Westfälische Hochschule

University of Applied Sciences
Gelsenkirchen Bocholt Recklinghausen

Research and Development at the Westphalian University

Research Report 2014 – 2017

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Content

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Foreword

Research at the Westfälische Hochschule (2013 – 2017)

In the year 2017, the Westfälische Hochschule (Westphalian University of Applied Sciences) celebrated 25 years of its existence. Originally founded as a School of Engineering, the university today operates in a much wider range of fields, as the contributions in this Research Report demonstrate.

Research activities range from social sciences and sociological questions to the technical and natural sciences and the challenges of achieving secure internet communications which are increasingly affecting us all today.

The Westphalian University of Applied Sciences has long been known as a powerhouse of ideas where young people work with their professors to develop their initial ideas right through to the stage of an actual product and, at the end, venture to take the step of founding a new company. This leads to the creation of new jobs, and not only for the highly-qualified graduates of our university, for, after all, those who produce goods and services also need plenty of helping hands. And what is worthier of "the toil of noble men"* than striving to create jobs?

I am very pleased that the research carried out here at the Westphalian University of Applied Sciences is starting to have an increasingly strong impact in this area too, and I can only encourage all members of our university to go further down this path.

With the building of the "InnoCent", space for the setting-up of young companies has successfully been established right next door to our premises in Bocholt. This can above all be traced back to the huge efforts of local entrepreneurs and other key players in the region. The executive board of the Westphalian University of Applied Sciences is now working towards setting up comparable facilities in Gelsenkirchen in the next few years.

I am looking forward to being able to continue working with you in the coming years on the establishment of the Westfälische Hochschule as a driver of innovation for the region. On behalf of the entire executive board of the Westfälische Hochschule, I would like to offer my sincere thanks to all those who are accompanying us on this path.

* Friedrich Gottlieb Klopstock (1724-1803), "Ode to Lake Zurich"

For the executive board of the Westfälische Hochschule (Westphalian University of Applied Sciences)

Prof. Dr. Michael Brodmann
Vice-President

Michael Brodmann
Vice-President Research and Development

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Fields of Work for Commercial Lawyers in the Area Between Law and Business

For a long time, Germany has had attorneys that do not work in law or state administration but in businesses and business associations instead. However, it took until 1993 for the first interdisciplinary law+economy university major to be introduced, specifically tailored to this profession. It was initially only taught at technical colleges and is still mainly taught there.

The Westphalian University of Applied Sciences is one of the pioneers in this field as the department has had a commercial law major on offer since 1995. This innovative major has proven to be a success, so far producing approx. 25,000 professionally active graduates in Germany, all working outside of traditional legal counseling, which is reserved for attorneys according to the Rechtsdienstleistungsgesetz (Legal Services Act).

In contrast to the original concept, which was based on an understanding of commercial lawyers as generalists for medium-sized businesses, the market penetration has mainly occurred in other areas and it is constantly on the rise.

Status Quo

Since there are studies into the professional and labor market for attorneys, focusing on parts of the attorney market as necessary, the Institut für Rechtsdidaktik und -pädagogik (Institute for Law Teaching and Learning) (IRDip, www.w-hs.de/irdip) has been studying the sub-segment of commercial lawyers in the field of business law for a few years. The goal is for the institute to develop its own range of study programs as needed, but at the same time to create transparency to show its students the variety of professional perspectives. Research up to this point has also shown that the insights garnered in this manner permit important inferences concerning the full attorney education at universities and the design of a coherent overall education system for legal professional qualifications.

Of course, the research of the Institute is first and foremost based on the professional activity of its own graduates, since the early beginnings and the size of the department make it one of the most important "producers" in Germany. In addition, surveys are conducted with current and potential employers and available statistics and job openings analysed. These results are also discussed at professional conferences, in particular the Wirtschaftsjuristentag (Commercial Lawyers' Day) held for the first time in 2015 (www.wirtschaftsjuristentag.de).

The results show not only that the majors offered by the department are marketable without restrictions, but also that there are numerous other attractive areas of work for commercial lawyers that not only offer competitive pay but also show better long-term professional perspectives for most graduates than the attorney market. Consistent with the basic concept of their education, commercial lawyers work mostly in typically interdisciplinary fields, in which, incidentally, full attorneys have been replaced by business administration professionals over time.

Views

The research also covers the still untapped market potential as well as the risks of the legal services market going through great changes. In particular, the upcoming LegalTech will have an impact not only on freelance attorneys but also employed commercial lawyers. It will be of vital importance to prepare commercial lawyers in time for the coming challenges of the next decades but also exploit the opportunities created by this interdisciplinary education. In many aspects, this education will have better future perspectives than traditional university attorney education so long as the respective universities and colleges realize these strengths and train their students in a targeted manner.

One of the areas that is going through change but has been neglected in Germany is the market for paralegals, who will be subject to increasing demands that are not covered by the traditional "ReNo" or "ReFa" training. There is room for new developments here, which are already being implemented in particular in larger law firms, but for which universities currently do not provide specific preparation. A market study and an international comparison is to help develop an academic education model to meet the modern requirements in this extensive professional field.

(Explanation: ReNo – Paralegals and notary's assistants, ReFa – Paralegals)

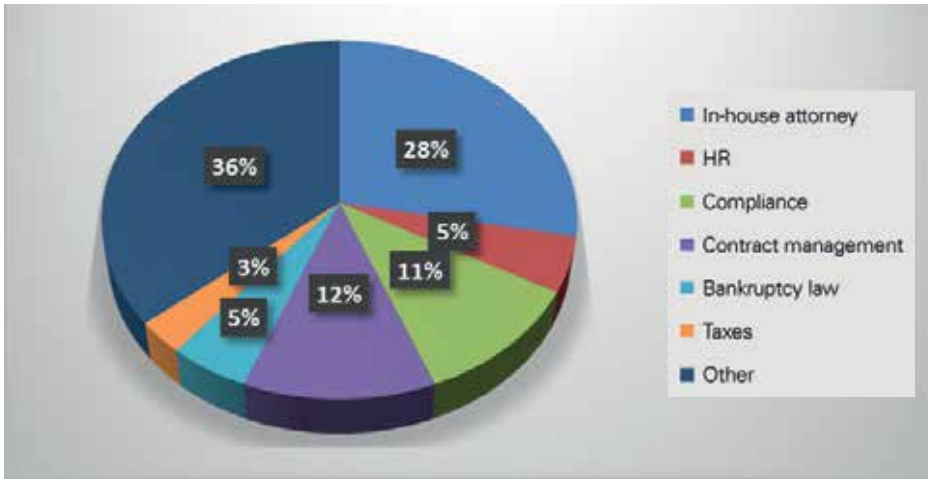

Fig.1: Areas of application for commercial lawyers

Current publications on the subject //

[1] Bergmans, B. (ed.): *Berufs- und Arbeitsmarktperspektiven von Bachelor- und Master-Juristen.* Stuttgart: Richard Boorberg Verlag, 2013.

[2] Bergmans, B. (ed.): *Zwanzig Jahre Wirtschaftsjuristenausbildung.* Berlin: Logos Berlin, 2015.

[3] Bergmans, B.: *Wirtschaftsjuristen und der Wandel des Rechtsdienstleistungsmarktes.*

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Crisis Capitalism and the Decline of the EU

Bontrup's research work describes the crisis and decline of global capitalism as the background for the severe crisis of the European economic and currency union. Basic factors are analysed first: The antagonistic processes of capitalist accumulation and the value-added production based on it; The employees not receiving compensation for the full value of their work but only the value of their labor force, and under neoliberal conditions, not even that anymore. This difference is a result of profit, interest, and ground rent. It is very interesting that there is a lot overlap between the work by Bontrup and the results of research by the French economist Thomas Piketty, who has become such a global sensation. His book "Capital in the Twenty-First Century" has made massive waves.

Thomas Piketty: "Capital in the Twenty-First Century"

The American Nobel Prize-winning economist Paul Krugman praises the book as a "revolution" and a "magnificent, sweeping meditation on inequality". Using long data series for 20 countries, which go as far back as the 18th century, Piketty provides evidence like no other economist before him that the return on capital (r) grows faster than the economic output: the gross domestic product (g). In other words, the inequality r > g is true. The consequence: there is an increasingly disproportionate distribution or concentration of wealth (capital) among a few, who are becoming increasingly rich even though they have long since stopped working and who then pass this wealth on to their heirs who have also not done a day's work for their inheritance. According to the book, as pointed out by Bontrup in his review of Piketty's work, nobody can claim any longer that capitalism is a fair economic system based on performance.

Distribution reality in Germany

Bontrup's research work, focusing on German income and asset distributions and the associated current debate about inequality[1], effectively agrees with Piketty's findings. In his research into distribution, Bontrup focuses on the mystification of competition and performance as well as the winners and losers in the system of capitalist paradoxes, while at the same time describing the distribution reality in Germany based on select empirical studies.

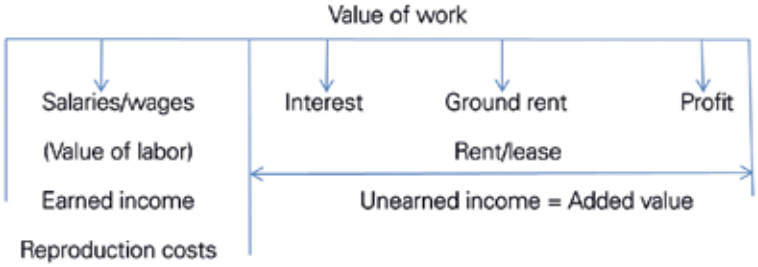

Fig.1: Capitalist liquidation process

System Regeneration

Bontrup also discusses in detail the destructive effect of the principle of competition, the catastrophic situation in the labor markets dominated by mass unemployment and the "working poor", and the capitalist "stop gap" state debt. Then, he goes on to study the historic development of the capitalist system after World War II, in particular in the Federal Republic of Germany, and the successive implementation of radical neoliberalism since the mid-1970s. Bontrup's research is completed by an analysis and assessment of the current European financial and economic crisis. He believes that it can only be resolved through a completely different economic policy in Europe, which would have to make a definite break from the crisis-enhancing neoliberalism as implemented in reality. For short-term regeneration, Bontrup proposes debt relief for the states. In addition, what is necessary is a fundamental EU-wide regulatory alternative achieved through deep democratization of the economy. Without real negotiation parity between capital and labor at the micro-economic level, the process remains intrinsically crisis prone, as does the entire system.

[1] See the series on justice in the Frankfurter Rundschau (2014).

Current publications on the subject //

[1] Bontrup, H.-J.: *Krisenkapitalismus und EU-Verfall.* Köln: PapyRossa Verlag, 2013. ISBN: 978-3-89438-537-8.

[2] Bontrup, H.-J.: *Pikettys Kapitalismusanalyse. Warum die Reichen immer reicher und die Armen immer ärmer werden,* pad-Verlag Bergkamen 2014, ISBN: 978-3-88515-260-6.

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Prof. Dr. Heinz-Josef Bontrup, Prof. Dr. Ralf-Michael Marquardt

Distribution Conflict in the Energy Transformation

While the energy transformation project itself is still supported by large parts of the German population and local companies, its implementation and especially the question of cost distribution have become more controversial. In particular since 2011, after the reactor meltdown in Fukushima, the "small" energy transformation, initiated back in 1999 with the "eco tax", has taken up speed, resulting in an "accelerated" energy transformation. The nuclear power phase-out deadline, which had previously been extended to 2037, has now been revised, going back to 2022, as originally planned in the nuclear consensus. In addition, eight older nuclear plants were immediately taken offline. Moreover, the Renewable Energies Act ((REA), Erneubare-Energien-Gesetz (EEG)) introduced as early as in 2000 has been enhanced greatly in the meantime and was amended on August 1, 2014. It has thus become the focal point of the energy transformation (see Fig. 1).

The energy transformation has already resulted in tremendous costs. Just the so-called differential costs for subsidizing renewable energies came to about 80 billion EUR by the end of 2013. For the period from 2013 to 2020, cumulative investment requirements are estimated at approx. 200 billion EUR. Individual studies expect total investment needs of 300 to 500 billion EUR by 2050.

Distribution Effects of Power Price Increases on Private Households

The research findings of the economists Bontrup and Marquardt investigate both cost and distribution questions. In particular, they indicate that many impact studies fail to offset numerous benefits such as the decline in market prices for electrical power, CO_2 emission savings, or decreasing dependence on fossil fuels. In addition, many investments – especially into the grid – would have been necessary even without the energy transformation.

By 2013, the energy transformation resulted in a price increase for private households for the total basket of goods of only 1% and of no more than 3% when considering indirect inflation trends. Macroeconomically, there are sufficient financing means available. In addition, only a part of the total economic savings of approx. 250 billion EUR in 2013 alone would have to be invested domestically in the future and no longer abroad as in the past. One should also critically examine the idea of loan financing for the restructuring process, especially in terms of more intergenerational justice. This is because a power supply which uses cost and emission-free energy sources will mostly benefit the future generations, whereas the development of the new supply system already incurs costs today.

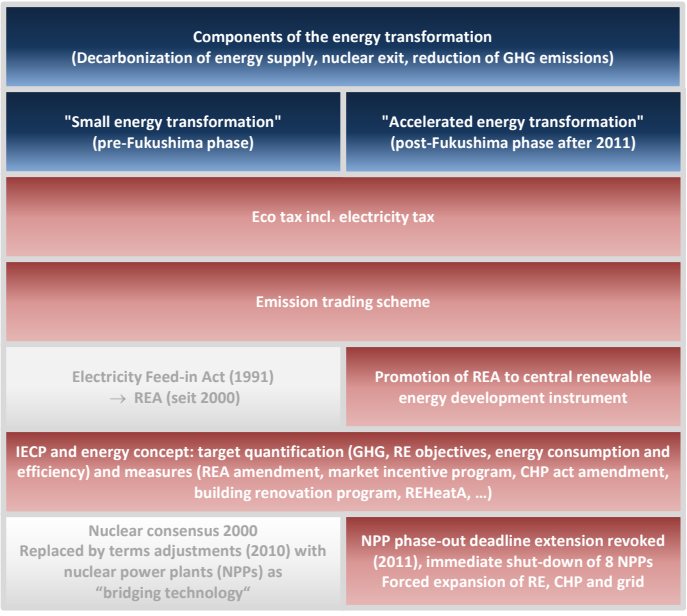

Fig. 1: Overview: energy transformation components (Source: own information)

GHG = greenhouse gases
NPP = nuclear power plant
CHP = combined heat and power
RE = renewable energies
REA = Renewable Energies Act [EEG = Erneuerbare-Energien-Gesetz]
REHeatA = Renewable Energies Heating Act [EEWärmeG = Erneuerbare-Energien-Wärmegesetz]
IECP = Integrated energy and climate program [IEKP = Integriertes Energie- und Klimaprogramm]

In their analysis of the distribution effects of the energy transformation, Bontrup and Marquardt conduct a differentiated study of the influences on the electricity price development. In particular, they determine the economic distribution effects in relation to different private household types. The focus lies again on the question of "power poverty", which might potentially result from the transformation. According to the study, approx. 5 million people suffered from power poverty in 2013. Of these, 3.3 million people would have also suffered this poverty without the additional financial burden caused by the energy transformation. The core problem of this power poverty is thus not as much the new organization of the power supply as the unequal income and asset distribution in Germany.

Distribution Effects of Electricity Price Increases on the Economy

In addition, by looking at 73 industries, they perform an in-depth study of the comprehensive and complex direct and indirect distribution effects of electricity price increases on the economy. Does the energy transformation threaten the international competitiveness of German entrepreneurs in this context or is this only propaganda by business representatives and lobbyists so they do not have to participate in the costs of the energy transformation? Based on the data from the Input-Output analysis, the two researchers provide incriminating evidence. It shows that, up to now, the burden on the energy-intensive industries has been, in fact, rather marginal. However, at the same time, they also identify industries that are protected from the direct as well as indirect cost effects of electricity price increases in order to keep them competitive.

In addition, Bontrup and Marquardt analyse in detail the effects of the energy transformation on the electricity industry as a whole and the distribution effects up to this point.

Current publication on the subject //

The results appeared in summarized form in: Bontrup, H.-J.; Marquardt, R.-M.: *Verteilungskampf der Energiewende*. Cologne: PapyRossa Verlag, 2015.

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Reductions in Working Hours in the German Economy

Bontrup's comprehensive research into working hours reaches the conclusion that unless working hours are reduced in the future, with neither pay nor staffing levels reduced, a full-employment economy will no longer be a possibility.

Since the severe global recession of 1974/75, Germany has been suffering under high unemployment. Just in the period from 2001 to 2013, the annual average of the associated fiscal costs amounted to 71.1 billion Euro. Without these costs, Germany would have achieved budget surpluses in this period.

Productivity Exceeds Growth

What is decisive for unemployment is the productivity rate ΔP_{rod} above the real growth rate (adjusted for price) of the gross domestic product ΔGDP_r. The result is a decreasing trend in the work volume -ΔWV, calculated as the rate of change obtained by multiplying the number of employees by the rate of change of working hours per employee:

$$\Delta GDP_r < \Delta P_{rod} = -\Delta WV \ (\Delta employees * \Delta working\ hours\ per\ employee)$$

The developments since the German reunification also confirm this long-term trend, even if it has slowed down. From 1991 to 2015, the average working volume decreased by only 0.1%. But this did not help put a dent in mass unemployment that was around from 1991 to 2015. In fact, the initially still sharply decreasing working volume (until 2005) was accompanied by a dramatic increase in the number of registered unemployed persons to almost 4.9 million. If the labor market demand had increased during this period (including demographic reasons such as the increase in women's employment), the unemployment rate would have been significantly higher, had it not been for an extreme increase in part-time employment. In the period from 1991 to 2015, the part-time employment rate increased from 17.9 % to 38.3 %, while full-time employment decreased from 82.1 % to 61.7 % in the same period.

This means that as early as in 2013, the calculated average weekly working time of all employees in Germany was 30 hours.

Only in 2006 did a successive decrease in the number of registered unemployed begin. Since then, the work volume has been increasing again – with the exception of the crisis year 2009 and the years 2012 and 2013. The average annual productivity rates of 0.8 % were below the real GDP growth rates of 1.4 %. The work volume, consequently, increased by 0.6 %. Such a modest productivity increase is due to an economic structural shift towards the service sector and underutilisation of the overall economic production potential.

Table 1: Development of work volume (WV) depending on GDP and productivity rates

Year	GDP (real)	Productivity*	Work volume	Work volume	Registered unemployed	
	In % pr. y.	In % pr. y.	In % pr. y.	In Mrd. h.	In 1.000	In % pr. y.
1991	-	-	-	60.082	2.602	-
1992	1,9	2,5	-0,6	59.735	2.978	14,5
1993	-1,0	1,4	-2,4	58.318	3.419	14,8
1994	2,5	2,7	-0,2	58.188	3.698	8,2
1995	1,7	2,4	-0,7	57.781	3.612	-2,3
1996	0,8	2,0	-1,2	57.074	3.965	9,8
1997	1,8	2,3	-0,5	56.770	4.384	10,6
1998	2,0	1,1	0,9	57.189	4.479	2,4
1999	2,0	0,9	1,1	57.745	4.099	-4,2
2000	3,0	2,5	0,5	57.960	3.889	-5,1
2001	1,7	2,7	-1,0	57.401	3.852	-1,0
2002	0,0	1,2	-1,2	56.705	4.060	5,4
2003	-0,7	0,8	-1,5	55.850	4.376	7,8
2004	1,2	1,0	0,2	55.946	4.381	0,1
2005	0,7	1,5	-0,8	55.500	4.863	11,0
2006	3,7	1,9	1,8	56.467	4.487	-7,7
2007	3,3	1,5	1,8	57.437	3.776	-15,8
2008	1,1	0,2	0,9	57.950	3.258	-13,7
2009	-5,6	-2,6	-3,0	56.133	3.415	4,8
2010	4,1	2,5	1,6	57.013	3.238	-5,2
2011	3,7	2,1	1,6	57.909	2.976	-8,1
2012	0,4	0,5	-0,1	57.845	2.897	-2,7
2013	0,3	0,7	-0,4	57.639	2.873	-0,8
2014	1,6	0,4	1,2	58.349	2.763	-3,8
2015	1,7	0,5	1,2	59.025	2.790	1,0
Y-AVG	**1,3**	**1,4**	**-0,1**	**-1.057**	**188**	**0,3**

* Per employment hour
Y-AVG –Annual average

Layoffs in the Electricity Market Could Have Been Prevented

As Director of the Westfälisches Energieinstitut (Westphalian Institute of Energy), Bontrup also investigated the question of working hours in the German electricity industry. Since the deregulation of the electricity markets in 1998 and the accelerating energy transition since 2010, every fourth job in the sector has been axed. In a research project, Bontrup shows that this could have been prevented by means of a reduction in working hours with no loss in pay. The working hours could have been successively adjusted from a 35-hour week to a 25-hour week. However, in reality, the only beneficiaries of the new distribution flexibility that resulted from the rates of productivity and price increases in the electricity sector were the capital owners. Wages in the electricity sector saw a dramatic decrease of 24.5% between 1990 and 2013.

According to Bontrup, the Paris resolutions on energy and climate policy passed in December 2015 will continue to exert enormous labor policy adaptation pressure on the German energy industry overall, but also on the electricity market specifically. If the human resources instrument of working hours reduction is not used, the electricity industry will see another huge wave of job losses. As part of the value creation in the future, the social partners must therefore distribute the still existing work in an even manner.

Current publications on the subject //

[1] Bontrup, H.-J: *Noch Chancen für Wachstum und Beschäftigung? Wachstumskritik – Arbeitszeitverkürzung fordern*. Bergkamen: pad-Verlag, 2016. ISBN: 978-3-88515-278-1.

[2] Bontrup, H.-J.: Arbeitszeitverkürzung in der Elektrizitätswirtschaft. In: *WSI-Mitteilungen*, Volume 6/2016, Year 69, pp. 460-470. ISSN 0342-300 X.

