38	32,8 %
7.02	I try to develop tools for product development	45	38,8 %
7.03	I try to improve working methods for product development	46	39,7 %

Building and maintaining network

No.	*Activity*	*Pers.*	*%-share*
7.08	I study new methods of combining product development and production (e.g. mass production vs. tailor-made solutions)	20	17,2 %
8.02	I participate in shows in my field	59	50,9 %
8.04	I participate in meetings of organisations in my field	30	25,9 %
8.05	I tell about my work to persons of influence in my field	25	21,6 %
8.06	I report about my work to my superior	92	79,3 %
8.07	I present my work in meetings at work	85	73,3 %
8.08	I write academic studies	25	21,6 %
8.13	I participate in the discussion on the Internet	16	13,8 %
8.15	I maintain a home page on the Internet	24	20,7 %
8.16	I keep my curriculum vitae up to date	48	41,4 %
8.17	I apply for grants related to my research work	17	14,7 %
10.09	I use German in my work	14	12,1 %

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