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Dipl.-Pflegewiss. Christoph Bräutigam, Dipl.-Sozialwiss. Michaela Evans, Prof. Dr. Josef Hilbert, Dipl.-Sozialwiss. Fikret Öz

Work Report Hospitals: Online Survey on Work Organization in Hospitals

Economic and social performance are closely interconnected in the health care system. The quality of care depends directly on the organization of work and the workplace. Many workplaces are still defined by inadequate organization and high levels of psychological and physical stress. This is a rather explosive issue, especially in view of the great need for qualified personnel.

Current Developments

Jobs in hospitals are undergoing changes in work and process organization. Responsibilities and activities as well as qualifications and competences are changing. There has previously been a gap in robust empirical data in research on reorganization activities in hospitals. The "Work report hospitals" studies the experiences that the employees have had with new work organization concepts, including the effects of such concepts on patients. Between October 2012 and February 2013, the Institut Arbeit und Technik, IAT (Institute for Work and Technology) conducted an online survey aimed at all general ward professionals in German hospitals, in which 2,507 respondents took part.

Results

The employees have great interest in the well-being of patients and very strongly identify with the social and health care policy goals of hospitals. However, the working conditions increasingly prevent success in achieving these goals. The results show broad commitment of employees to continuing education and training, albeit with only very limited support and guidance from employers. Increasing responsibility in the workplace is rarely rewarded with financial benefits or an improved professional position. A significant number of tasks are being shifted between the professions and services, which the employees feel will hardly lead to any positive effects in terms of workload and quality of care. There is mainly some experimentation with shifting individual activities between medical and nursing care as well as using healthcare assistants and other such services. Real reorganization of the entire complex of responsibilities is rare. What nursing personnel and physicians complain about in particular is that they do not have sufficient opportunities to interact with the patient while providing care. The possibilities for participation and reorganization in the workplace are assessed as poor. The employees are not very confident that the situation will improve in the future.

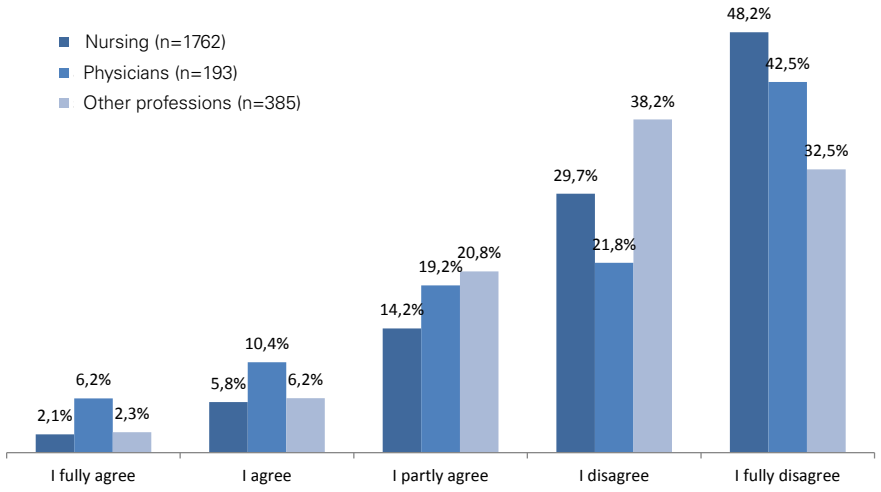

Fig. 1: "My working conditions have improved in the last 5 years."

Project information //

The project was financially supported by the Hans Böckler Foundation and conducted in close cooperation with the Friedrich Ebert Foundation and the German United Services Trade Union ver.di. The report in German can be downloaded at http://www.boeckler.de/pdf/p_arbp_306.pdf.

Current publications on the subject //

[1] Bräutigam, C.; Evans, M.; Hilbert, J.; Öz, F. (2014): *Arbeitsreport Krankenhaus: eine Online-Befragung von Beschäftigten deutscher Krankenhäuser.* Düsseldorf: Hans-Böckler-Stiftung. Arbeit und Soziales: Arbeitspapier, Nr. 306.

[2] Bräutigam, C.; Evans, M.; Öz, F. (2014): Professionalität: Arbeitsbedingungen als Stolperstein. In: *Die Schwester – der Pfleger* (2014), April, S. 372-374.

[3] Evans, M.; Hilbert, J.; Bräutigam, C.; Öz, F. (2014): Essay: Viel Engagement, wenig Klarheit: Ergebnisse aus dem "Arbeitsreport Krankenhaus" zum Wandel bei Qualifizierung und Arbeitsteilung. In: Naegler, H. (Hrsg.): *Personalmanagement im Krankenhaus*. 3. Aufl. Berlin: "Medizinisch Wissenschaftliche Verl.-Ges.", 2014, S. 138-145.

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"At Home Together? Birlikte evde?" – Residential Alternatives for Turkish Migrants Requiring Care

The first generation of the so-called guest worker migrants from Turkey to Germany are reaching retirement age. If they become care-dependent, in view of their migration background, cultural, and religious specifics or even their social situation, their care requirements might be different from those of elderly persons born in Germany. Even today, the older generation of people of Turkish origin are already widely considered to be suffering from insufficient care provision. The effects of the compensating factor that is family will decrease with progressing integration into German society and increasing demands on the younger generation in terms of, for instance, their own employment. For this reason, an increasing use of professional care services must be expected. The project "At home together? Birlikte evde?" studied the acceptance and the possibilities of joint housing in residential care / dementia facilities among care-dependent migrants of Turkish origin.

Research Goals

The most important goals of the study are:

- The development of a representative data basis on the views of elderly persons of Turkish background living in Germany on the topics of residential needs in advanced age, need for care, dementia, and acceptance of various forms of community housing.
- The development of a residential concept outline.

Approach

The close cooperation with the project partner Zentrum für Türkeistudien und Integrationsforschung ZfTI (Foundation Center for Turkish Studies and Integration Research) was essential, since people with language and cultural competence made it possible to access the target group. The survey methods included international research, expert interviews, biographical interviews, and group discussions with elderly persons of Turkish origin, as well as a representative phone survey of more than 1000 people over the age of 50 with a Turkish background.

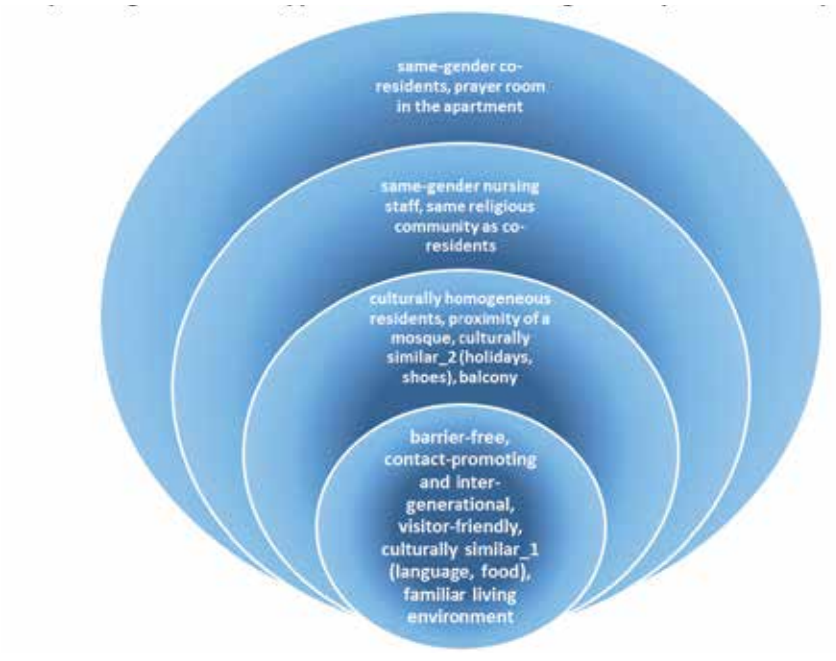

Fig. 1: Key housing needs of elderly persons with a Turkish background beyond their own appartment

Results

Important findings of the study are:

- If they were no longer able to stay in their own accommodation, about 30% of the respondents would find the residential facility alternative attractive.
- The most important argument in favor of a residential facility is the professional nursing and medical care. But a familial ambience is also important.
- Another important aspect is language and cultural competence of the personnel as well as traditional meals.
- The buildings should be able to accommodate large visitor groups.
- In terms of location, the facility should definitely be well integrated into the local area.

Specific needs due to the cultural background that were expressed mostly related to the food, which should be adapted to Turkish eating habits, and the language competence of the personnel. The latter is also expressed by persons with a Turkish background who have lived in Germany for decades. Family visits should be possible 24/7 and there should be a room available for this purpose that allows larger groups to get together. These aspects are very important to the majority of the respondents in order for them to feel well in such a residential facility. About a half of the respondents would also be happy to see their further wishes being met, such as the proximity of a mosque.

Project information //

The project was supported by the GKV umbrella organization (of the central interest group of statutory health and care insurers in Germany) as part of a model program pursuant to § 45 f SGB XI. The project was conducted over a period of one year (03/2015 – 02/2016). The scientific work on behalf of IAT was performed by Michael Cirkel and Christoph Bräutigam. The Zentrum für Türkeistudien und Integrationsforschung in Essen (Ms. Rukiye Bölük and Prof. Dirk Halm) was the project partner.

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Media Watchblogs as an Instrument of Media Accountability – an International Long-Term Study

The free media plays a decisive role in the transmission of information in the public sphere, in the exposure of grievances and in the development of a public debate leading to the forming of opinions. But who controls the media?

One instrument for the objective monitoring of media content is the media watchblog. This modification of the term *watchdog weblog* describes blogs whose operators fulfil the role of a *fifth estate* (in the same way as the mass media functions as the *fourth estate* towards government institutions).

Degen, Spiller, Kronewald and Gürtler have carried out an investigation into media watchblogs as an instrument of media accountability in a long-term study between 2011 and 2016. Media watchblogs are to be distinguished in their essence from other key players operating in the area of press control, such as the press councils in Germany, Austria and Switzerland or the Independent Press Standards Organisation in Great Britain. Typically established institutions initiate complex investigation procedures, when complaints arise. Most of those fail to come to a result any faster than a state court procedure. By contrast, media watchblogs, like other weblogs, can issue reports immediately and can evaluate media events almost in real time. They can be operated at a very low level of cost and are accessible worldwide, around the clock.

So-called external watchblogs are independent of the traditional media and explicitly prescribed for a critical analysis of journalistic reporting.

Theoretical Framework Conditions

For watchblogs as potential controllers of the mass media, a system theory perspective is suitable, according to which journalistic media represent a sub-system (cf. Malik (2004)). Social systems are not concrete entities, but rather they form their identity by distinguishing between the system and their surrounding environment and creating boundaries. According to Luhmann (1995), the fundamental element of a social system is communication. This means that individual players, such as journalists, do not stand at the centre of a social system, but are to be characterised as having an important external role to play.

Methodological Approach

The investigation of the functional capacity of watchblogs as a *fifth estate* was based on the qualitative analysis of semi-structured guided interviews conducted with watchblog operators in four countries. Those to be interviewed were chosen in a two-stage selection procedure. In the first step, assessments were made in particular on the media landscape and the watchblogs in selected German-speaking and English-speaking countries, in order to determine the countries in which conditions for watchblogs are most favourable. In the second phase of the selection process, the most prominent media watchblogs were identified using independent blog ranking lists, and the operators were contacted.

Results

The watchblog scene in the selected countries shows a very low level of continuity. Only a few operators publish regularly and without interruption. Many of the watchblogs are only active for a few months and then stopped to operate. The operators who were interviewed for this study did not feel that they were in a position to guarantee the continuity of their watchblogs, despite the relatively high level of success which they had already achieved in their particular niche.

Those interviewed shared the observation that the blogger scene was shrinking and that quite a few providers were migrating onto social networks. However, media watchbloggers were unanimous in seeing social networks as an opportunity to reach more recipients. Watchbloggers are of the opinion that the audiences of social networks are fundamentally different from the average blog reader, because Facebook and Twitter are less suitable for an in-depth discussion about the failings of the media.

While Facebook is not an adequate medium for criticism of the media, use of Twitter provides the possibility of promoting blog posts in an appropriate way – "I think Twitter and blogs complement one another in the way they try to make the media accountable. While blogs can explain problems in detail, Twitter is the right way to promote these commentaries quickly and simply." In accordance with this, the bloggers in Great Britain have made huge efforts to gain a relevant number of followers on Twitter.

Outlook

The media plays an important role in democracy. In the digital era, a new media landscape has arisen in which private individuals have the option of making their views accessible for a larger audience – via social media and through cheap publishing platforms such as blogs.

Yet there are several factors which speak against the potential of media watchbloggers as a *fifth estate*. There are, for example, no codified ethical or qualitative standards for media watchblogs. Furthermore, the continuity of the blogosphere is low, due to the fact that most operators maintain their watchblog as a hobby. There is at present no notable incentive which could make watchbloggers take on responsibility for a *fifth estate*. In order that watchblogs can play a greater role in the control of the mass media, two options seem plausible: Either the available resources need to be pooled through concerted action, or government and other institutions such as public broadcasting corporations need to restructure their financial resources in favour of independent watchblogs so as to enable watchbloggers to make the running of their watchblog into a full-time activity. Watchblogs which are operated by non-profit organisations with a clear legal mandate could gain in importance long-term and could secure the objectivity and continuity of independent media criticism.

The publication and the sources for this work can be found in the German Research Report 2016, pages 12–13: www.w-hs.de/kooperieren/forschung-und-entwicklung/forschungsbericht/.

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Streaming Journalism – Use, Content and Potential

Live streaming is changing journalism. Journalists from established media companies are sharing real-time videos of scheduled events, breaking news events and editorial conferences through providers such as Periscope and Facebook. These new options for publication are live and audio-visual, involve the recipients as users and set up communications from mobile to mobile. 25 streams were examined by means of a content analysis, and ten journalists who use this technology were interviewed in structured interviews. The most important challenges currently being faced are interactivity with the users during the streaming and finding a context-sensitive way of dealing with the selection of subjects for reporting. Streaming journalism is undergoing rapid development, and it is conceivable that there will be some interweaving with established forms of publication.

Streaming as a Form of Mobile Journalism

Streaming journalism is live and audio-visual. It can be considered as an innovation of mobile journalism, which is the way it was described by Cornelia Wolf (2014); it is therefore a sub-system of institutionalised journalism which can be used on mobile devices. Journalistic streams involve the recipients as users – they can give immediate feedback with comments and assessments. Streams may take the form of a chat, in which one side, the journalist, communicates through audio-visual means and the other side, the user, with text and emoticons. The communication is carried out "mobile to mobile", meaning there is no need for any complicated or expensive equipment, studio or production location. The basis for this communication is formed by the criteria for media innovation according to Neuberger (1999) and Wolf (2014) – multimediality, topicality, additivity, interactivity, selectiveness, ubiquity, constant connectivity, context-sensitivity, intuitive usability and playfulness.

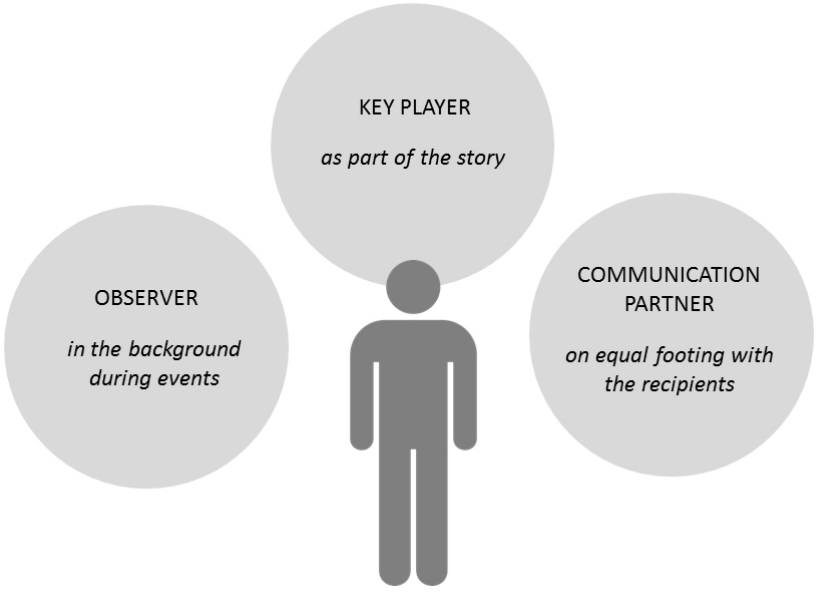

Fig. 1: The streaming journalist's understanding of their role

Uses and Boundaries

New and mixed forms of presentation arise intuitively, and the formats are characterised by a high degree of authenticity. However, those interviewed also recognized that there is a risk of quality problems arising. In particular where interactivity is required, the individual journalists involved sometimes feel overstretched. Live journalism via streaming is still in the experimental phase. To achieve consolidation and increased professionalism, the journalists involved need support from an editorial team – a division of labour similar to established segments of journalism.
It is foreseeable that there will be further steps in development – for example, fast highlight editing or best-of productions for networks and an increase in multimediality across parallel video windows. Live tools have the potential to become an integral component of the media mix.

Current publication on the subject //

Degen, M.; Köhler, A., Spiller, R. (2016): Streaming Journalismus: Nutzung, Inhalte und Potenziale. In: Hoofacker, G., Wolf, C. (2016), *Technische Innovationen – Medieninnovationen? Herausforderungen für Kommunikatioren, Konzepte und Nutzerforschung.* Wiesbaden: Springer publishing house.

Sources //

[1] Neuberger, C. (1999). Vom Papier auf den Bildschirm. Die Zeitung in der Metamorphose. In: Neuberger, C.; Tonnenmacher, J. (Hrsg.): *Online –Die Zukunft der Zeitung?: das Engagement deutscher Tageszeitungen im Internet.* Wiesbaden: Westdeutscher Verlag. S. 15-56.
[2] Wolf, C. (2014). *Mobiler Journalismus, Angebote, Produktionsroutinen und redaktionelle Strategien deutscher Print- und Rundfunkredaktionen.* Baden-Baden: Nomos.

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Dr. Stefan Gärtner, Dr. Franz Flögel

Comparative Studies of Financial Systems – New Differentiation Methods Required

Common differentiation methods used in comparative studies of financial systems have only limited capacity for explaining the national variations, in particular in terms of susceptibility to crises. Hence, we have developed a classification along the spatial-geographic centrality level of the banking system differentiating between decentralized and centralized "financial value chains", based on the particularities of the German financial system. A "financial value chain" is a network of actors that organizes the path from the source of capital all the way to its employment as well as the cash flow and allocation of returns and risks, whereas "financial systems" rather focus on the financial market actors, their interrelationships, and their customers.

In a decentralized financial value chain, financial intermediaries primarily convert regional savings into regional loans. Savings banks and credit unions are examples of regional financial intermediaries in the sense of regional savings-investment cycles. In contrast, centralized financial value chains mainly require the spatial proximity between the financial market actors in the sense of inter-company division of labor. Essential parts of the centralized value chains are thus concentrated in a few locations, but both – the capital acquirer and capital donors – usually have a different spatial reference frame.

Level of Centrality of Banks and Its Effects on Business Loans

In addition to individual case studies, specific indicators were developed. In order to approximate the small-scale spatial distribution of banking locations with the spatial concentration of employees in the financial sector, a "spatial concentration index" (SCI) has been formed. The higher the value, the higher the spatial concentration of employees. The illustration shows that the spatial concentration of employees increases with the degree of specialization.

Furthermore, we formed an indicator for credit unions and savings banks in Germany, which considers the savings and loan volumes on the level of all (in total, approx. 1,500) business areas. According to this, there is a great degree of overlap on the regional level between regional savings and investments. The correlation coefficient (acc. to Pearson) between savings deposits and loans is 0.96 for savings banks and 0.92 for credit unions. In addition, we have restructured the Bundesbank statistics in order to be able to distinguish the different dynamics of decentralized and centralized banks (especially after the crisis in 2007).

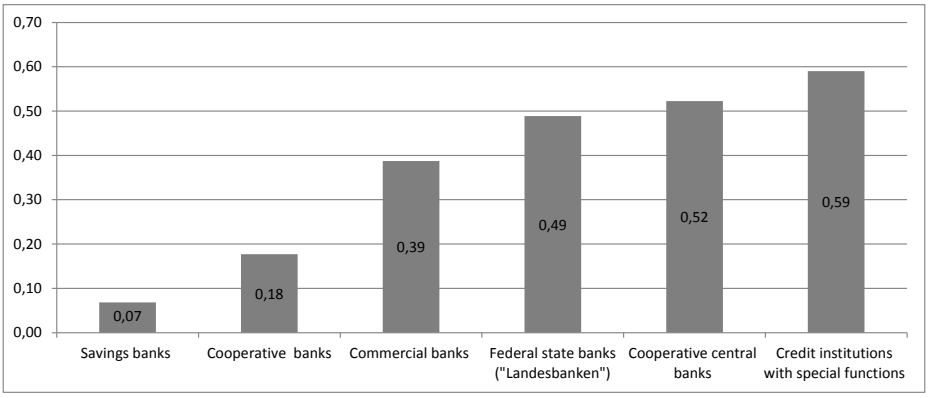

Fig. 1: Concentration index of employees in the financial sector
Source: Federal Employment Agency; own calculations

Outlook

As part of a recently initiated project ("Financial Systems as Part of the German Model: an International Comparison of Company Financing from a Spatial Perspective"), we will investigate the level of centrality of banking systems and their political, social, and economic context factors in a comparison between Germany, the UK, and Spain.

Project information //

www.iat.eu
Research project "Savings banks and spatial factors".
Supported by: Research funding of the Sparkassen-Finanzgruppe e.V.

Current publications on the subject //

[1] Gärtner, S. (2016): Gefährliche Größe: Sparkassen und Genossenschaftsbanken müssen sich reformieren, heißt es – und sich zusammenschließen. Das aber wäre falsch. In: *Süddeutsche Zeitung*, 29.8.2016, S. 18.

[2] Gärtner, S. / Flögel, F. (2017): Zur Bedeutung und Zukunft dezentraler Banken für die KMU-Finanzierung in Deutschland. In: *ZfKE – Zeitschrift für KMU und Entrepreneurship* 65, H. 1/2: Finanzwirtschaftliche Herausforderungen für KMU, S. 41-60.

[3] Flögel, F. (2017): Distance and modern banks' lending to SMEs: ethnographic insights from a comparison of regional and large banks in Germany. In: *Journal of economic geography* 17, July 2017, 23 p.

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Under-Representation of Women
on Boards of Supervisors and Directors of Publicly Traded (Large) Companies

The project "Women in Top Management Teams" investigated the research hypothesis that the likelihood with which women are appointed to top management teams (TMT) and in particular Boards of Directors increases with the visibility of their performance and their person in the appointment process. The project did in fact confirm this hypothesis. We have found parallels in the project "Recruitment for Performance", which studied the recruitment process from the perspective of executive headhunters.

Visibility
Successful visibility is generated by characteristics of (potential) top managers which are considered to be suitable, as well as by habitualized patterns of thought and perception of the relevant decision-makers. It thus always includes two sides: candidates present certain characteristics they consider relevant and, in doing so, hope to become visible. For this purpose, they often employ a "stage" to allow others to get to know them. *Successful* visibility then also includes a third factor: positive acceptance of the presented characteristics. A central role is taken by the 'habitus', defined by the sociologist Pierre Bourdieu as a stable set of individual dispositions that can often only be changed over the long term. The habitus determines both how a person is perceived and how they perceive others.

Generating Successful Visibility – the Three Acts of "Doing Visibility"
We have discovered three phases in the process of generating successful visibility:

1. (Potential) top managers try to embody a suitable habitus based on their knowledge. A central objectivized visibility factor seems to be the candidate's professional competence. According to the currently prevailing view, such competence is evidenced by the candidate's education (usually suitable degree, doctorate), applicable experience, and positive results of previous work, as well as intercultural competence (foreign experience).
2. Success in achieving visibility of a suitable habitus as perceived by the relevant decision-makers in appointment processes (i.e. in particular, chairmen of Boards of Supervisors, members of appointment commissions, executive headhunters, and chairmen of Boards of Directors). This is influenced in particular by the following four factors:
   - Networking
   - Mentoring/Sponsoring
   - Appearances on visibility stages
   - Handling visibility risks
3. *Successful* visibility as a necessary condition for **successful appointment to a top management position**:
   The appointment of more women to TMTs is often hindered by decision-makers' tendency to minimize decision risks. They subconsciously and consciously apply the similarity principle and stereotypes (positive and negative) in order to manage uncertainty. However, in certain situations, an optimal appointment decision requires risk management, i.e. weighing and betting on certain risks that open new opportunities.

How to Present a *Suitable* Habitus
In the field of top management, there is a unique understanding of what a *suitable* habitus is. Even though women may correspond to the *suitable* habitus in the field of top management, they are, however, at variance with the prevailing gender stereotypes. They are therefore often confronted with doubts concerning their "authenticity" and thus their credibility as a person: if women correspond too much to a *suitable*, implicitly male habitus, they are considered not sufficiently feminine. But if women correspond *too little* to the habitus considered suitable for top management, they are then considered unsuitable for top management teams.

Embodying a *suitable* habitus requires adaptation by both men and women. The knowledge of what is considered *suitable* in certain situations permits deliberate rule violations, which in turn makes it clear that the actors know the rules very well. Deliberate rule violations thus can become a means to present yourself as a competent player.

Procedure
The projects used various methods that complemented each other for a comprehensive analysis in a process-oriented study design: After studying the current research, the TMT project went through a discourse analysis of central press reports on the current under-representation of women in top management teams. Based on these results, we then conducted structured interviews with 11 female and 7 male experts from Germany and abroad, as well as with a total of 43 members of top management teams, of which 22 were women (BoD / BoS f)[1] and 21 were men (BoD / BoS m)[1]. In the recruitment project, structured interviews were conducted with 11 representatives (both female and male) of leading executive headhunters with experience in recruiting members for Boards of Supervisors. The results were compared with a parallel survey in Norway.

[1] BoD – Boards of Directors, BoS – Boards of Supervisors, f – female, m – male

The publications for this work can be found in the German Research Report 2014, pages 14-16: www.w-hs.de/kooperieren/forschung-und-entwicklung/forschungsbericht/.

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Willingness to Pay for Electromobility – an Investigation Among Builders of Energy Efficient Houses

For the successful introduction of sustainable electromobility, it is important to know promising target groups. Builders of energy efficient houses seem to fit the criteria of early adopters especially because they have some technical knowledge and, therefore, they know that the first step towards energy efficiency is to reduce energy consumption.

Two questions arise in this regard. Firstly, whether those who build more energy efficient houses will be more willing to reduce their automobile energy consumption. Secondly, whether they will be more willing to pay for electric cars compared to builders of less energy efficient, conventional houses.

Interviews and Data Collection

Computer based interviews were conducted with house builders who have built their houses since 2009 or who are planning to build their houses in the near future. Questions concerning the energy efficiency of their house, the main attributes of the car they next plan to purchase ('desired car') as well as the main attributes of their current car to be replaced by the 'desired car', the utilisation of the desired car, and questions on socio-demographics were asked. In addition, investigations with hypothetical choice situations were part of the interview. The respondents were asked to choose between their 'desired car' as described before, a plug-in hybrid electric car and a battery electric car. In eight choice situations the attributes of the two electric cars varied in relation to the 'desired car' according to an orthogonal design. As one of those attributes the battery electric car was in some situations equipped with a range extender, transforming it into a range extended electric car. The results shown below are based on 165 interviews with 1,316 choice decisions.

Desired Cars

Faced with the situation of replacing their present car, house builders of more energy efficient houses (KfW 55 to Plus-Energy house) as well as those of conventional houses (KfW 100 to KfW 70) would rather choose a car in a larger vehicle class. Accordingly, around half of both groups of house builders would replace their car with a more powerful one. By contrast, there is a statistically significant larger percentage of house builders of more energy efficient houses who intend to reduce the fuel consumption of their 'desired car'.

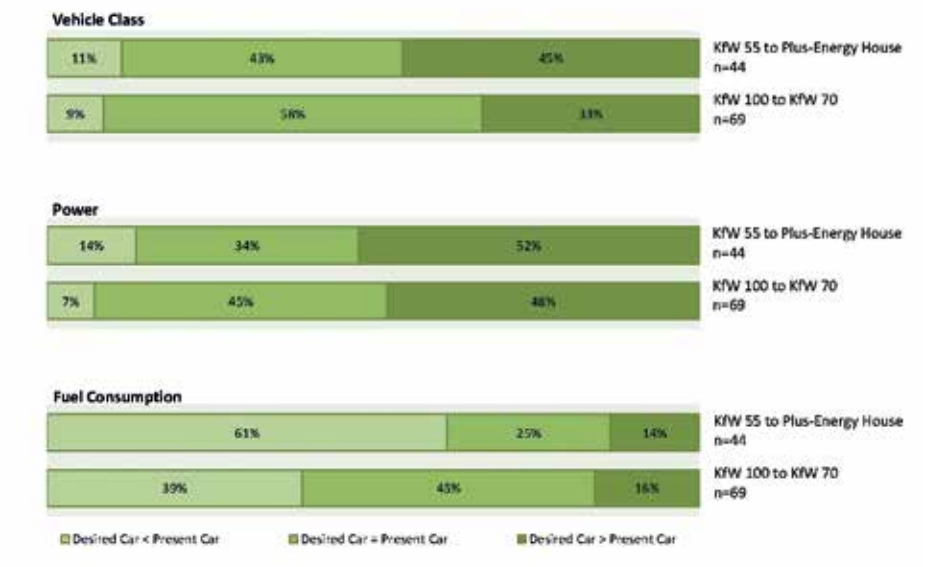

Fig. 1: Attributes of desired cars campared with present cars

Willingness to Pay for Electric Cars

Discrete Choice models explicitly take into account the relationship between the attributes of goods and the decision of consumers which goods they choose to purchase. It is assumed that a consumer chooses an alternative from which he derives maximum utility.

The choices the respondents made within the experiment were used to estimate the probability P that a car was chosen as a function of the attribute levels. In example the probability P that the battery electric car (BEV) / the range extended electric car (REEV) was chosen is described as:

$$P_{BEV/REEV} = \frac{e^{\beta_{BEV/REEV} x_{BEV/REEV}}}{e^{\beta_{ICEV} x_{ICEV}} + e^{\beta_{PHEV} x_{PHEV}} + e^{\beta_{BEV/REEV} x_{BEV/REEV}}}$$

where X were the vectors of attribute levels of the three alternatives (internal combustion engine car (ICEV), plug-in hybrid electric car (PHEV) and battery electric car (BEV/REEV)) and β were the vectors of estimated utility coefficients of the attributes.

The estimated utility coefficients are statistically significant and all of their signs are plausible. The indicator variables 'Group of House Builders $_{PHEV}$' and 'Group of House Builders $_{BEV/REEV}$' are positive, indicating that house builders of more energy efficient houses have a higher willingness to pay for PHEV and BEV/REEV than those of conventional houses.

Project information //

This work was financed within the Elektro-Mobil.NRW2010 programme of the federal state NRW and EFRE. It was produced in cooperation with the architectural office Thiel in Münster.

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Competence Development Model "Resource-Efficiency at Work"

Instead of reducing workload factors for an aging workforce, many companies give in to competitive pressures and intensify the workload even more. Relief seems unlikely, especially considering the looming skilled labor shortage. At the same time, companies are wasting their limited personnel resources on activities that do not create added value. The competence development project "Resource-Efficiency at Work" (ResA), supported by the Bundesministerium für Arbeit und Soziales (Federal Ministry of Labor and Social Affairs), deals with solutions to master these different developments.

Companies Are Facing Great Challenges in the Future

Many companies are confronted with very similar challenges:

- They attempt to counter international cost pressures by increasing productivity. Achieving higher efficiency is generally associated with work intensification.
- They react to increasing workloads of aging workforce by expanding the company's health management programs.
- In order to ensure sufficient influx of young skilled workers, companies strive to become an attractive employer through employer branding.

What stands out when looking at these three challenges, is that they are usually discussed and tackled completely independently from each other. Is there no common denominator for these problems? When thinking more widely about established measures for increasing productivity, it becomes clear that preventing waste can have an impact on all three fields of action. It not only increases productivity but also tackles the causes of high workloads and unnecessary commitment of scarce personnel resources. This becomes tangible considering excess production achieved under difficult conditions, preventable but burdensome transportation, or unnecessary reworking done on weekend. This waste decreases productivity, increases workloads, and binds skilled workers to non-value adding tasks.

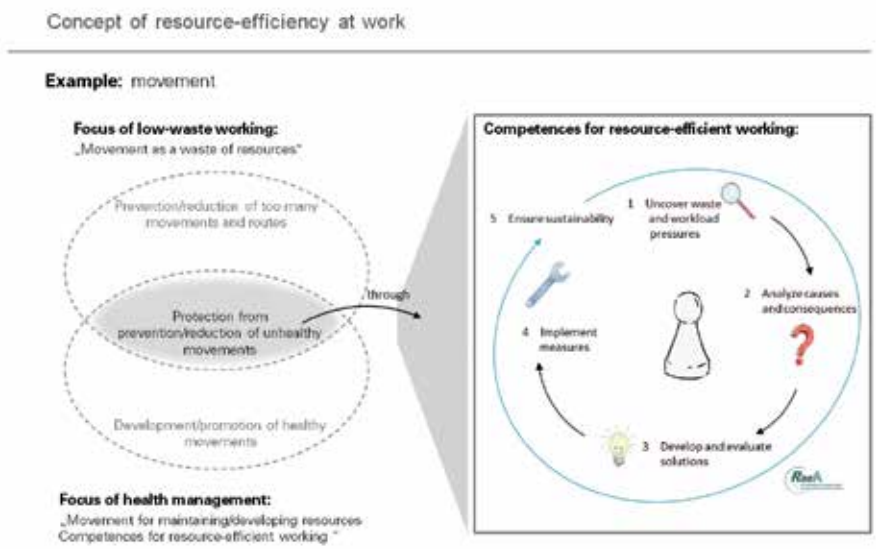

Fig. 1: Resource-efficiency at work – a solution?

Concept of Resource-Efficient Working

However, as long as such initiatives for resource-efficient working are not only treated as cost cutting programs with a sole focus on productivity increases but are additionally used to decrease work intensity, they can make a valuable contribution to keeping employees healthy and to overcoming skilled labor shortages.

In order to succeed in implementing these initiatives, skilled staff and management need to have competence in resource-efficient working. They need to be encouraged and enabled to

- uncover waste and workload pressures,
- analyse the causes,
- develop and evaluate solutions,
- derive and implement measures, and
- ensure the sustainability of the improvements.

As part of the project, a workshop concept, guidelines, a tool box, and additional materials were developed to help companies to improve their workers competence in resource-efficient working.

Project information //

The ResA project is financially supported by the Federal Ministry of Labor and Social Affairs as part of the initiative "New Quality of Work". The purpose of this joint initiative which brings together the Federal Government and the Federal States as well as economic bodies, trade unions, businesses, social insurance institutions, and foundations, is to create a higher quality of work as a key to innovation and competitiveness in Germany. To this end, the initiative provides practical examples, consulting and information, possibilities for exchange, and funding programs for projects that implement new personnel and labor policy approaches. You may find more information at www.project-resa.de.

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"CultNature" Bio-Montan Park NRW – Sustainable and Cost-Efficient Strengthening of Non-Marketable Land Areas

With sustainable and productive city planning, climate protection in urban areas, and by making living and working more attractive for people and the region, "CultNature" (CN 1 & 2) are projects that look after areas formerly used by the coal and steel industry. Of the approx. 12,600 hectares of surface areas, about one third is currently used for commercial or industrial purposes. As a result, the regeneration of at least two-thirds of this potential area will consist in open space development (green areas, forests, leisure spaces, parks, wastelands). CultNature wants to use biomass, wind and photovoltaics in an economically viable way to raise the attractiveness of land area where higher purposes such as trade or habitation cannot be developed. The expected profitability associated with this mix of uses will take some strain off municipal budgets as such recycling areas are envisaged to contribute towards covering the costs of their development and use (e.g., park maintenance). The developed organizational scenarios range from temporary to permanent usage options.

The necessary data on location, size, and structure as well as previous and current use of the areas is provided by mining land research. It identifies former mining areas and their current use according to the land use maps and data bases of the RVR (Regional Association Ruhr).

Use for Generating Energy

The energy-related use of former coal and steel industry areas serves as a strategic lever for making locations and city districts more attractive, while at the same time also shaping the energy transformation in the RVR area and dealing with the climate change. The productive parks, which earn their maintenance costs through renewable energies, are not corn or rapeseed fields with wind turbines along the edges, but instead, they are vibrant park areas which supply energy.

Fig. 1: Interactive planning tool for organization and development of former mining areas (balancing of cost and revenue structures)

Implementation

"CultNature" wants to develop new area utilisation strategies compatible with the energy transformation for the cities and districts of the Ruhr area, develop networks of actors and initiate coordination processes at the municipal level (municipal projects), as well as identify specific area development potentials, and test them in planning projects (area projects).

In order to organize and develop former mining areas, "CultNature" uses an interactive planning software tool. It makes it possible to represent transparent cost and revenue structures of different CN solutions by balancing e.g. arising maintenance costs against revenue from the generation and use of renewable energies.

Project information //

The project is conducted by the Institut Arbeit und Technik (Institute for Work and Technology) at the Westfälische Hochschule (Westphalian University of Applied Sciences) in cooperation with RAG Montanimmobilien, NRW.Urban, RVR and bmr. It is financially supported by the European Regional Development Fund and the Federal State of North Rhine-Westphalia (NRW).

For more information on CultNature 2, visit www.iat.eu/cultnature.

Current publications on the subject //

[1] Lehner, F. et al (2014): *Cultnature: Bio-Montan-Park NRW; ein Projekt zur nachhaltigen Stadt- und Regionalentwicklung in nordrhein-westfälischen Bergbau-Rückzugsgebieten*; Zwischenbericht nach der 4. Projektphase. Juli 2014. Gelsenkirchen: IAT.

[2] Becker, D, / Leisering, B. (2014): *Trotz guter Absichten noch großer Nachholbedarf: Stand von Klimaschutz und Energiewende im RVR-Gebiet.* Gelsenkirchen: IAT. Forschung Aktuell, Nr. 04/2014.

[3] Paul, H. / Krüger-Charlé, M. (2014): *Daten-Bergbau in Bergbau-Daten: Methoden und Resultate der Bergbauflächen-Recherche im CultNature-Projekt.* Gelsenkirchen: IAT. Forschung Aktuell, Nr. 01/2014.

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Diffusion of Medical Technology Innovations – The Transcatheter Aortic Valve Implantation (TAVI)

Aortic valve implantation is indicated in the event of a degenerative calcified aortic valve stenosis, which is the most frequently occurring heart valve disease in the Western countries. The frequency of this disease is rising with increasing age and will become more prominent before the background of demographic change. The "first transcatheter aortic valve" implantation (TAVI) was introduced in 2002, (Cribier et al. (2002)): The old heart valve is removed with the aid of a balloon and an aortic valve prosthesis is implanted without opening the rib cage and the use of the obligatory heart-lung machine. The TAVI is described as particularly suitable procedure for patients subject to extremely high risk with standard treatment (see Figulla et al. (2009)).

International Comparison

In international comparison it is particularly noticeable that the TAVI is quite popular in Germany; this includes the actual volume of interventions performed, as well as the number of centers applying this method (Mylotte et al. (2013); see table 1). The quick diffusion combined with the simultaneously unclear evidence position has repeatedly been the center of criticism (Storz-Pfennig, Dettloff and Schmedders (2013)).

Examination Goal

The goal of the examination was to trace and analyse the method's diffusion process in an effort to obtain an extensive image of the diffusion process. The diffusion in Germany was demonstrated based on secondary data analysis (quality reports by hospitals, DRG statistics, G-DRG fixed cases and the supplemental compensation catalog). The implantations processes in hospitals were analysed based problem-focused interviews with cardiologists and heart surgeons. The interview were transcribed and the contents were analysed by applying the Greenhalgh model et al. (2005).

Table: Minimal invasive aortic valve implantations in Germany 2006 to 2014.

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Endovascular[1]	68	221	969	1.935	3.574	4.933	6.798	7.853	10.347
Transapical[2]	-	18	494	1.476	2.225	2.748	2.928	2.961	2.965[3]
Total	68	239	1.463	3.411	5.799	7.681	9.271	10.814	13.264
Number of centers	2[4]	7[4] + 3[5]	22	61	80	90	91	93	100
Thereof without heart surgery	-	-	-	-	14	18	18	17	23
Conventional	-	-	-	10.285	10.321	10.289	9.949	9.899	9.953

[1]OPS 5-35a.00, [2]OPS 5-35a.01, [3]AQUA-data 2010-2015, [4]Number of inquiring hospitals pursuant to § 6 section 2 KHEntgG (Hospital Remuneration Act) endovascular, [5]Number of inquiring hospitals pursuant to § 6 section 2 KHEntgG transapical.

Source: demonstrated based the DRG-statistics, quality reports of the hospitals pursuant to; § 6 section 2 KHEntgG; AQUA-Institute 2010-2015.

Further Diffusion Process

It has been shown that the TAVI has been extensively applied in Germany a few years after it was integrated in the remuneration system. The positive impact factors on the diffusion speed, as well as the negative factors were identified. The positive factors include contextual factors, such as remuneration, or the lesser statutory hurdles during the introduction process, as well as relative advantages regarding patient-relevant benefits of the TAVI in comparison to other procedures. The cooperation of cardiology and heart surgery within the hospitals implementing this method also decisively impacted and respectively affected the success of the implementation: Adequate cooperation enabled a quicker introduction of the TAVI.

Forecast

Despite the adapted statutory framework conditions, the TAVI diffusion process has not yet been concluded and will accelerate again on a median to long-term perspective. It has been shown the introduction of this method is largely dependent on the relationship of cardiology and heart surgery within the hospitals. Diffusing medical technology innovations are quite complicated processes and a combination of numerous differentiating factors on multiple impact levels which influence the diffusion process. The Greenhalgh et al. model (2004) has proven to be a suitable theoretic foundation and can and/or should be used for further studies.

For sources on the subject, see using www.w-hs.de/kooperieren/forschung-und-entwicklung/forschungsbericht/, original research report of 2016, pages 16-17.

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Innovation Report
North Rhine-Westphalia

Like many industrial regions, North Rhine-Westphalia is facing a number of new challenges closely connected to economic and social structural changes. The ecological restructuring of the energy supply, increasing digitalization, changing social demands and challenges (e.g., demographic change) lead to massive structural changes and can often not be accomplished without additional investments and innovation. With this in mind, the project supported by the Hans Böckler Foundation empirically investigated the current position of North Rhine-Westphalia in Germany in terms of innovation. The goal was to determine the specific innovation-related strengths and weaknesses of the region.

University Education

The availability of qualified employees is of central importance for businesses and the position of NRW in terms of innovation. This federal state can boast very positive developments in this respect, such as the introduction of guaranteed university entry quotas for students without an Abitur [school-leaving qualification], especially in the STEM subjects. At the same time, compared with all of Germany, fewer students who are guaranteed a place at university commence higher education studies, while the graduation rates have been lagging behind the German average for years.

Further Professional Education and Training in Businesses

The training rates of businesses in North Rhine-Westphalia are overall above the German average. The number of newly concluded initial training contracts in North Rhine-Westphalia also suggests that the trend here is somewhat more positive than in Germany as a whole. Nonetheless, despite a comparatively good economic situation, NRW also saw a decrease in training completion rates.

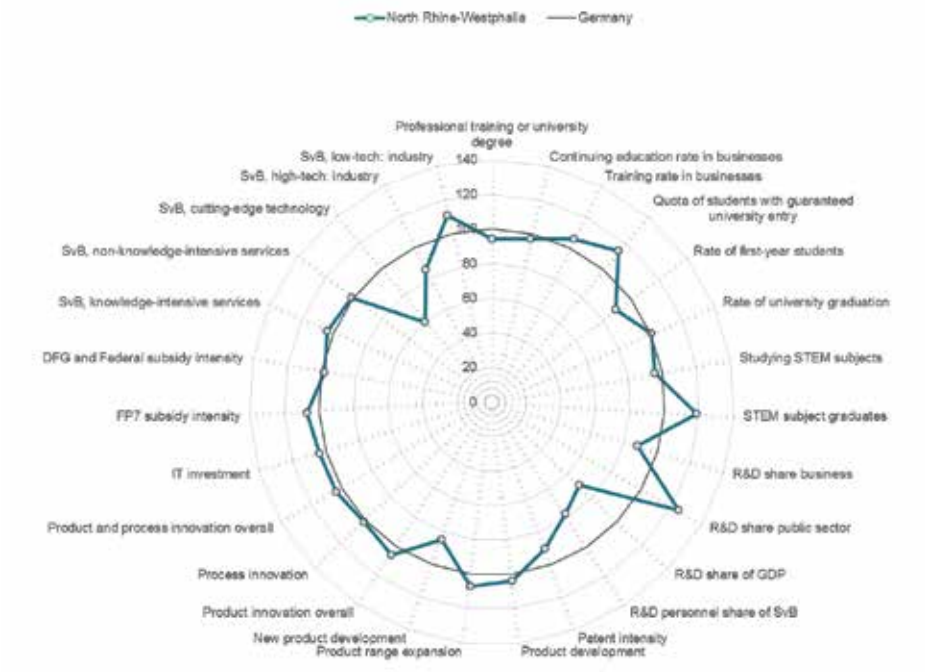

Fig. 1: Outline of innovation position of North Rhine-Westphalia (Germany = 100)

Explanation of the abbreviations used in the graphic:
SvB – employees subject to social security contributions
R&D – research and development
STEM – science, technology, engineering, and mathematics
DFG – Deutsche Forschungsgesellschaft [German Research Foundation]
FP7 = 7th Research Framework Program of the EU, 2007-2013

Research & Development and Product Innovation of Businesses

The research and development efforts of the businesses of North Rhine-Westphalia have been at a below-average level compared to the rest of Germany for some time now. This is certainly caused by the particularities of the economic structure of this federal state. NRW has a smaller share of research-intensive industry fields. At the same time, the results also show that there are clear differences due to company size. The above-average commitment of medium-sized businesses contrasts with a below-average R&D commitment of small businesses and the very large businesses. As a consequence, the position of North Rhine-Westphalia according to a number of R&D-related indicators is below average. For instance, one of such indicators is the share of businesses with new product developments. However, the businesses of this federal state are doing much better in terms of product developments that are not directly connected with research and development, for instance, the further development of existing products.

Conclusion

An innovation policy exclusively focusing on high-tech areas would only be suitable to a limited degree considering the special conditions and economic structures of this federal state, which is also more strongly defined by so-called "low-tech" industries than other states. An improvement of the innovation position of the state would also require significant investments into education and training. Economic and social challenges, as they are for instance associated with increasing digitalization, require not only suitable digital but also modern and well-equipped educational infrastructure.

Especially the latter aspect also shows that, in addition to political actors, what is needed are business actors for co-determination, for instance in the Boards of Supervisors of the businesses.

Current publication on the subject //

Nordhause-Janz, J.; Terstriep, J. (2017): *Innovationsreport NRW*, Research Support Working Paper Number 026, January 2017, Hans-Böckler-Foundation, Düsseldorf.

Project information //

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Living Independently in Your Own Home in Old Age

Through the Integration of Social Support, Medical Care and Care Services, and the Use of Modern Techniques

Germany has an ageing population, and this is a trend which will continue further. The number of people requiring care and suffering from dementia, and therefore the number of people dependent on care and support, will continue to grow. Yet, at the same time, it is common for the persons affected to express the wish to remain within their own four walls for as long as possible – the household as a healthcare location – and to put off for as long as possible, or even avoid completely, the move into a long-term care institution. Under what circumstances can this wish be fulfilled?

Approaches to Finding a Solution

In order to strengthen the household as a healthcare location, various approaches have been pursued for some time now; these can be roughly divided into social solutions and technology solutions. The social approaches include new forms of living such as shared housing involving several generations, shared housing between groups of elderly people, and assisted living schemes. It is increasingly frequently the case that the design of the residential district immediately surrounding the home also plays a part.

Approaches focusing on social aspects also include the reorganisation of medical care (General Practitioner) and of the provision of care services – following the further training and qualification of their medical specialist staff, local doctors can delegate certain duties, e.g. home visits, to their staff.

Technology-based approaches for improving the suitability of the household as a healthcare location include building and housing technology. As a first step, attempts are made to at least ensure that the home is set up in as accessible a way as possible. Through the use of information and communications technology, the home can be made "intelligent", namely through the use of sensors in the home which "recognise" when the resident is in a situation of medical emergency and can send a call for help. It has been possible for some time now to use telemedicine to monitor and manage vital parameters – such as blood pressure and blood sugar levels – at a distance from a telemedicine centre.

Fig. 1: Aspects of living in the local community in old age – source: www.aq-nrw.de

Conclusion – Need for Improvement as Far as the Eye Can See, but Land is in Sight

Across the country, there is a diverse landscape of new forms of living; however, it is difficult, or even impossible, to get a precise overview. The situation is similar when it comes to activities aimed at pushing ahead with the design of living spaces which are suited to the needs of elderly and sick people. As far as the reorganisation of medical and care activities in the household is concerned, several very promising approaches have been observed.

Telemedicine has indeed made a lot of progress in recent times. However, there is still a lack of sustainable options for financing. Apart from one exception, telemedicine has not yet been accepted into the catalogue of equipment covered by the health insurance companies.

In terms of building and housing technology, it has been established that only five percent of homes in which elderly people live are even set up in a properly accessible way. It is even more seldom to find that technical assistance systems suited to elderly people have found their way to the end user; up until now, they have been found only in the manufacturers' showrooms.

Whilst, in the past, medicine, care and technology often worked separately and without any coordination on solutions to support elderly people in living in their own homes, there has for some time now been an increase in collaboration between representatives of the various different disciplines.

Current publication on the subject //

Heinze, R. G.; Hilbert, J.; Merkel, S.; Paulus, W. 2014: Health care is coming home – but how to open the door? In: Pohjanen, E. (ed.): *Impacting individuals, society and economic growth:* proceedings of the 5th AAL Forum, NorrKöping, Sweden, 24 - 26 September 2013. Linköping: New Tools for Health, p. 297-299.

Project information //

www.iat.eu

Ministerium für Gesundheit, Emanzipation, Pflege und Alter des Landes Nordrhein-Westfalen

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"eDrivingSchool" – Increasing Acceptance and Accelerating Market Roll-Out of Electric Vehicles

The goal of the project "eDrivingSchool" was to increase acceptance and accelerate market roll-out of electric vehicles used for commercial purposes. The intention was to show that modern electric vehicles are already capable of satisfying the requirements of professional mobility. For this purpose, the vehicles were used every day under the usual conditions. The Westfälische Hochschule (Westphalian University of Applied Sciences) focused on the use of power from buildings with a positive energy balance – the so-called "self-generated power". General concepts like the "electric car connected to the solar grid" have been around for a long time and they are within the reach of those private users who can cover the additional expenses. Until now, there has been a lack of robust data, findings, and suitable optimization strategies for commercial implementation. Based on its link with the infrastructure, the demonstration project examined the connection of electric vehicles and buildings as a master plan for use in commercial contexts.

Use in Driving Schools

The eponymous pilot study implemented a new concept of driver training using electric vehicles. The hypothesis that driving schools are ideal multipliers for generating new users was confirmed in interviews with the learner drivers. Familiarizing learners with electric vehicles as part of their driver training is suitable for introducing users to electromobility. It is a better alternative to conventional product marketing, which could be of essential importance for the market ramp-up of electromobility.

Use in Commercial Businesses

In the second pilot study, the transporter of a business was replaced by an equivalent electric vehicle. The study focused on the energy system. The grid consumption of the entire business was minimized thanks to the building self-generating power from photovoltaics and the use of combined heat and power (CHP) cycles. An energy monitor based on the KNX/EIB standard[1] recorded the load profiles of all generating and consuming units. As a result of operational optimization, a closer link developed between generation, consumption and storage. In terms of cost-efficiency, variations in seasonal changes, operating time, and revenue / operating cost functions were studied. Whether an electric vehicle, as an additional power consumer, will have an effect of lowering the overall energy costs will depend on the operational management. The profitability of the electric vehicle is then again determined by the dimensioning of necessary energy storage and mileage. A minivan with a daily mileage of 50 km can definitely be economically viable. Due to regulations in driving schools, driving school cars can only achieve a fraction of the mileage covered by a van and could only prove to be economically viable on a cross-company basis.

Fig. 1:
"eTransporter"

Fig. 2:
Logo of the project

Conclusion and Outlook

Whether the increase of overall efficiency can be used by the energy network and the higher costs of electric vehicles and additional energy storage can be offset is not determined a priori by an operating cost calculation. What the project has shown is that, in addition to good energy management, the electric vehicle also needs to be used to capacity. This can be achieved reliably in commuter traffic. The results of the project not only form the basis for implementations in other businesses but they also promote the creation of a decentralized CHP[2] and RE[3]-based grid structure.

The sample study of electric vehicles in full driving school use and as a delivery and field vehicle in the Münsterland and eastern Ruhr regions has provided initial insights into the technical and economic framework conditions for the successful use of such vehicles in vehicle fleets.

1 KNX/EIB standard – standard in the area of building automation

2 CHP – Combined Heat and Power

3 RE – Renewable Energies

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Regionale Wettbewerbsfähigkeit und Beschäftigung

Project information //

Project partners: Hochschule Bochum (Bochum University of Applied Sciences), Institut für Elektromobilität (Institute for Electro-mobility) (Lead Manager); Westfälische Hochschule, Institut Demand Logistics (Institute for Demand Logistics); Franz Rüschkamp GmbH & Co.KG; H&V Energietechnik GmbH & Co.KG; Mobile Vielfalt GmbH.

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Economic Foundation of Social Innovation

Europe is facing great socioeconomic challenges which have further intensified in view of the current economic crisis. These include long-term and youth unemployment, an aging society, insufficient education and training, gender-specific inequalities, migration and integration, as well as globalization and climate change, to name a few. Though technological innovation was viewed as a driver of prosperity and growth for a long time, it appears to be insufficient under the current framework conditions. In this context, social innovation[a] represents a promising approach for meeting socioeconomic challenges effectively.

a Social innovation is a combination of new ideas and new forms of cooperation beyond established institutional contexts, with the effect of empowering and (re)integrating weak and marginalized population groups through the innovation process or as a result thereof.

Why Social Innovation

According to current forecasts, the long-term growth of the GDP (gross domestic product) of the EU-27 will decrease from 2.7% in 2008 to 1.5% by 2020 and to 1.3% for 2031-2060 (EC 2012[1]). In large parts of the EU, the unemployment rate has increased and will likely remain at a high level until 2018, with great regional disparities coming into play (EC 2014[2], IMF 2013[3]). Youth unemployment has exceeded the 25% threshold in 13 member states. Structural changes of the labor market, such as deregulation and the increase of fixed-term contracts, in combination with insufficient education levels, further strain the situation. Women today still make up the majority of part-time and unpaid workers. In parallel to all this, due to the aging population, the costs of retirement funds are increasing as are health care and nursing costs, met by governments all over Europe – the very same governments which are having to deal with strict budgetary constraints.

Doing Things Differently

This situation requires a new way of thinking, new knowledge, new alliances, new processes, and new forms of dialog beyond the traditional, profit-oriented paradigm. What we mean are innovations as a complement to technological innovation that achieve real convergence between economic growth, sustainability, inclusion, equality, and diversity and that do so by tapping into the innovative and productive potential of society – including those who are currently excluded. In the coming years, a central challenge for Europe will be creating a socioeconomic system that is suitable for effectively stimulating social innovation.

Social Innovation for Intelligent and Inclusive Growth

The cooperation project SIMPACT, promoted by the European Union in the 7th Framework Program, is making a central contribution. Twelve research institutions in ten European countries are studying the question of how social innovation can contribute to forming an economic foundation[b] for intelligent and inclusive growth. Based on a multidisciplinary approach, a theoretical model of the economic dimensions of social innovation is developed. It is further substantiated by empirical analyses and transferred into improved business models, indicators for measuring social innovation, as well as political control instruments and methods of impact analysis. The continuous reflexive exchange between the actors involved in the innovation process forms a central component of these research activities.

Fig. 1:
Simpact consortium

b Economic foundation is not understood as "economization" of social innovation but, rather, as an attempt at theory-guided and empirically founded identification of economic components (actors, resources, institutions), goals (social and economic), and principles (forms of efficiency and governance). This understanding makes it possible to identify levers for increasing the social and economic effectiveness of social innovation and to develop corresponding political support measures.

Sources //

1 European Commission (2012): The 2012 Ageing Report. Economic and budgetary projections for the 27 EU Member States (2010 – 2060). European Economy, 2(2012).
2 European Commission (2014): Investment for jobs and growth. Promoting development and good governance in EU regions and cities. In: Dijkstra, L. (ed.), Six reports on the economic, social and territorial cohesion, Brussels, Luxembourg: Publications Office of the European Union, June 2014.
3 IMF (2013). World Economic Outlook, April 2013. Hopes, Realities, Risks. International Monetary Fund: World Economic and Financial Surveys.

Project information //

www.simpact-project.eu

Simpact consortium //

- Westfälische Hochschule (Westphalian University of Applied Sciences), Institut Arbeit und Technik (Institute for Work and Technology) (Coordinator)
- TU Dortmund, sfs – Sozialforschungsstelle (Social Research Center)
- Euskampus Fundaziona, sinnergiak Social Innovation Center (ES)
- University of Economics Prague, Center for Social Innovation Studies (CZ)
- TNO – Netherlands Organization of Applied Scientific Research (NL)
- University Maastricht, UN-MERIT (NL)
- Politecnico di Milano (IT)
- NEOMA Business School (FR)
- University of Bath (UK)
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Constitutional Restrictions of Retroactive and Retrospective Tax Laws in Comparison: What Germany Should NOT Learn from the USA

In order for the law to fulfill its function of governing human behaviour effectively, the respective legal system must be reliable. Although this also applies to tax laws, the *German Federal Constitutional Court* distinguishes between retrospective legislation on the one hand and retroactive legislation on the other. While in the first case, it is generally accepted by the Court (exceptions apply) that the legislator enacts rules with detrimental effects on the individual which take effect only after their publication but tie in with sets of facts which have commenced prior to that date, with respect to the second case, there are a few instances in which the Court even allows for Parliament to subsequently tax events which have been fully completed in the past. Notwithstanding recent significant concessions, the basis of this case law, i.e. the Court's drawing on the assessment period laid down by the legislator, continues to face considerable criticism.

Given this finding, comparative law as an accepted method of constitutional interpretation imposes itself. Thus, in the course of his stay sponsored by the *Heinrich Hertz-Stiftung* as a Visiting Research Scholar at the *Levin College of Law (University of Florida)* with its top-ranked tax program, *Mike Wienbracke* analysed the *U.S. Supreme Court's* decisions on the question of whether, and if so, to what extent, U.S. Congress complies with the U.S. Constitution when, on occasion, increasing the tax burden in hindsight. After all, it was the *ex post facto clause* of Art. I Sec. 9 of the U.S. Constitution that inspired the formation of the absolute prohibition of retroactive criminal laws set out in Art. 103 Sec. 2 of the German Federal Constitution.

Normative Basis

And also in the given context of fiscal laws, both constitutional documents are on an equal footing: they each simply lack a provision explicitly addressing the aforementioned kind of legislation in the tax field, thereby necessitating recourse to the applicable general provisions of the respective constitution. From the US perspective, this provision typically is the Due Process Clause of the Fifth Amendment to the U.S. Constitution.

Laissez-Faire Jurisprudence

Beyond its wording, which indicates mere procedural guarantees, this clause is generally understood to comprise certain substantive rights as well. Albeit, ever since *Franklin D. Roosevelt's* "Court Packing Plan", economic laws in principle are subjected to a rather lenient standard of review by the *U.S. Supreme Court*. Aiming at prohibiting legislative arbitrariness, a rational relation to a legitimate legislative interest suffices for upholding respective Acts of Congress.

Rational Basis Test

With this rational basis test also applying to the matter at hand, and given that the majority opinion of the *U.S. Supreme Court* considers raising government revenue a constitutionally legitimate interest justifying the retroactive application of tax laws, it comes to no surprise that retroactively increasing an already existing tax – as opposed to the retroactive introduction of a wholly new tax – in general is not being considered to violate the Due Process Clause, even when no prior notice is given.

Conclusion

From the point of view of the German Federal Constitution, not only this result as such, which is also favoured by some proponents of the economic analysis of the law, appears disconcerting; but the same applies to the underlying lack of a distinction between the different kinds of retroactive legislation on the terminological level. Although both shortcomings are being addressed in U.S. legal scholarship, each fragment offered therein as a self-standing alternative has been put together by the *German Federal Supreme Court* to a comprehensive "retroactivity doctrine" decades ago. Following *Guido Calabresi's* insight in *United States v. Then* that "wise parents do not hesitate to learn from their children", the above finding may serve as a starting point for future investigations along the lines of "German legal export to the U.S.".

Current publication on the subject //

Wienbracke, M.: *USA – Land der schier unbegrenzten bundesverfassungsrechtlichen Möglichkeiten rückwirkender belastender Steuergesetzgebung*, ZVglRWiss 114 (2015), pp. 337-354.

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German Internet Index – The Internet at a Glance

The Institute for Internet Security at the Westfälische Hochschule (Westphalian University of Applied Sciences) in Gelsenkirchen in cooperation with partners started the first research project in the field of internet key performance indicators in August of 2010: the "German Internet Index (GIX)". The project pursues the goal to make the complicated internet structure more transparent and to illustrate its current and future potential with regard to Germany.

Internet Inventory

Providing data relevant to the decision-making process renders an important contribution for securing the critical internet infrastructure in Germany. The factually and functionally structured key performance indicator system generates key information with indicator functions and is an important tool for scientific internet analysis. The method for generating the performance indicators particularly aims to reflect the current condition of system-relevant internet components, providing differential determination dimensions for target and actual conditions and functions as a strategic decision-making tool in the problem areas demonstrated.

Data Sources and Processing

In technical terms, the "German Internet Index (GIX)" provides tools to process and analyse comprehensive data sets gathered from arbitrary sources. Based on a modular architecture, the framework simplifies maintenance and extendability to cope with user needs and future requirements.

Designed with holistic concepts and transparent methodology, GIX facilitates rigor quality management with policies for data preprocessing and standardization to ensure accurate results. A key objective of analysis performed in GIX is to support proper interpretation of real-world observations by unveiling complex interactions between technical measurements. This data modeling capability helps to identify, assess and predict mid to long-term changes which would otherwise remain hidden in simple data exploration.

Fig. 1: GIX-Dashboards Overview
All relevant information can be easily examined and demonstrated on the GIX-Dashboard.

Dynamic visualization features are provided to highlights key findings in an intuitive way, allowing users to customize views and drill down into details corresponding to their specific needs. For additional benefit, an archive of historical time series is fostering consistent combination of data to evaluate or benchmark reference measurements and support data-based decision making for a wide range of domains and applications.

Visualization and Presentation

Thanks to a high-performance data visualization capability based on modern web-technologies, the internet key performance indicator system can also display the data collected and correlated in a precise manner. Diverse tools provide different views of the performance indicators. In addition to expert tools for detail analysis, an informational portal providing an overview and reporting functionalities is available as well. Complicated correlations and development trends, which can be determined by the intelligent analysis technology, can be easily examined and demonstrated.

Current publications on the subject //

[1] Feld, S.; Perrei, T.; Pohlmann N.; Schupp, M.: *Ein Internet-Kennzahlensystem für Deutschland: Anforderungen und technische Maßnahmen*. In: P. Schartner · J. Taeger (Hrsg.): Tagungsband DACH Security 2011.

[2] Pohlmann N.; Sparenberg, M.; Siromaschenko I.; Kilden, K.: Secure communication and digital sovereignty in Europe. In: Reimers, H.; Pohlmann, N.; Schneider, W. (Hrsg.): *ISSE 2014 Securing Electronic Business Processes*. Heidelberg: Springer Vieweg 2014, pp 155-169.

[3] Pohlmann N.; Sparenberg, M.; Siromaschenko I.; Kilden, K.: "Schengen-Routing": Hohe Kosten für wenig Schutz. In: *IX* 02/2014.

Project Information //

Sponsored by BMWI
www.internet-sicherheit.de

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Secure Identification and Authentication – Project "Secure eMobility"

The integration of electric vehicles in the existing power network will result in increased communication with the environment and the existence of significant dependency on the infrastructure (Smart Grid). The concept of the "Secure eMobility" project ("SecMobil" project) is taking these requirements into consideration in three project pillars, "eMetering" (secure energy measurement), security architecture (identity management) and the secure services (applications) and it is the first "eMobility" project in which IT security as a necessary cross-sectional technology has been introduced.

In cooperation with other research partners, a standardized security architecture that will enable a secure and creditable exchange of information and data between diverse domains; particularly electric automobile manufacturers, energy suppliers, transportation companies and traffic regulation systems is to be established. The demonstrator charging station created in the "SecMobil" project can be used by the popular commercial electric cars after successful authentication of the user via nPA (neuer Personalausweis) (new personal identification card), a Security-Token[1] or "AuthService[2]", all of which are used within the framework of the Institut für Internet-Sicherheit's (Institute for Internet Security) – if(is) – identity management.

Goals and Results

Within the framework of the research project, the first nPA-based OpenID-Provider (see www.personalausweisportal.de), a user-oriented (for self-identification) identity provider, which was implemented as a demonstrator of the nPA has been developed. The identity provider implemented in the research project is based on a Public Key Infrastructure (PKI) and enables nPA-based identity binding of the smart card security tokens issued (e.g. Yubikey Neo).

The "AuthService" as a future-oriented symbiosis of distributed smart card technology and state-confirmed identities has followed based on these research results. The citizens are using their new German personal identification card (nPA) to initially confirm their identity on a one-time basis and subsequently use the secure, user-friendly security token, which can be used anywhere, on daily basis.

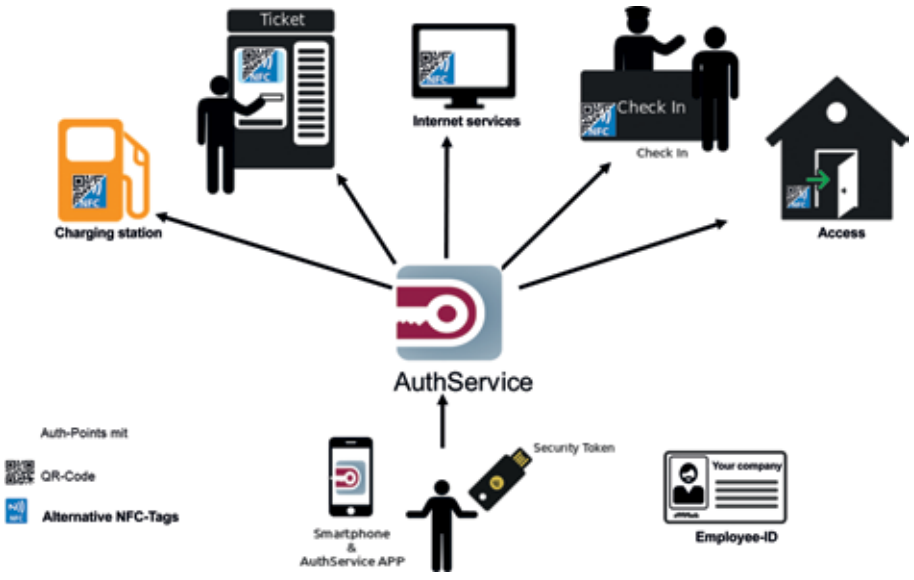

Fig. 1: Areas of Applicability for Project "Secure eMobility"

Lateral Thinking as the Path for Creative Research

The secure authentication of the energy customer at the charging station required in the research project and the corresponding identification have been bundled and implemented in the "AuthService" and transferred to other areas of daily life. The charging station identification method via a QR code[3] and/or NFC tag[4] can be used at the diverse authentication stations as demonstrated in the figure. The security token can be used for registration purposes for internet services, ticket vending machines, opening building doors and at charging stations, as well as for confidential user-peer-to-peer-communication.

A secure QR code and the internet connections, which are currently available everywhere is sufficient to securely and easily perform an authentication process with the smartphone camera and the security token. The "AuthService" has been expanded by the pay-service feature for creating user-signed payment tokens at the charging stations within the framework of the "Secure eMobility" project and its usability will be reviewed in all areas of electronic payment transactions.

1 Security Token: check card with personal codes for the secure use of online services.

2 "AuthService": authenticated after user identification with the smartphone and security token.

3 QR code: data display via black and white pixels.

4 NFC tag: close range communication for non-contact data exchange via wireless technology.

Project Information //

The "AuthService" architects, Markus Hertlein und Pascal Manaras, are the founders of the XignSys GmbH today, a Spin Off of the Westphalian University of Applied Sciences.

Current publications on the subject //

[1] González Robles, A.; Pohlmann, N.: Sichere mobile Identifizierung und Authentisierung. In: *Datenschutz und Datensicherheit - DuD* (October2014), Volume 38, Issue 10, pp. 684-690.

[2] González Robles, A.; Pohlmann, N.: Identity Provider zur Verifikation der vertrauenswürdigen digitalen Identität. In: Schartner, P.; Lipp, P.: *Syssec DACH-Security Conference* (2014), pp. 260-272.

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Fraud Protection for Online Banking

In 2015, 40 million German citizens have already conducted their banking business online [1]. Criminal activities, such as unauthorized access to bank accounts or fraudulent manipulation of online-transactions result in financial losses for banks and end users. According to official reports of the German Federal Bureau of Investigation (Bundeskriminalamt – BKA) those losses summed up to 27.9 million Euro in 2014 (at 6,894 cases, approx. €3,995 per case). The estimated number of unreported cases is probably significantly higher than the official figures reported by the BKA because the financial institutions try to avoid such negative press to avoid damaging their reputation.

Exposed Areas in Online Banking

Currently, a significant problem in online banking is the fraudulent manipulation of the banks' websites by so called banking Trojans on the bank customers' end device. The banking Trojans can manipulate the local presentation of the bank websites on the client's side utilising "Man-in-the-Browser" attacks. This allows the attacker to launch highly effective "Social-Engineering" attacks which cannot be detected by the current security mechanisms to secure transaction (e.g., smsTAN). For example, the user accessing the bank website is scammed into believing that he has received an unauthorized deposit and should return this deposit via a click.

User Protection

Within the scope of a research project, a system that can detect website manipulation based on collective intelligence and alert users' that accesses a manipulated website, has been developed. The system works in a way that information regarding the structural setup of a website are directly transmitted by numerous wide-spread end systems to a centralized "Manipulation Detection System" during the visit of each website. This server is able to determine whether the currently presented website was manipulated or not.

Alert system

In addition, an "alert-system" which estimates the current thread level in the online banking landscape and alerts users if the level is currently high, has been developed as well. Currently, if an adversary wants to successfully attack an online banking user, she must scam the user into "misconduct" via a "Social Engineering" attack. Since it is quite difficult to counter these attack on a technical level, the user must be included in the online banking security concept. An alert-system can warn the user at times of extremely high risk of being targeted during an online banking session. The relevant indicators to be used for the assessment must be identified in order to evaluate the current risk situation. Four different categories of key security indicators have been selected for this risk assessment:
(1) Phishing,
(2) activity of banking Trojans,
(3) current fraudulent cases, and
(4) known vulnerabilities.
These indicators are used to train machine learning and artificial intelligence algorithms in such a manner that the current risk situation can be precisely assessed.

Fig. 1: Alert System Concept

Sources and publication on the subject //

[1] Bitkom: Online-Banking ist bequem und sicher, https://www.bitkom.org/Presse/Presseinformation/Online-Banking-ist-bequem-und-sicher.html, 2015.
[2] Bundeskriminalamt: Cybercrime. Bundeslagebild 2014, 2015.
[3] Urban, T., Pohlmann, N.: Sehen heißt glauben! Aufdeckung von Webseiten Manipulation. In: *Proceedings der DACH Security 2016 Konferenz.*

Project Information //

The research project was sponsored by the BMBF. The project was active for three and a half years, 10/2015 – 01/2018.

Bundesministerium für Bildung und Forschung

The research project "Betrugsschutz beim Online-Banking" (short BOB or "Fraud Protection for Online Banking") is conducted by the Institute for Internet Security – if(is) in cooperation with the Technical University Berlin, the University of Saarland, the Avira Operations GmbH & Co. KG, and the Fiducia & GAD IT AG. Integral approaches to make online banking safer, especially for private customers were created within the framework of this research project. This projected amid to bring light to the dark area in misappropriation of online banking, develop measures against misappropriation, and promote fraud recognition.

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Prof. Dr. Klaus Thiel, Stefan Evers M.A.

Prognosis of Socio-Demographic Data for Reducing the Scatter Losses in Online Targeting

The project goal is to analyse the surfing behavior of online portal internet users and based on this, establish a prognosis of his socio-demographic characteristics. An improved prognosis of the conditional variables (socio-demographical) should decrease the scatter losses in targeting.

Data Description
Cookie data is the base data demonstrating the user's specific daily behavior (maximum of 82 days). Amongst other things, the cookie collects the surfing behavior on the portal pages, as well as the partner-pages the user has activated to reach the online portal, and if the user as such initiated a search inquiry on the on-line portal. An online survey is conducted to record the conditional variables for the random pattern of users.

Challenges of Data Processing
Processing the data is difficult due to the complicated data structure, the contextual interpretation and the data volume. With regard to the data structure, the informational volume is different for each user and therefore a design matrix cannot be derived directly. Based on this, the initial user information *n* is not necessarily identical in content with the initial information of the user *n+1*. In addition the raw data contains search queries. In most cases these are individual texts and can only be assigned to one user. Interpreting the data poses additional challenges, because in some cases information derived from the cookie data is contradictory. Further, the available data set is quite large and complex and requires numerous processing steps.

Data Processing Methods
The data is processed and analysed with the Open Source Software R (version 3.0.2, 64 bit). R is installed on a server (operating system Windows 7, 90 GB RAM). The functions *reshape2* and *stringr* are used for processing the data. Large data volumes can be uploaded and used to create a design matrix. The individual user information is sorted within the design matrix enabling the recall of certain information in the same column for each user. The search queries are analysed with *stringr*. The texts are summarized and the contents are interpreted.

Fig. 1: Steps for the reduction of scattering losses

Statistical Methods
The data is analysed using diverse statistical methods. The primary focus is on machine learning and the regression theory. Machine learning can identify the patterns and relations needed for subsequently creating a prognosis with the prepared algorithm. Within the scope of the regression theory, the focus is on decision trees, classification trees, random forest, logistics regression and multiple logistics regression. The goal is to establish a prognosis of the users' socio-demographic characteristics regarding the conditional variables for which no information is available.

Processing
The more precisely an unfamiliar user (unknown socio-demographic characteristics) can be characterized, the better the socio-demographic characteristic and goal-oriented communication in online marketing. It can easily be determined that a different advertising banner should be blended in for a 30-year old man than a 55-year old woman. In addition, the analyses can proactively counter customer churn. A decisive factor for customer churn is the so-called "piece-by-piece use of services". Since users can only be observed for 82 days in the best case-scenario, the intensity of the use of services can be measured during the time progression.

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GeoFuelCells – Autonomously Operated Drill Hole Sensors Utilising PEM Fuel Cells as Energy Source

A fuel-cell based energy supply system for drilling applications was developed in the context of a research project entitled "Autonomously Operated Bore Hole Sensors Utilising Fuel Cells – GeoFuelCells" by the International Geothermal Centre (GZB) in Bochum in cooperation with the Westphalian Institute of Energy of Westfälische Hochschule [Westphalian University] of Applied Sciences.

Requirements of the System

Electrical energy is necessary for monitoring the drilling process and the in-situ characteristics of an investigated underground reservoir even during the exploration phase. In state-of-the-art applications, the electrical energy is either supplied via cables to or by batteries that are equipped to the drilling system. Both alternatives have crucial disadvantages like high costs and limited operability. Batteries for example degrade quickly and lose charge with increasing temperature. Furthermore, the Li-mono cells that are currently used will not cope with the temperatures at drilling depths of several kilometres, where the temperature rises approx. 3 to 6 K per 100 metres to above 150 °C. To overcome problems with common solutions, a fuel cell system was developed in the context of the aforementioned project, which was intended to prove the use of fuel cells as an autonomous and long-term stable energy supply system. The first system was designed for a temperature range of up to approx. 100 °C. A subsequent step will be the development of a high-temperature fuel cell system that is suitable for the use at temperatures above 150 °C as well as being able to withstand the vibrations of drilling and the pressure changes within the bore hole.

Fig. 1: Complete system without gas supply

Implementation

The designed electrochemical device is a proton exchange membrane (PEM) fuel cell. The operating temperature of a PEM fuel cell is limited by the polymer membrane that suffers from significant chemical degradation at elevated temperature levels. Additionally, the peripheral components (pumps, valves etc.) and the power electronics have to be correspondingly temperature resistant. For operation of the PEM fuel cell in a drilling system, it was necessary to develop a new design, especially for the electrodes, having a circular geometry with a diameter of four inches. At the same time, the geometry must be suitable for withstanding the high mechanical stress caused by vibrations and pressure changes.

In order to be able to draw conclusions regarding the applicability of the fuel cells, the problem of sealing at different operating temperatures was investigated in the framework of the project. A further section of work was concerned with finding the correct operational parameters for achieving a balanced water economy of the cell, which is crucially important to the stable operation of the system.

The balance-of-plant components of the system and the sensors to be supplied require a regulated input voltage, to be generated via power electronics from the 0.6 V to 0.9 V per cell of the fuel cell (depending on load). These power electronics were also developed in a cylindrical design in the framework of the project, in which it was of primary importance to meet the demanding operational conditions as well as the demands of the construction volume. The regulatory control of the whole system in the power electronics was also constructed such that autonomous operation is ensured. Tests carried out to date in the laboratory have shown that the targets set have been completely achieved with the system developed. Further findings are expected from the test in the drilling pipe yet to be carried out.

Project information //

Project partners of the joint project: Geothermiezentrum (Geothermal Centre), Bochum.

The project was financed in the framework of the NRW-Ziel-2-Programm (EFRE) 2007-2013.

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Nano Structured Electrodes for Low Cost Fuel Cell Systems

Nowadays, it is possible to produce hydrogen environmentally friendly in a large quantity by applying water electrolysis powered by renewables. Produced gas via electrolysis can be stored e.g. in cavern reservoirs, pipelines or large pressurised containers, enabling long-term storage. The reconversion of renewably produced hydrogen can be done without pollutants and highly efficient in modern fuel cells. Thus, the entire energy conversion chain can be sustained CO_2-free. Moreover, fuel cells based on polymer electrolyte membranes (PEM) are ideally suitable for dynamic operations and can respond rapidly to changes in the electrical grid (feed-in scenarios), resulting in a compensation of surges in electricity demand. It can be assumed that due to legal specifications and current funding instruments, purchase incentives to private customers are generated and stationary fuel cell systems for cogeneration of heat and electricity (CHP) will achieve a significant importance, soon. The use of this technology in fuel cell electric vehicles is another feasible application. The first manufacturers of fully electrically driven vehicles are offering a hydrogen-powered fuel cell option, so decarbonisation of the transport sector also appears promising.

PEM-Fuel Cells

One main component of a PEM fuel cell is the catalyst, which accelerates the chemical reaction by enhancing the reaction rate of hydrogen and oxygen to water. Platinum is widely used for this purpose and distributed homogeneously in nano-sized particles at the interface between the membrane and the electrodes, respectively (anode and cathode). Although PEM fuel cells have entered the market, the reduction of platinum and the optimisation of the catalytic layers have become the subject of ongoing research and development activities, aiming to reduce especially the costs of PEM fuel cells. The scientists of the working groups "hydrogen energy systems" and "material science" of the Westphalian Institute of Energy are cooperatively active in this cross-disciplinary research. The subject of investigation in a research project terminated in 2015 entitled "New Membrane-GDL-Assemblies for PEM-fuel cell Systems" (in short, NanoFuelCells) (funding code 005-1111-0010) was a catalyst layer supplemented by the use of carbon nano-fibres (CNF). In the framework of this project it was possible to prepare a laboratory demonstrator of a fuel cell electrode with optimised platinum loading.

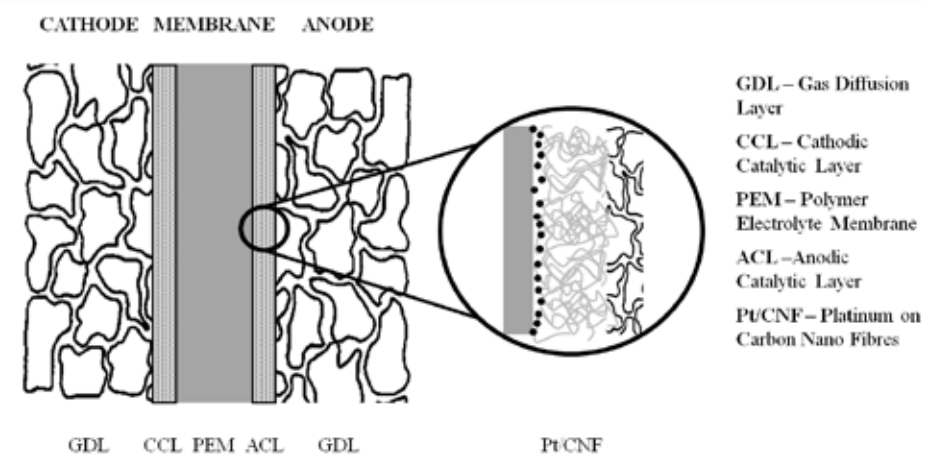

Fig. 1: Diagram of a membrane electrode unit for PEM-fuel cells (cross-section)

An efficient preparation procedure has been developed, that leads to a significant platinum savings in PEM fuel cells in comparison to manufacturing methods that are typically applied. These noble metal savings result from the use of an electrochemical process for the deposition of platinum nanoparticles onto CNFs. A plasma physical pre-treatment of the CNFs assists to the deposition of nano-particles. In particularly the plasma treatment improves the distribution of catalyst particles on the surface of the carbon structures. The favourable carbon particles that are utilised as precious metal catalyst support offer an increased specific surface. Furthermore, in comparison with the carbon blacks usually used as catalyst carriers, the CNFs offer higher electrical and thermal conductivity and an increased corrosion resistance in PEM fuel cell environment. Subsequently to the NanoFuelCell project, since March 2016 the research teams are involved to the R&D project "Development of Low Cost Gas Diffusions Electrodes Based on CNTs/CNFs for Use in PEM-fuel cell Systems, abbreviated to LOCOPEM" (funding code EFRE-0800111), which targets to transfer the laboratory demonstrator to a near industry-scale prototype.

For current publications, see using www.w-hs.de/kooperieren/forschung-und-entwicklung/forschungsbericht/, original research report of 2016, pages 24-25.

Project information //

https://www.w-hs.de/kooperieren/forschungsinstitute/westfaelisches-energieinstitut/homepage/forschung-wei/wasserstoffenergiesysteme/locopem/

The project is a part of the cooperatively carried out doctoral study of Dr. Ulrich Rost, together with the Politehnica University Temeşoara (Polytechnic University of Temeşoara) in Romania.

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A Novel System Approach for Hydrogen Production from Renewable Energy Sources

There is a broad common agreement that a transformation of the energy sector towards an energy economy based on renewable energy sources is necessary to fulfil the Paris Agreement on holding the increase of global average temperature to well below 2 °C compared to pre-industrial levels. Due to the fluctuating generation of electrical energy by photovoltaics and wind turbines, it is, therefore, inevitable that dynamic storage systems must be developed. Currently, a peak power of about 90 GW is already installed within the German electrical grid. Nevertheless, increased utilisation as well as a further increase in the share of renewable energy systems in the near future is needed and expected.

Water Electrolysis

One suitable method for environmentally friendly storage of large quantities of energy is the electrochemical generation of hydrogen via water electrolysis. Electrolysers use electrical energy to decompose water molecules into their components oxygen and hydrogen. The storage of hydrogen under pressure in caverns or in pipeline systems is already commercially successful. In addition to that, the pressure level can be raised for a high volumetric energy density due to the low density of hydrogen, which allows the use of storage systems with limited volume. Pressurised gas storage for mobile applications already work with pressure levels of up to 700 bar. Accordingly, it is advantageous to directly generate hydrogen at high-pressure levels via the electrolysis process. Expensive compression stages can then be omitted and investment as well as operational costs can be reduced. At the Westfälische Hochschule [Westphalian University] of Applied Sciences a novel system approach for high-pressure hydrogen production is being developed. It is expected that the developed system will be suitable for an up-scaling to industrial dimensions of prospective electrolysis systems.

Development of High-Pressure Electrolysers

In the recent past, the research group of Prof. Brodmann focused on the development of dynamic high-pressure polymer electrolyte membrane (PEM) water electrolysis. This approach follows the already-patented principle of single cell hydraulic compression, which enables modular electrolyser designs that are scalable in size and hydrogen production rate. Furthermore, high-pressure hydrogen generation is facilitated by optimised pressure controls. A laboratory scale demonstrator has already been realised. The device allows for hydrogen production with an output pressure of 50 bar. Partners for these developments and for future work are the companies "iGas energy GmbH", "ProPuls GmbH", and "Obitronik GmbH".

Ongoing actions focus on the implementation of a fully modular PEM-electrolyser with segmented planar pole plates, within the R&D project "VOMPELS". It is aimed at transferring the existing laboratory model into a close to industry design. A prototype system will be developed comprising electrolyser cells with an active surface area of up to 600 cm^2, which can be safely operated up to a pressure of 100 bar. In this way, in the future it will also be possible to build medium sized applications for the storage of excess energy from photovoltaics and wind turbine generators.

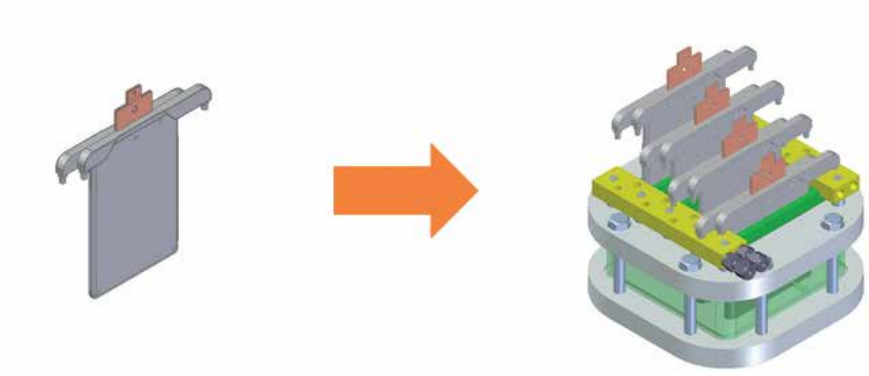

Fig. 1: Schematic drawing of the modularly constructed electrolyser with four individual cells.

Project Information and Publications //

https://www.w-hs.de/kooperieren/forschungsinstitute/westfaelisches-energieinstitut/homepage/forschung-wei/wasserstoffenergiesysteme/vompels/

Current publications on the subject //

[1] Brodmann, M.; Rost, U.: Hochdruck-elektrolyseur in Taschenbauweise, *HZwei* 4 (2016) 22 – 23.

[2] Wirkert, F.J.; Roth, J.; Rost, U.W.; Brodmann, M.: Hydraulic cell compression for performance preserving upscaling of PEM electrolyzers, *Int. J. Smart Grid Clean Energy*, 6, 3 (2017) 10.12720/sgce.6.3.171-176.

[3] Lentz, K.-H. ; Rost, U.W.; Oberschelp, W.; Brodmann, M.: Hochdruck PEM-Elektrolyse, in *T. Luschtinetz, J. Lehmann (Eds.), proceedings of the 24. Energie-Symposium Nutzung Regenerativer Energiequellen und Wasserstofftechnik 2017*, p. 77 - 81, Stralsund, 2017.

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"Process-Factory"– Integrative Methods for the Development of Bio-Production Processes on the Example of Sustainable Manufacture of Industrial Chemicals

Industrial biocatalysts are often treated as black box systems in the framework of non-structured biological models. Process optimisation in fermentation reactors often takes place on a "trial & error" basis. By contrast to this, the improvement of product formation or cellular characteristics should be brought about by the direct involvement of metabolic conditions (metabolism) and their regulation. To do this, predictions from mathematical models need to be adjusted and suitable measurement and regulation rectors need to be developed. This procedure will be compiled in the framework of the project with the example of production of the industrial chemical acetone with the help of a recombinant micro-organism (*E. coli*). The developed method should fundamentally be transferable to other processes and thus deliver an important contribution to strengthening industrial biotechnology.

Integration of Measurement and Regulation Systems

The use of regulated fed-batch fermenter systems for the manufacture of industrial products may be the current state of technology, but it is significantly restricted by the use of simple regulatory algorithms which do not take into account the current metabolic situation. For this reason, a system is to be developed that uses these (metabolic) actuators for optimisation of the process itself (see diagram).

Process-Factory

The innovative character of the process-factory lies in the first time construction of a measurement and regulation system based purely on the cell situation which enables sustainable production of industrial chemicals (here: acetone) in high-tech fermentation processes. This production process will contribute critically to solving the named problems in the manufacture of environmentally tolerable substances using micro-organisms.

The technological and methodological approach can later be used in industrial processes and ensure sustainable supply of industrial chemicals. If the proposal is successful, it will be possible to transfer this procedure to other specialised micro-organisms producing high-value substances.

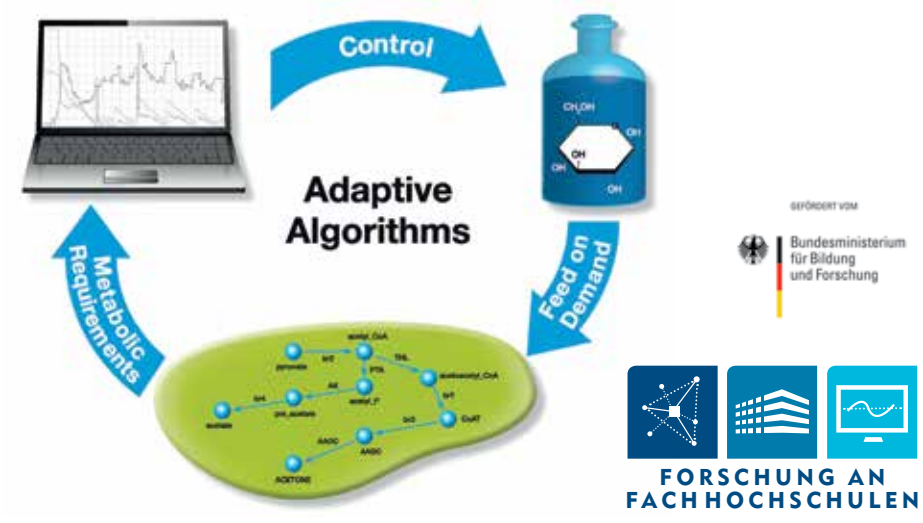

Fig. 1: Adaptive Algorithms

The aim of the project is to construct a generally applicable method for the fast development of bio processes through the integration of stem and fermentation optimisation.

On the basis of already completed feasibility studies, the current project intends to develop as an example the micro-organism *E. coli* as a whole cell biocatalyst for the sustainable production of the industrial chemical acetone. The methods to be developed are intended to give a perspective on the eco-efficient manufacture of acetone from cheap substrates.

Molecular Biology

The strain of *E. coli* used in this work is a genetically changed variant of *E. coli* BL21. In this organism, a synthetic Operon (ace4) coding for acetone production was added using genetic cloning strategies. This consists of the gene sequence responsible for acetone production (adc, ctfAB & thl) which was isolated from *Clostridium acetobutylicum*.

Work Packages

It is planned to compile three aspects in the project and link them thematically:

1. Development of *E. coli* as host strain for whole cell bio-transformation
2. Equipment development (agitation flasks with integrated measurement and regulation technology, here especially: waste gas sensors)
3. Method development for process optimisation

The production performance is intended to be optimised systematically and as a combination of theoretical and experimental work. The basis of this procedure is a mathematical model of metabolism to be able to exploit the biotechnological potential and describe the effect of changes. This will allow the material flows to be directed toward the product acetone. Optimised production strains will then be constructed based on the mathematical description using methods from molecular genetics and synthetic biology that can soon be used in industrial processes.

Project information //

FHprofUnt 2013: Funded by the Bundesministerium für Bildung und Forschung (Federal Ministry for Education and Research).

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"MeRoSy" – Control of Robots by Head Motion

Currently robots are mostly controlled by hand. People with physical restrictions, such as paralysis of the upper extremities, are not able to use manual interfaces. As well people whose hands are otherwise occupied benefit from a hand-free interface to control a robot e.g. in manufacturing scenarios where human-robot interaction is needed.

Objectives

As part of the joint BMBF-project MeRoSy the R&D group "Sensortechnology and Actuators" is working on human-robot interaction to control a robot in 3D by head motions. An assistance system is developed using Magnetic Angular Rate Gravity (MARG) sensors placed on top of the head to control the robot. Machine learning tools are used to learn new tasks and adapt existing solutions to new constraints. The problem solving behaviour of the user is analysed and reproduced. Based on two application scenarios, a head control system is developed and tested within the scope of the project. The first scenario is a library work-station for motion disabled user with the challenging task to catalogue books. The second scenario is an assembly work-station where the user works in collaboration with a robot and controls it via head motion while simultaneously performing tasks using the hands. Ethical, social and legal implications are addressed.

Human-Robot Interaction Technology and Design

A chip system with nine microelectromechanical system sensors – gyroscopes, acceleration and magnetic field sensors – is used. Three angles for head motions in pitch, roll and yaw orientation are derived from the raw sensor data by sensor fusion. The testbed is an "Universal Robot 5" (UR5) with six degrees of freedom in motion and an additional one for the gripper. In figure 1 an interaction design is proposed by mapping the degrees of freedom to four groups representing control of the robot in vertical plane, horizontal plane, orientation and to open or close the gripper. Switching between the groups as well as activation is performed by head gestures.

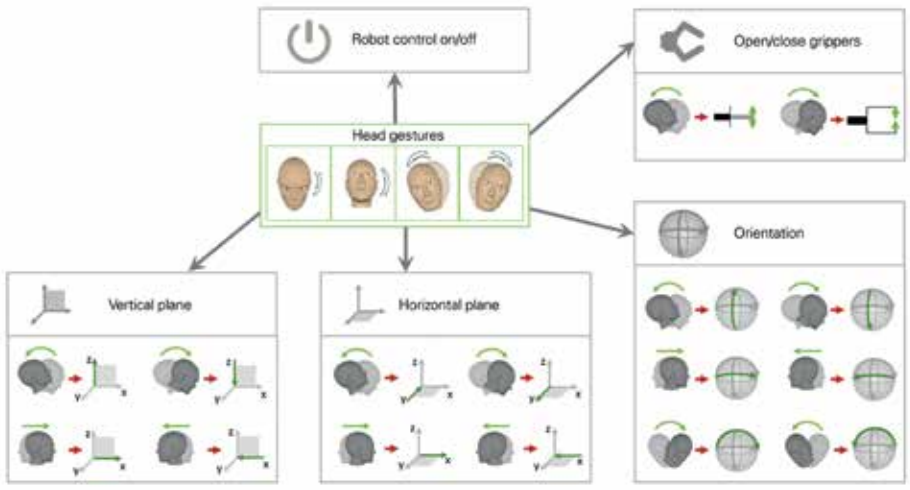

Fig. 1: Interaction Design for robot control with seven degrees of freedom

Usability Study

The research on robot control was conducted by an usability study with the "UR5" to get information on performance and efficiency of the proposed interaction technology and design. The study with 12 users, paralysed downward the neck, was performed at the Center for Spinal Injuries, BG-Hospital Hamburg. 24 healthy users tested the interaction at the Westphalian University of Applied Sciences, Campus Gelsenkirchen. The interaction technology and design was analysed with a questionnaire and by recording the timeframe and necessary attempts for accurately implementing the gestures. Overall the interaction was intuitive and successfull. However, the head gesture recognition will be improved in the future.

Project Information //

The research project is sponsored by BMBF. The project will be active for three years, 1/2015 - 12/2017.
The research project "MenschRoboter Synergie – Lernen und Adaption in der Mensch-Roboter Evolution (short MeRoSy)" is a joint project with three academic and two SME partners.
http://www.technikzummenschenbringen.de/projekte/merosy

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

Current Publications on the Subject //

[1] Rudigkeit N.: AMiCUS - Motion Sensor-based Human-Robot Interface for Intuitive Realtime Control of a Robot Arm Using Head Motion. Doctoral Dissertation, University of Bremen, 9/2017.
[2] Jackowski A., Gebhard M. and Thietje R. (Center for Spinal Injuries, BG-Hospital Hamburg): *Head Motion and Head Gesture-Based Robot Control: A Usability Study*, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol.26, No. 1, January 2018.

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Separation of Rare Earth Magnets

The recycling of "rare earth metals" from various areas of the waste and recycling industry improves raw material independence, which is an important pillar of the export ratio, and thus ensures our prosperity. The challenge of making rare earth metal recycling processes marketable consists in finding a sufficient quantity of material mixtures that contain only a small share of scrap. The Zentrum für Recyclingtechnik (Center for Recycling Technology) studies the automated separation of high-performance magnets and iron particles with a view to providing a usable intermediate product for rare earth metal recycling.

Initial Situation

High-tech products such as mobile phones, laptops, flat screen monitors, batteries, and motors exist thanks to raw materials from the element group of rare earth metals. Rare earth metals, such as the lanthanides as well as yttrium and scandium, have special metallic properties, which facilitated a technological revolution in mass products based on permanent magnets such as electro-mechanical energy converters, storage media, or signal generators. Rare earth metal magnets have a higher magnetic energy product than other materials. They allow for greater energy efficiency and the possibility of downsizing.

Fig. 1: Separating rare earth magnets with eddy current separators
While permanent magnets are ejected using opposing magnetic fields, iron particles are attracted due to their magnetic properties and removed from the field by conveyors.

The Procedure

In the current recycling structure for used components, these high-performance magnets enter into the metal recycling loop and are shredded together with scrap steel. The current technology therefore does not make it possible to sort them out from the scrap mixture as a separate fraction. The rare earth metals fraction dilutes further in the steel melt. In a process called "Magnesort", developed at the Westfälische Hochschule (Westphalian University of Applied Sciences), the magnets are first partially demagnetized by means of appropriate thermal treatment and can then be separated in an artificial alternating electromagnetic field. This process concentrates a separated fraction of corresponding permanent magnets.

Study Approaches

After a patent for the process had been registered, various studies of the separation process were conducted at the Center for Recycling Technology. What these tests have shown is that even magnetic dust, generated when shredding brittle magnetic scrap, can be separated.

We have been able to determine specific separation rates by studying shredded scrap made from hard drives containing permanent magnets, which usually end up together with other metals in a larger fraction when disposed of according to the standard procedure. By doing so, we have also been able to evaluate the practicability of the process. We have derived new methods of using the process for separating various magnetic materials and further reducing the loss of non-selectable magnets.

Studies are currently being conducted as part of Bachelor and Masters theses. At the moment, there is an ongoing doctorate program in cooperation with the Universität Duisburg-Essen (University of Duisburg-Essen), which is expected to provide further results.

For current publications, see using www.w-hs.de/kooperieren/forschung-und-entwicklung/forschungsbericht/, original research report of 2016, pages 32-33.

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FIRE – A Distributed IT-Supported Information System for Deployment Support of Fire Departments and Emergency Services

The IT-system FIRE provides all of the data and information for a current deployment to fire departments and emergency services via mobile end devices. In addition, it also supports the collaboration of all parties involved at the location as well as with the central control post. This support is based on a collaboratively prepared and updated sketch map and reciprocal exchange of information, such as photographs or other documents.

The sketch map is loaded onto digital 2D-cards as well as a digital 3D model (see figure). The cards are supplemented with automatically provided (static) geographical data, such as the location of fire hydrants or geographic building references. Additional dynamic information provided are the current location of all parties involved in the deployment, as well as information provided manually during the deployment, such as information regarding hazardous zones and blockages.

System Configurations

The FIRE hardware platform consists of mobile end devices (tablets, smartphones) for use on location and multiple PCs (desk tops, servers) at the central command post, which permanently synchronize their information statuses via the relevant information channels (GSM, GPRS, UMTS, LTE).

Since all of the static information (maps, 3D models, hazardous substance databases, rescue maps,...) are installed on the end devices, FIRE also provides an extensive and high-performance information system significantly exceeding the current daily practical operations, if the respective communication options are not available. This enables searching for information in various databases as well as semantically ("provide all information on hazardous substance XYZ") or spatially ("show me all water tapping points in 300 m circumference of the location") on site, as well as at the control center.

Fig. 1: 2D-sketch map (left) and corresponding excerpt from 3D-model (right)

On-Site Use

In an effort to relief the emergency staff/ first responders to the highest degree possible, the central control center can also take over the information management on the devices at the location, so that the emergency staff/first responders can access the exact information required at the moment without having to perform an extensive search. The central control center can also access external informational sources and, for example, retrieve the proper "rescue map" for a certain license plate number and provide this map as a link or copy to the emergency staff/first responders on site "electronically".

Project and Operator

The project sponsored within the framework of the BMWi ZIM program started in 2012 and was initially introduced to the interested professional audience at the Interschutz 2015 (trade show). The two essential student-project participants are now employed with "3dis" and are working on creating a suitable practical system. A cooperation with a control software provider, who will be managing the market access, has currently been established. The first operator is the Bocholt fire department who significantly supported the project. FIRE is scheduled to be expanded in the region within the framework of within the "Regionale 2016" (www.regionale2016.de) to demonstrate the interaction with multiple fire departments and other emergency services.

FIRE is another successful example for assisting in the research qualification of students enrolled in Master Degree studies at the university; here from the Master's program "Distributed Systems" at the Bocholt campus.

Project Information //

The project was sponsored within the framework of the BMWi ZIM program.

Gefördert durch:

Bundesministerium für Wirtschaft und Energie

aufgrund eines Beschlusses des Deutschen Bundestages

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Lead-Flow-Batteries as Energy Stores of the Future

Redox-Flow-Batteries have a great potential for storing renewably generated electricity like, for example, in increasing the domestic current from wind or photovoltaic installations. Flow-Batteries, by contrast to conventional batteries, are used with fuel cells, as the reduction and oxidation materials are not present in the cells as active masses, but are dissolved in the electrolyte and fed by pump to the electrochemical cells during operation, where the reaction takes place. These battery types have the special characteristic that, that capacitance and power can be scaled separately from each other as the power is dependent on the size of the cell, whilst the capacitance of the system is determined by the size of the tank or the quantity of electrolyte. This makes adjustment of such a system relatively easy and cost-effective for different applications. In addition, flow batteries are able to achieve very high numbers of cycles and thus long life times (> 10.000 cycles or > 10 years). The long lifetimes are primarily possible because the active masses do not undergo any physical changes during operation, as is the case for example in the memory-effects in Nickel-Cadmium cells or the capacitance loss in lithium ion.

However, the materials currently used like separators and peripheries in VRFB[1] systems are relatively expensive and the energy density rather low, being determined by the poor solubility of the active species in the electrolyte. These factors, along with the relatively expensive configuration with battery management system and pumps, are preventing a wide introduction to the market.

The Lead-Flow Battery

A special form of redox-flow battery is the lead-flow battery or SLFB (Soluble-Lead-Flow-Battery). In this so-called Hybrid-Flow battery, the active masses are dissolved in the discharged state in the electrolyte, but are separated onto the electrodes during charging and form a solid film there. The capacity and the power cannot be scaled up completely independently because of this, but the cycle stability and the ability of the system for deep discharge compared with conventional lead batteries is significantly increased, at a low price comparable with lead batteries. The great advantage of the SLFB compared with other redox-flow batteries is that the SLFB works with a single electrolyte. This removes an entire circuit with tank, pump and pipes and a membrane separating the two half-cells from each other. This not only has a positive effect on the price, but drastically increases the energy density.

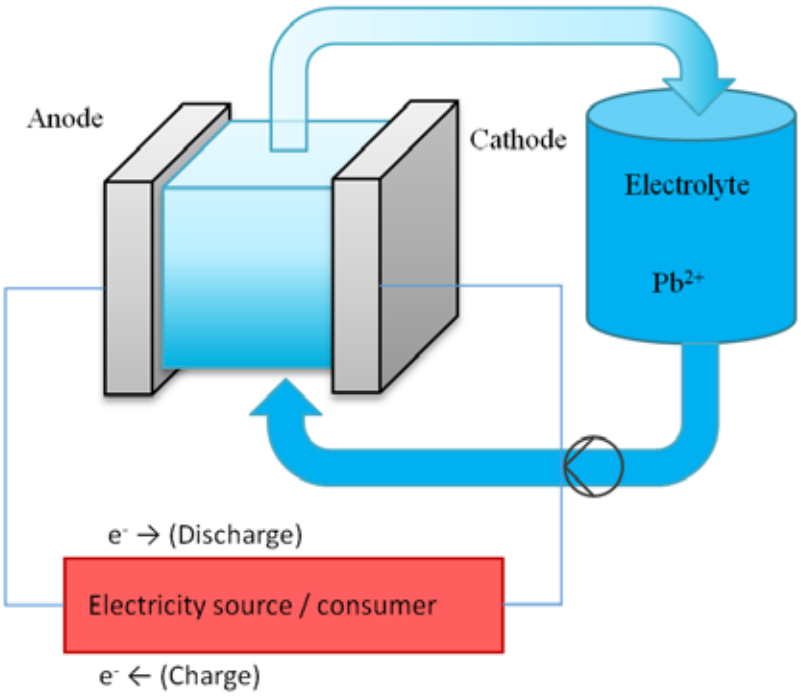

Fig. 1: Diagram of the SLFB
During charging lead oxide (PbO_2) is separated at the cathode and elemental lead at the anode.

Advantages of the Lead-Flow Battery

Compared to conventional lead batteries, the SLFB has the great advantages that self-discharge is very low; the cell has a long lifetime and there are no limits in respect of deep discharge. Whilst conventional batteries can suffer irreversible damage during a single deep discharge through grid corrosion of the current collector, with the SLFB it is possible to completely free the electrodes from the active masses again through a complete discharge, and so set the cell back to its original condition. This makes the cycle lifetime expectancy similarly high to the other redox-flow systems.

The Development of Special SLFB Systems

The Westfälische Hochschule (Westphalian University of Applied Sciences) is engaged with the development of SLFB systems for network stabilisation and e.g., use as uninterrupted electricity supply (UES). The SLFB has enormous potential especially in the area of UES. At the moment, lead-acid batteries are used in these systems but these are high-maintenance despite the relatively low prices. Prototypes have been developed as part of various Masters' work which have achieved more than 460 cycles without fault. With the use of a system such as this, e.g. for increasing the domestic current demand from photovoltaic with one charging and discharging cycle per day, this would correspond to a service interval of more than a year.

[1] Vanadium-Redox-Flow Battery

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Vanadium-Redox-Flow Batteries: Revolutionary Storage Technology for Renewable Energy

Redox-Flow Batteries (RFB) are storage systems with a high efficiency and significantly higher lifetime than conventional batteries. The number of cycles is around 10,000 cycles which corresponds to an expected lifetime of over 10 years. In this kind of storage, electrical energy is transformed into chemical energy and vice versa. The active species are present as solutes, the so-called electrolytes. This ensures that the batteries remain stable over the whole timeframe, since the active masses do not undergo any physical changes and thus no memory effects arise. The power is limited only by the electrode surface area and the storage capacity by the quantity of electrolyte. That means that these two quantities can be varied independently of each other. Energy storage and transformation are thus spatially separated from each other. That means that RFBs can be very flexibly adjusted to different areas of usage.

The Vanadium Redox-Flow Battery

In the vanadium redox-flow battery, vanadium salts are dissolved in sulphuric acid and used as both positive and negative electrolytes. This is possible because vanadium is stable in four charging conditions. This makes the battery especially robust since a mixture of the electrolyte does not lead to the destruction of the cell. The electrolyte is not subject to any change and so does not lose any value over the time of use. There is as good as no self-discharge, which also means that long storage times can be achieved. The Coulomb efficiency of this type of battery is significantly higher than 90%.

A problem with this battery type is primarily the high price of the individual components, especially the ion exchange membrane. Another disadvantage is the low energy density that results from the poor solubility of vanadium in sulphur.

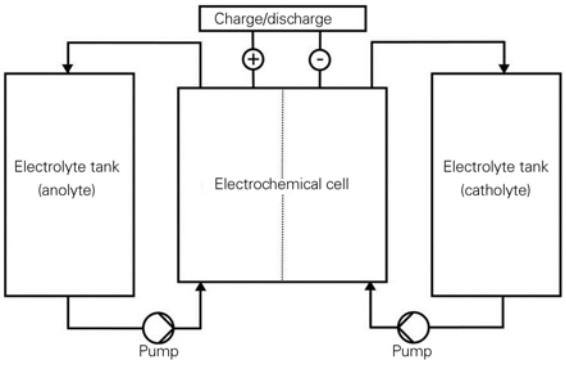

Fig. 1: Schematic Sketch of a Redox-Flow Battery

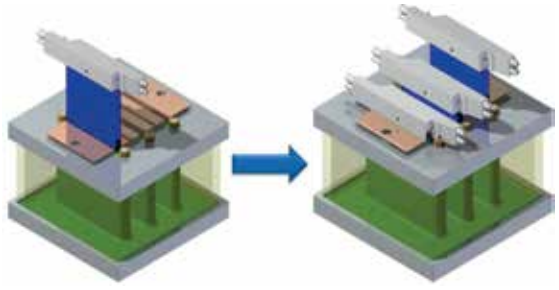

Fig. 2: Schematic Construction of a Modular Stack in Pocket Construction

NRW-Project VARZELL

A fully modular stack for a vanadium redox-flow battery with segmented cell design is to be developed within the "EFRE.NRW" project "VARZELL". To do this, the system of hydraulic pressing developed and successfully tested at the Westphalian University for Fuel Cells will be used.

In this process, the individual battery cells of a stack are placed separately in pockets which are located in a pressure container. It is possible to use a suitable tracking of pressure to regulate the applied surface pressure Δp dynamically, dependently of the operation point and the cell characteristics. Furthermore, temperature control of the stack can be achieved by circulation of the hydraulic fluid. Hydraulic pressure offers the advantage of homogeneous pressure distribution in the cell. Due to the homogeneous hydraulic pressure at the individual cell level, it is theoretically possible to realise cells and thus individual cell power as large as desired. To realise space-saving stacks, however, a construction is being sought in which several cells can be built into one pocket.

In addition, the cost of the batteries must be reduced. To do this, the high-cost ion exchange membrane needs to be replaced by a suitable cheaper material. The final design will be manufactured by injection moulding by the project partner Hamco to reduce costs. In this, both the sealing elements and the membrane will be injected directly during the manufacturing process.

EUROPÄISCHE UNION
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Ministerium für Gesundheit, Emanzipation, Pflege und Alter des Landes Nordrhein-Westfalen

EFRE.NRW
Investitionen in Wachstum und Beschäftigung

Current publication on the subject //

L. Elbers, R. Förster, H.-J. Lilienhof: *Comparison of a flow-by and a flow-through setup for a Vanadium-Redox-Flow battery.* International Flow Battery Forum (IFBF), Karlsruhe 2016.

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Zinc Air Flow Batteries with Alternative Electrolytes

The continuously growing consumption of electrical energy means the demand for economically and ecologically acceptable storage systems is also growing. One possibility for storing electricity is presented by electrochemical energy stores, especially zinc-air batteries. These are especially characterised by their great energy density of up to 400 Wh/kg while using common and thus cheap materials and being environmentally friendly.

Up to now, the zinc-air market has been mainly dominated by primary, non-rechargeable batteries, which have become established primarily in the hearing aid sector due to their very high energy density. The main problems which are preventing wide market introduction of secondary (rechargeable) cells are dendrite formation, corrosion stability of the gas diffusion electrode, drying out and carbonisation of the electrolyte through contact with CO_2 from the air.

Replacement with Ionic Fluids

One promising possibility for the realisation of secondary zinc-air systems is currently being researched in the BMBF project "Zinc-air batteries with new materials for the storage of renewable energies and network stabilisation – LUZI". The project is concerned with the possibility of replacing the currently used alkaline electrolyte with so-called ionic liquids. Ionic liquids (IL) are organic salts with very low melting points, so they are liquid at room temperature, which are used without a solvent.

Various metals are separated as homogeneous shiny coatings through the special characteristics of ILs according to what is currently known, which counters the widespread cell failure of a secondary zinc-air cell through dendrite formation. The IL does not evaporate due to the extremely low vapour pressure at room temperature, so the cell will not dry out during operation or during longer periods of inactivity. The water uptake of the electrolytes can be precisely controlled due to the composition of the IL and so the composition of the electrolyte remains constant over a long period guaranteeing a correspondingly long lifetime for the cell.

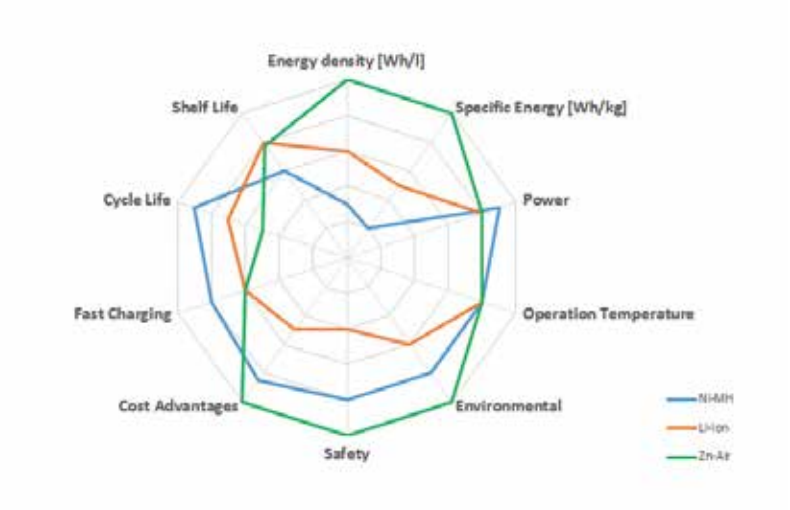

Fig. 1: Comparison of various battery technologies

Development of Gas Diffusion Electrodes for Use with ILs

Since ionic fluids have completely different characteristics compared to traditional aqueous electrolytes, a new design of the gas diffusion electrodes is unavoidable. In so doing, familiar manufacturing processes for gas diffusion electrodes will have to be completely re-structured and substitutes found for established materials, since these will sometimes be unsuited to the completely different wetting characteristics of ILs. A current approach with great promise for production of such gas diffusion electrodes is the dry powder process. In this the various components of the electrode are ground and then after a mixing procedure compressed into an electrode. Electrodes like this can, compared with a solvent-based process, be manufactured extremely cheaply and in great quantity, which will keep the price of the cells low.

Project information//
Funding Code: 03SF0499C

gefördert vom
Bundesministerium für Bildung und Forschung

Current publications on the subject //

[1] Lanfranconi,M.: Lilienhof, H.-J.: *Zinc-Air-Flow-Batteries for grid storage application*, Intern. Flow Battery Forum (IFBF), Karlsruhe 2016.

[2] Lanfranconi,M.: Lilienhof, H.-J.: *Charakterisierung von Gasdiffusionselektroden für die Zink-Luft Flow-Batterie*, 3. GDE-Fortbildungstag der DECHEMA, Mai 2016.

[3] Lanfranconi,M.: Lilienhof, H.-J.: *Zinc-Air-Flow-Batteries: Prospects and Challenges*, First International Zink-Air Battery Workshop, Ulm, April 2016.

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Electromobility for All – The "Tata E-Nano" Project

Electric vehicles produce no emissions locally, move almost silently and are significantly more energy efficient, especially over short distances than vehicles powered by internal combustion engines. However, due to the limited storage capacity for drive energy in their traction batteries, they have only a restricted long-range capability. The currently high market prices of electric vehicles are another reason why electric vehicles are not more widespread and are still have a rather niche presence.

In order to show that electric mobility can be affordable for everyone, Professor Mihatsch's team has set itself the aim of developing a 4-seat electric vehicle for less than €5000.

Vehicle

A realistic speed profile was necessary since the vehicle was to be designed for urban and cross-country use. The students Roman Morinc and Florian Sterzing had measured a bespoke driving cycle, the Cycle RE13 since the European Test Cycle NEFZ is not realistic. A Smart was driven, and the measurements taken with an optical "DIAdem" sensor. This enabled a theoretical required drive power to be calculated, which in turn formed the basis for the selection of the drive train.

To be able to get the vehicle at a (serial) final price of €5000, the vehicle basis also had to be cheap. The decision was made to use an Indian Tata Nano, which is in production with a two-cylinder rear-mounted engine. The vehicle is surprisingly simple and cannot compete with current vehicle on comfort and safety aspects. However, it offers space for dour adults and meets the requirements for urban functional mobility.

As only a 48 V system was under consideration due to safety reasons, the possible electric drive motors were so limited in torque that the 4-gear drive was first left in the drive train. The internal combustion engine with all its peripheral parts was removed and, in its place, the electric motor purchased from China flange-mounted in the drive by means of a self-designed motor carrier. All other components like E-gas (electrical accelerator pedal), power inverter, battery and battery management system were also produced in China for cost reasons.

Fig. 1: From petrol to electricity
At the wheel (of the right-hand drive Indian vehicle): Team Leader Prof. Dr. Guido Mihatsch, behind him: colleague Thorsten Most, by the boot: Vivek Yadav from New Delhi, with the no-longer-needed tank: Hayssam Siala, with the battery: Matthias Hamm.

Trials on the Power Test-bed

The teaching area of vehicle technology at the Recklinghausen site has its own 200-kW power test-bed, where the E-Nano was to drive its first kilometres. The team had to experience that for little money you can't expect high quality of the purchased components. The team spent many hours finding solutions to problems that arose until the Tata was running. The inverter, the E-gas, the battery management system and two battery cells had to be replaced in the course of the trials. The overheating of the inverter was countered by the installation of powerful air cooling.

And It Is Running!

After more than a year of development work, the "Tata E-Nano" was extensively tested on the ADAC test facility. The maximum speed could not be determined because a longer stretch of road is needed for that. Acceleration is pleasingly good and corresponds to the projected values. Enough torque is available to move off in second gear. The low centre of gravity also allows rapid cornering, even if a roll stabiliser would have been beneficial.

The target cost of €5000 could be met in serial production. For this the vehicle should be improved in relation to crash safety with reinforcement panels. A preliminary study has shown that the necessary panels would increase the total mass of the vehicle by ca. 25 kg.

Outlook

Two further development steps are now apparent:

The first is that the central motor is to be replaced by two wheel hub motors, which would make the drive shaft superfluous. This would improve the degree of overall effectiveness and increase the range to the same extent.

The second is that a range-extender would give the E-Tata long-range capability. This could be a free-piston linear generator based on natural gas.

You can find a comparison between the standardised European driving cycle with the self-measured driving cycle in the original research report of 2016, pages 42-43, under https://www.w-hs.de/kooperieren/forschung-und-entwicklung/forschungsbericht/.

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Characterisation of Sorption Properties of Polyethylene (PE) Using a Model:

Poly-Parameter Model of the Linear Free Energy Relationships

The sorption behaviour of dissolved organic substances with plastics in water is of great interest in many areas. Examples are leaching from plastic packaging in foodstuffs or diffusion of toxic substances in drinking water pipes. The adsorption properties of some plastics are also used in trace analysis (SPME)[1] or as adsorption filters in cigarettes.

Sorbed substances can be transferred back to the surroundings by desorption processes. Even micrometre sized plastic particles (microplastics) can under some circumstances adsorb, transport and desorb toxic, organic substances in aquatic environments.

Method

Having a robust theoretical model for estimating sorption is necessary for an adequate estimation of sorption properties of micro-plastic particles and the dangers they pose. Some of these models describe the sorption properties in certain systems, like the log $K_{o/w}$ value. This calculates the distribution between 1-octanol and water in a two-phase system. To avoid errors in adaption to a different system, a poly-parameter model was used to estimate the sorption data.

During this project, PE-HD (high density polyethylene) was characterised for a QSER model by Abraham et al., which used the poly-parameter model (ppLFER: poly-parameter linear free-energy relationships)[2]. Sorption experiments were carried out for this with around 30 substances in a PE-HD/Water system and distribution coefficients were determined for each of these substances through batch experiments. Distribution data beginning at two and going up to five decades below the respective solubility in water was established and set using this sorption isotherm. Samples were added up to equilibrium in the contaminated medium und then measured using GC-MS and Headspace technology or thermo-desorption. The concentrations of the organic substance in the water and plastic phases (c_W and c_P) were then correlated. This procedure yields the distribution of the substance in the two-phase system assuming Freundlich sorption behaviour.

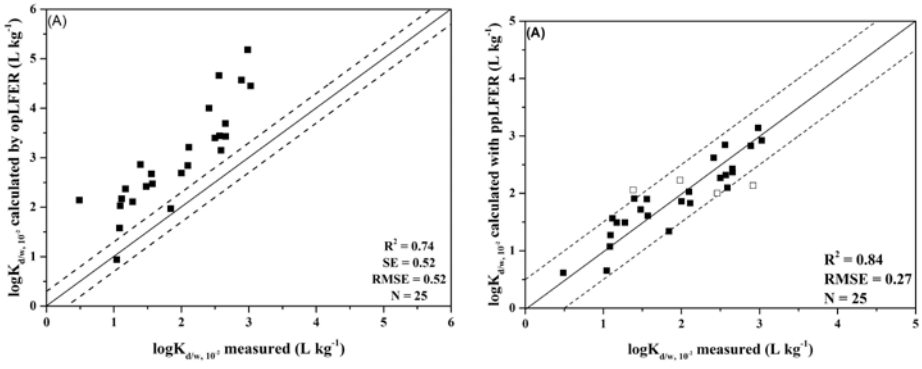

Fig. 1: Comparison of the spLFER-Approach (left) with log $K_{o/w}$ to the ppLFER-Approach (right). The illustrations show the calculated logarithmic distribution coefficients (log $K_{d/w}$) against the actually measured logarithmic distribution coefficients. A clear improvement can be seen in the ppLFER model compared with the spLFER model in relation to the coefficient of determination (R^2), and the root of the mean square of error (RMSE).
(spLFER – single-parameter model of the linear free energy relationship)

Results

A multiple regression analysis (MRA) was then carried out with the distribution data from the isotherms and the sorbate descriptors from the literature. Information from the MRA or ppLFER-equation in the form of:

$$\log K_{p/w} = e_{p/w}E_i + s_{p/w}S_i + a_{p/w}A_i + b_{p/w}B_i + v_{p/w}V_i + c_{p/w}$$

could then be interpreted. The descriptors e, s, a, b, v and c denote certain properties of the system, like e.g., the H-bonds acidity and alkalinity (a & b). A negative value of a or b indicates in this case stronger interactions in the plastic phase. The sorption characteristics can thus be estimated using these descriptors. In the case of PE-HD, mainly non-specific interactions with the sorbent (like Van-der-Waals interactions) are the dominant form and H-bonds acidity and alkalinity are abundant in the water phase. This can be traced back to the molecular structure of PE-HD, which consists of branched, long-chain hydrocarbons, which themselves can only participate in non-specific interactions. Also sorption to PE-HD is dependend on the polymers density and crystallinity.

1 Endo, S.; Hale, S. E.; Goss, K. U.; Arp, H. P.: Environ. Sci. Techn. 2011, 45, S. 10124-10132.

2 Abraham, M. H.; Ibrahim, A.; Zissimos, A. M.: J. Chromatogr. A 1037 (2004) S. 29-47.

Project information //

Tobias Uber M.Sc., is the cooperative PhD student of the Universität Duisburg-Essen (University of Duisburg-Essen) and the Westfälische Hochschule (Westphalian University of Applied Sciences).

The project was partially funded by the internal university funding of the Westfälische Hochschule (Westphalian University of Applied Sciences).

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"SyncFueL" – Synchronized Self-Generated Power for Charging Electric Vehicles

"SyncFueL" stands for "synchronized self-generated power for charging electric vehicles". The system is supposed to allow for charging in which the feed from PV[1] and CHP[2] systems is synchronized with the consumption at a remote charging station or plug. It allows using generated energy as "self-generated power" for own consumption even outside of the plant property or one's own property to charge e-vehicles.

System Equipment

Additionally, a so-called "synchronized mobile smart meter" (SMSM) is used. Our project partner "hsag" holds the patent for this. The SMSM allows for a power-synchronized use of self-generated power at remote outlets. The power generator, charging station, and vehicle are equipped with SMSM components. The user receives information about the power currently available and can manage the charging process accordingly.

The users thus tap the energy of power providers, but offset the cost with that of their self-generated power and do not pay more for the charging station. Smaller grid components are calculated for the regional feed-in and withdrawal of self-generated power.

In order to ensure general acceptance and create the necessary framework conditions, we plan to create dialog forums with representatives of the federal government and business in parallel with the scientific-technical work.

Field Test

For the field test, we will use four business units at four locations of the Klinikum Westfalen. The electric vehicles will include the those of the municipal fleet of the City of Dortmund. The Federal Ministry of Traffic and Digital Infrastructure (BMVI) subsidizes the project with more than 1.8 million Euros as part of the Electromobility Rhein-Ruhr model region.

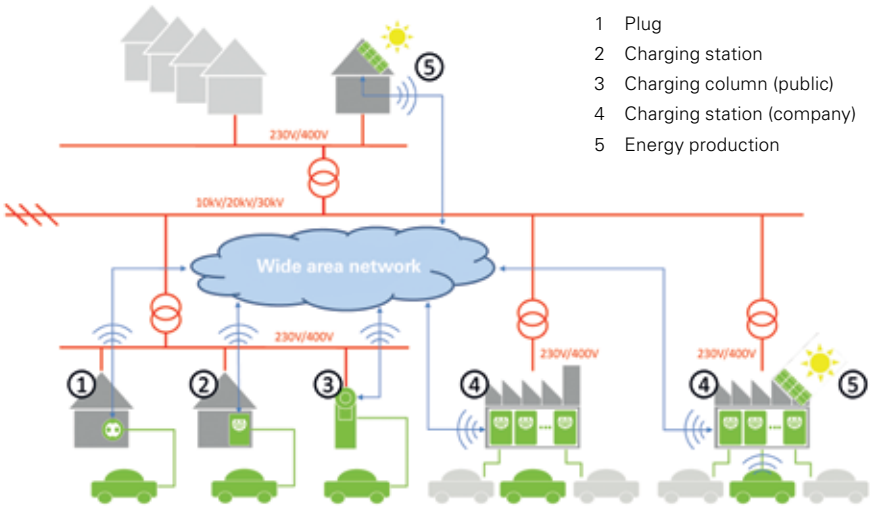

Fig. 1: Project "SyncFueL" 2014

The potential decrease of power costs at remote charging stations resulting from the synchronized charging of self-generated power is the lever for refinancing e-vehicles and charging infrastructure. This approach allows for new business models for electromobility in different areas of application. In addition, this generates insights into the area of using self-generated power in a business context, in particular in the area of trades, retail, services, and SMB[3]. It also looks at heating systems and the development of energy management systems and cost models, in particular in terms of integration into decentralized regional energy supply structures.

1 PV – Photovoltaics
2 CHP – Combined Heat and Power
3 SMB – Small and medium-sized businesses

Project information //

Project partner:

1. TU Dortmund, Institut für Energie Systeme, Energieeffizienz und Energiewirtschaft ie3 (Institute for Energy Systems, Energy Efficiency, and Energy Management ie3) (consortium leader)
2. TU Dortmund, Lehrstuhl für Kommunikationsnetze (Communication Networks Institute) CNI
3. Westfälische Hochschule (Westphalian University of Applied Sciences), Institut Demand Logisitics (Institute for Demand Logistics)
4. Klinikum Westfalen GmbH
5. Heidelberger Services AG – hsag
6. City of Dortmund

Subsidy from the special fund "Energy and Climate Fund", individual plan 60, chapter 6092, title 68304, budget year 2014, for the venture "Synchronized self-generated power for charging electric vehicles".

Patent application:
Already submitted (synchronized mobile smart meter, patent rights held by hsag).

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Structural Stabilization of the Earwig Wing

The wings of two different earwig species were examined, measured and compared within the scope of a doctoral thesis. The earwigs are an insect group commonly referred to as "earbug". Numerous people are not aware that the earwig is capable of flying. An aspect which is supported through well hidden wings and species with reduced or not anymore existent wings. The winged species are able to fold their hind wings skillfully underneath their significantly shorter elytron (front wings) in a manner where they are no longer recognizable as such. This folding process is accomplished by skillfully combining a (longitudinal, transversal and fanning) process, which takes place completely within the wing and in absence of muscular activity. The extremely compact folding enables the animals to navigate in very dense habitats (brush, dung piles) without damaging the extremely thin membranes of their large wings.

The wings contain the elastic protein Resilin in numrous locations – which are most likely supporting the wing stability in the deployed state and folding respectively. It is autofluorescent under UV light.

Research Goal

The intent of this thesis is to clarify how the folding process is achieved completely without any muscular actuation and how the complex folding patterns impact the ability to fly. Unterstanding the fine kinematics and the acting forces will lead to bionic applications in, for example, light-weight engineering.

Method

The wings of two different size species (*Forficula auricularia* and *Labia minor*) have been measured in detail; in particular the vein patterns and the emerging joint angles were recorded using both a stereo and transmission-light microscope (Leica DM 750, Leica S8 APO). After that, the images were analysed using *ImageJ* software. The resilin content was documented via a UV stereo microscope (Leica M165 FC). The wing kinetics were verified on free-flying *Labia minors* via three-dimensional kinematic observations (MotionXtra NX3, 1000 Hz).

Fig. 1: Example of a small earwig (*Labia minor*) with folded wings. Visible are the front wings (elytron, see arrow) and a small portion of the hind wings folded underneath.

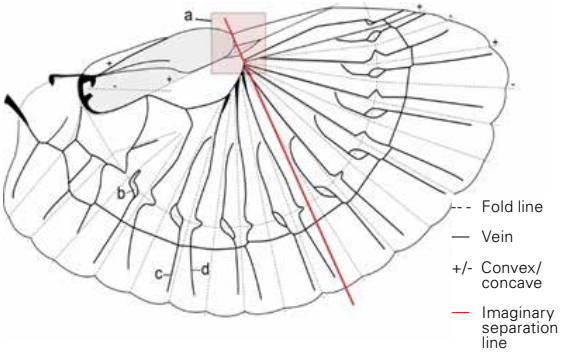

Fig. 2: Image of a spread out hind wing of a *Labia minor*. The area highlighted in gray demonstrates the visible area in folded condition.
a: center joint of the wing, b: patch, c: intercalary vein, d: radial vein

Findings

Both species demonstrate significant greater folding ratios than previously known (1:15 and/or 1:18 instead of 1:10). The observations of folding models resulted in a detailed description of the so-called resilin-patch function (extensions). These can be anatomically, as well as functionally classified as two different types: the close-veined functions as a tension spring, and open-veined as a compression spring. This allows the wing to be skillfully folded and unfolded.

Perspective

The effective direction of the force vector created hereby is currently determined and recreated based on its complexity via FEM (Finite Element Method). The self-stabilization of the wing will be examined as well.

One can imagine self-folding or unfolding systems packaged as small as possible in the future. In particular in the era of light-weight engineering where everything must become increasingly more light-weight, but more efficient at the same time, such a dually optimized wing is an opportunity to learn new approaches to – maybe deployable – lightweight structures.

Project information //
Doctoral thesis, Universität Duisburg-Essen (Prof. W. Kowalczyk) at the Westfälisches Institut für Bionik (Prof. T. Seidl), University Department Bocholt at the Westfälische Hochschule (Westphalian University of Applied Sciences).

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Airborne and Ground Robots for Use in Rescue

When earthquakes occur, speed is of the essence. Professor Hartmut Surmann, with his students, has thus developed airborne and ground robots in the robotics laboratory of the Westfälische Hochschule (Westphalian University of Applied Sciences) which can be used in precisely this situation.

Airborne and Ground Robots for Use in Rescue

In natural disasters it is important to first get an overview of the situation. This can be done with airborne robots in the air and robots on the ground. To ensure that reconnaissance of the area is fast and so possible rescue efforts can be started as quickly as possible, several flying and ground robots are normally used, whose various data must be coordinated by many different sensors and networked.

The flying robots will provide reconnaissance, navigate through smoke and heat, send pictures and protect themselves from hazards or avoid them in the first place.

In order that this will all work as intended if it happens for real, Surmann and his collaborators and students from the robotics laboratory are taking part in international exercises e.g., on the premises of the old Hoesch steelworks Phoenix-West in Dortmund. Participants from seven countries and eleven establishments practised the deployment of airborne and ground robots for deployment in rescues there in 2016.

Technical Equipment

Precise 3D environmental data are needed today not just for reconnaissance in rescue deployments, but also in other applications, for example to coordinate the rescue resources effectively. Along with ground robots, with laser-based measurement systems, small airborne robots (known as UAVs, Unmanned Aerial Vehicle) are used. Only light sensors such as cameras with wide angle lenses are used on the UAVs for reasons of weight restrictions. Along with GPS-positioning and autonomous flight algorithms based on that, non-metric positioning processes for the interior spaces or in areas where there is no GPS signal are also implemented. In this, the positions are calculated as separation distances from previously made pictures and used for location of the UAV. Furthermore, semantic information from the 3D environmental data recorded by the robots is calculated using processes of machine learning and artificial intelligence.

Fig. 1: Registration of Camera-Laser-Point Clouds
Airborne robots can only carry a small weight by comparison with ground robots. Camera data from the quadcopter are therefore transferred by a complicated computational process (Structure-From-Motion, Multi-View-Stereo) into 3D-point clouds. These serve the ground robots as an initial map and are combined with the 3D-point clouds of a 3D-Laser scanner located on the ground robot. In this, surfaces are extracted and classified from the two point clouds.

Deployment in Amatrice

This was the case for example on 1st September 2016 when the Italian fire service asked whether Surmann could help in carrying out reconnaissance flights and trips for people in churches in Amatrice which were inaccessible due to danger of collapse. The data obtained were to serve as a data base for construction and restoration. A team of international scientists then did just that with Surmann.

The robotics laboratory is well-connected and cooperates with the Fraunhofer Institute for Intelligent Analysis and Information Systems (IAIS) and works together in the TRADR* research project with internationally leading universities and research establishments.

* TRADR (Long-Term Human-Robot Teaming for Robot Assisted Disaster Response) – EU-financed, international research program for the use of robots in disaster zones.

Current publication on the subject //

Kruijff-Korbayov, I.; Freda, L; Gianni, M; Ntouskos, V.; Hlavac, V.; KUbelka, V.; Zimmermann, E.; Surmann, H.; Dulic, K.; Rottner, W.; Gissi, E. *Ground and Aerial Robots in Earthquake-Response in Amatrice*, Italy: A Field Report, SSRR 2016, Lausanne, 2016.

Project information //

http://homepage.informatik.w-hs.de/HSurmann/
Videos of various projects can be seen on the robotics laboratory's channel: http://www.youtube.com/RoblabFhGe.

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Zelia – Living Independently in Your Own Home in Old Age: Minimally Invasive AAL System for Monitoring the Well-Being of Elderly People Living Alone

On account of changes in our demography and the increasing break-up of family structures in geographical terms, there is an increasing number of elderly people living in one-person households, often to a large extent in relative social isolation. This means that there is an increased risk that accidents or acute medical emergencies may occur at home and go unnoticed, as a result of which the necessary help cannot be provided.

The functioning of the established emergency call systems is dependent on the ability and the willingness of the user to interact with them. Alternative solutions in the field of AAL (Ambient Assisted Living) involve the installation and use of additional sensor sytems in the home or directly onto the body. The often high purchase costs and the problems associated with invasion into the immediate private sphere of the person in question, as regards their wish to determine how their personal information is handled as well as the protection of their personal data, both have a negative effect on the acceptance level of such systems.

Approach to Finding a Solution

Within the scope of the research project "ZELIA" – a German acronym taken from the phrase 'Living independently in your own home in old age' – research is being done into the conception, as well as the possible options and boundaries, of a minimally invasive AAL approach, which is exclusively based on the evaluation of centrally measured consumption data (electricity, gas, water). Most of the devices and equipment found in the household which can be related directly or indirectly to an activity of the occupant use electricity. The research project therefore exclusively makes use of this form of energy as an input variable to be measured for the system.

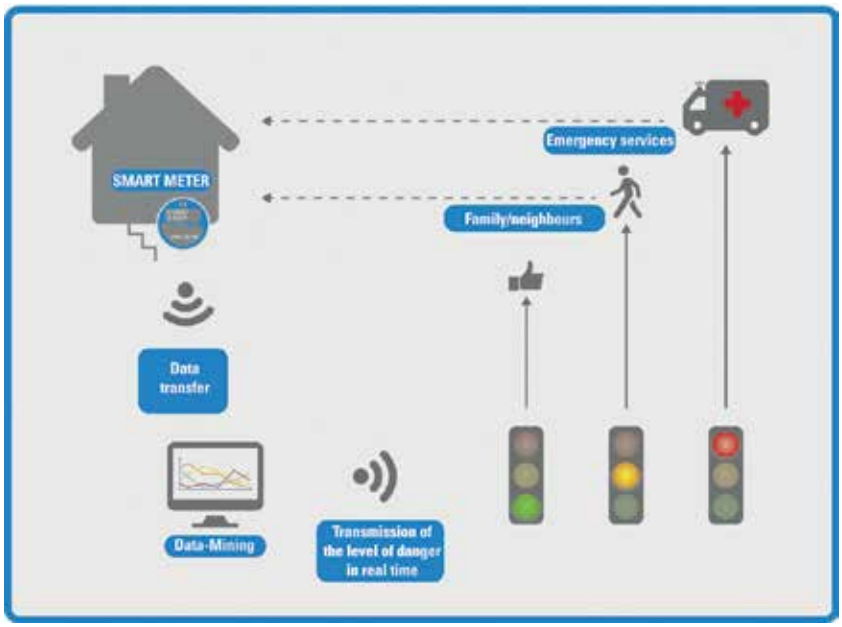

Fig. 1: Overview of the Zelia system
Fundamental design of the AAL system developed in the ZELIA project
The data is recorded in the household and is then sent for analysis; a status report on the household in question can be developed on the basis of this analysis.

Methodology and data set

A typical energy use profile will be created for each individual household, using both metadata (geographical situation, age of the occupant, etc.) and external data (weather and calendar effects). On the basis of the historical data of a household, the monitoring system creates typical daily records and compares these with current data in order to draw conclusions about the situation of the occupant. The activity records consist of the amounts of all the variables derived from so-called characteristics, which together quantify the typical activity of a given household. By characteristics, we mean the various different measurable or countable variables and events, whereby it is to be distinguished between characteristics which are device-dependent and those which are independent of a device. For every characteristic that is independent of a device, a reference pathway is defined on the basis of historical data, and a tolerance range to be associated with it is determined, whereby for monitoring purposes, it is only these tolerance ranges that are needed. When new measurement data arrives at the server from the households, the pathways of all characteristics up until the current point in time are determined, and a comparison is made with the respective tolerance range. If one or several of the current pathways lies outside of the respective interval limits, then an alarm will be activated. The device-dependent characteristics are based on the identification of individual devices or pieces of equipment from the overall electricity consumption of a house. Only manually-operated devices (e.g. coffee machine, cooker, TV) are taken into consideration in the monitoring process, as the characteristics derived from them can lead to the drawing of direct conclusions on the well-being of the occupant or on the ability of the occupant to operate the electrical device in question.

Project information //
www.projekt-zelia.de

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Development of a Modular H-Wind-Rotor Design for De-Centralised Energy Supply

Extension and exploitation of wind energy represents an important pillar in the future renewable energy supply. Along with the large megawatt installations, small wind energy appliances in the region of single and double figure kilowatts offer a possibility for decentralised energy supply in many different construction types. In small wind energy installations with a vertical axis, the wind profiles of the appliance are arranged in a straight line and parallel to the axis. These installations are known as H-rotors. The advantages of the H-rotor are in the simple design without wind direction tracking and good accessibility to the individual components. The investigations for further development of the H-rotor at the Westphalian University in Gelsenkirchen relate to a modular design of the flow-mechanical components und the integration of a transverse flow generator arranged close to the ground.

Modular H-Rotor Design

Compared with horizontal axis rotors, the H-rotor is distinguished by a simple basic design; e.g. no wind direction tracking or rotation of the rotor blade profile (pitch control) is necessary, as it is with conventional horizontal axis runners. In addition, good access and easy servicing is provided by the wind rotor and the generator being located close to the ground.

The design of the modular H-rotor developed at the Westfälische Hochschule (Westphalian University of Applied Sciences) in Gelsenkirchen in the 3-kW power class is distinguished by the flexible configuration of the number of rotor blades, profile shapes, variable profile depths and variable installation angles of the rotor blade profile. Furthermore, the integration of a ground-mounted transverse generator has been completed in collaboration with the faculty of electrotechnology. This type of generator has a significantly higher degree of effectiveness in comparison with conventional longitudinal machines.

The modular design enables a variable number of rotor blade profiles to be used. The power electronics for connection of the generator to the supply grid were developed and placed in operation.

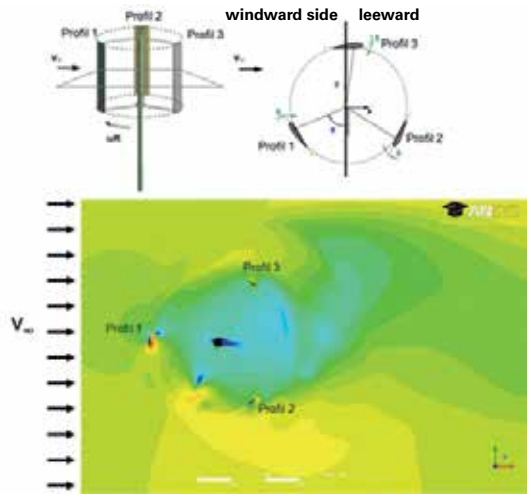

Fig. 1: H-rotor with 3 profiles
Top left: 3D-arrangement; top right: horizontal cross-section; bottom: speed range (warm colours – high speed, cold colours – low speed)

Flow Simulation

To limit the large number of constructive designs and find the optimal aerodynamic design versions, extensive flow simulations using the CFD software ANSYS CFX were undertaken. The figure shows the rotor configuration with three profiles and a snapshot of an exemplar speed range of a 2D flow-simulation of the H-rotor. The angle β denotes the variable installation angle of the profile relative to the tangent on the rotation circle. The flow is with a homogeneous velocity distribution of magnitude v_∞.

The coloured contour plot shows a reduction in speed when the rotor is subject to flow. A power coefficient c_p of the H-rotor was determined from the results of the simulation. The power coefficient represents the relationship of the shaft power P_{Welle} to the theoretical wind power P_{th} and is an important indicator in evaluating the aerodynamic quality of the wind rotor.

Simulation calculations with complex 3D-models are currently being carried out so that conclusions can also be drawn about the effects of support braces, the rotor shaft and the profile end caps. The H-rotor is currently being manufactured in its different modular designs in parallel to the flow simulations, to carry out the extensive tests and verifications of the calculations.

Current Publications on the subject //

[1] E. Hau: *Windkraftanlagen, Grundlagen, Technik, Einsatz, Wirtschaftlichkeit.* 4. Auflage, Springer Verlag, 2008.
[2] R. Gasch, J. Twele: *Windkraftanlagen: Grundlagen, Entwurf, Planung und Betrieb.* Vieweg Teubner, 8. Auflage, 2013.
[3] M. Rüter, W. Oberschelp, U. Baader, G. Schröder, *Design of a Transverse Flux Machine for small Direct Driven Wind Turbines.* PCIM, Nürnberg, 2010.
[4] ANSYS CFX 15.0; ANSYS, Inc., USA.

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A Virtual Microscope into the Biomolecular Nano-World

The role of membranes and proteins in biological processes and structures can hardly be overestimated: membranes form the borders of different cell compartments and determine transport or secretion processes. Proteins catalyze the chemical reactions of our metabolism in form of enzymes, as receptors or transmitters they play an important role in cell communication and signal transfer, as transporters they carry other molecules and as structuring agents they support cellular stability. Particularly for modern medicine, the understanding of these functions is of crucial importance since proteins are the major targets of pharmaceutical drugs.

Simulation Techniques as Virtual Microscopes

The biomolecular world of membranes and proteins takes place on the nanometer scale (one million nanometers equals one millimeter), which cannot be perceived by the naked eye or even with the most powerful light microscopes. Only electron microscopes enable their visibility, however, only in form of specifically prepared static images. Therefore computer-aided simulation techniques have been increasingly utilised to study nano-scale processes. These may be regarded as virtual microscopes that allow for visible insights into molecular dynamics.

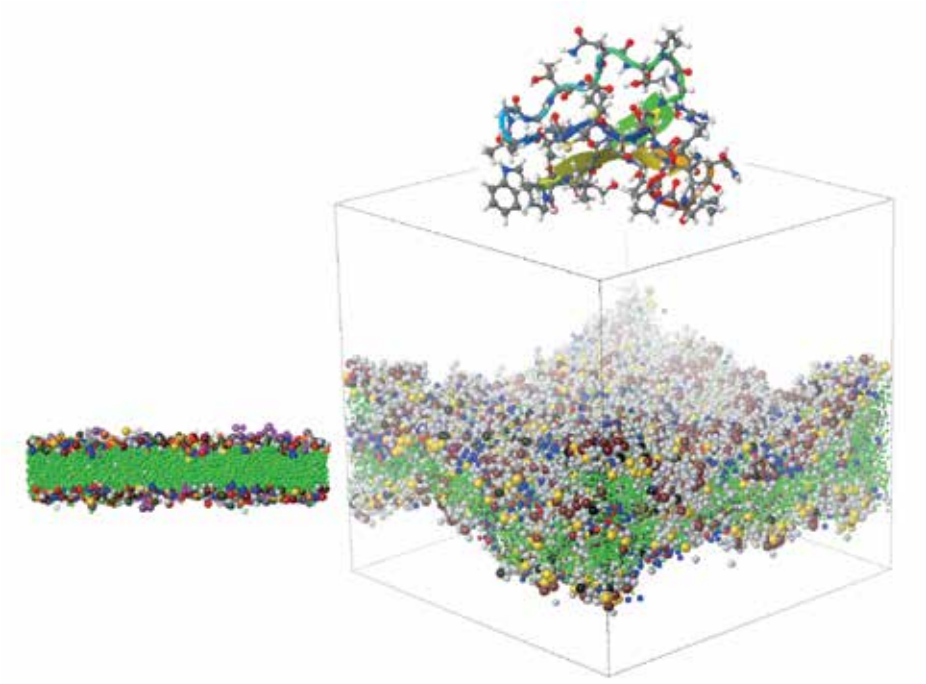

Fig. 1: Antibiotic effect of Kalata B1 Proteins (above): Attack and destruction of a cell membrane (left)

Molecular Fragment Dynamics

Unfortunately, from a molecular point of view, the nano world is still huge: Nano systems comprise hundreds of thousands up to millions of atoms, therefore atomistic simulations are computationally expensive and very time-consuming even with today's fastest computers (where simulation jobs may run for weeks and months). The joint project of CAM-D Technologies (Managing Director Dr. Hubert Kuhn), CeNIDE (Inorganic Chemistry and Center for Nanointegration Duisburg-Essen led by Prof. Dr. Matthias Epple) and the Westphalian Institute for Health at the Westphalian University of Applied Sciences tries to tackle this problem: the Molecular Fragment Dynamics (MFD) technique, developed by CAM-D Technologies, is a comparably fast mesoscopic simulation method which is extended to allow for the study of large biomolecular nano systems within hours up to a few days. The project partners expect a significantly improved practical applicability especially for industrial environments due to the combination of reduced simulation periods with a simplified and intuitive handling.

Project Information //

Doctoral thesis by Andreas Truszkowski M.Sc., at the Westfälische Hochschule (Westphalian University of Applied Sciences) in cooperation with the Universität Duisburg-Essen.

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"Magnetic Particle Imaging" with Ferromagnetic Carbon

Nanofluids, defined as fluids with suspended nanoparticles, are of interest for biomedicinal applications. "Magnetic Particle Imaging" (MPI) is a ground breaking new imaging procedure. It uses superparamagnetic iron oxide particles and measures their response of their non-linear magnetisation to external magnetic fields. MPI allows a qualitative visualisation of the concentration of nanoparticles in real time. It promises greater sensitivity compared to MRI (Magnetic Resonance Imaging) as well as spatial and time resolution. Therefore, MPI is envisaged for example in functional heart diagnosis. With a biofunctional encapsulation of the nanoparticles, MPI could be suitable for tumour treatment.

In the following, a biocompatible nanofluid based on a carbon material that is ferromagnetic at room temperature will be presented. We are also presenting the modelling and the results of numerical investigations of the suitability of ferromagnetic nanoparticles for MPI and MPI-images with this material.

The research coordination is with the Departamento de Física, Universidade Federal de São Carlos (UFSCar), Brazil, where the ferromagnetic carbon is manufactured, and with the Laboratorium Medizinphysik (Medical Physics Laboratory), Westfälische Hochschule (Westphalian University of Applied Sciences), Gelsenkirchen Campus, which is undertaking the modelling and calculation of the MPI images. We had the good fortune of being able to look after excellent exchange students, without whom these results would not have been conceivable.

Ferromagnetic Carbon

Ferromagnetic carbon can be produces by a vapour-phase redox reaction in a nitrogen atmosphere. The magnetic domains are measured to 1 µm using atom-/magnet power microscopy (AFM/MFM). Recent reports confirm that ferromagnetism arises from defects which spread in the process. The characterisation of the nanofluid by transmission electron microscopy (TEM) reveals a platelet shaped morphology. The size of the particles in the nanofluid is calculated at 10 nm, and hysteresis proves the ferromagnetic behaviour.

MPI-Imaging

In an MPI-Scanner model, two Maxwell coil pairs arranged at a separation of d = 1 m generate the stimulating magnetic fields. Their gradients are 2.5 T/μ_0m, the measurement field is 30 mm x 15 mm. The response of the nanofield, i.e., the measured signal, is determined by hysteresis; in the ferromagnetic case it is described by a differential equation which is solved numerically. Finally, the signal is reconstructed into an MPI image with the single value resolution.

In the illustration, MPI-images of superparamagnetic iron oxides are compared with ferromagnetic carbon. The two-dimensional object was reconstructed with a resolution of 64 x 64 Pixels. The image contrast improves with higher concentrations of particles. The picture quality is comparable, although the ferromagnetic carbon generates a more angular image. Because of the currently low saturation magnetisation of the ferromagnetic carbon, the generation of a strong MPI signal will only be possible in the future. The development of a clinical MPI scanner for human medicine also needs further research.

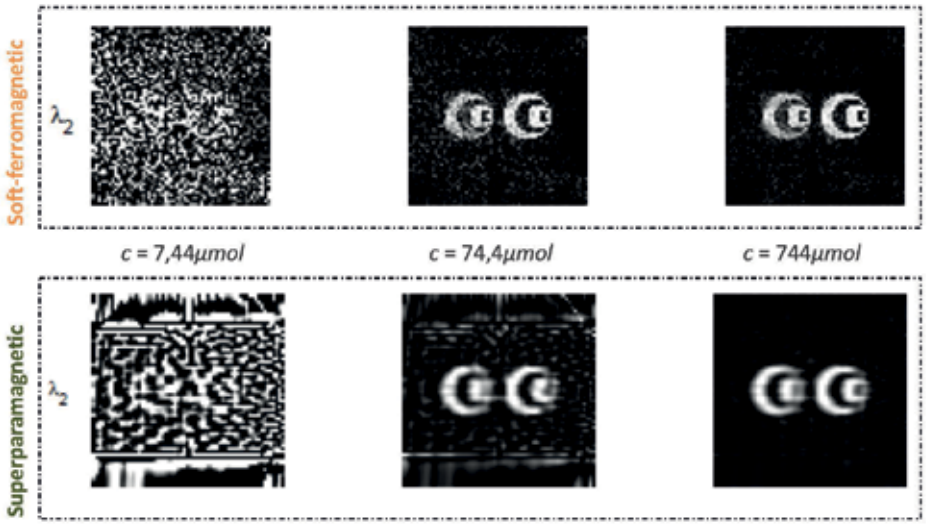

Fig. 1: Reconstructed MPI-images of a two-dimensional phantom with a fixed parameter of regularisation (λ) and different concentrations c of the superparamagnetic (bottom) and ferromagnetic nanofluid (top)

Current Publications on the Subject //

[1] Euting, S.; Araújo-Moreira, F. M.; Zylka, W.: Magnetic Particle Imaging using Ferromagnetic Magnetization. In: *Proceedings in Physics*. 140. Wiesbaden: Springer, 2012. DOI: 10.1007/978-3-642-24133-8_3.

[2] Araújo-Moreira, F. M.; Euting, S.; Zylka, W.: *Biotechnological applications of nanostructured magnetic carbon*. Brazilian Materials Research Society (MRS) Meeting, Florianapolis, 2012.

[3] Euting, S.; Araújo-Moreira, F. M.; Zylka, W.: Magnetic Particle Imaging using Ferromagnetic Carbon. In: *Biomed Tech*, Vol. 56, 2011. DOI: 10.1515/BMT.2011.236.

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Models for the Growth and Therapy of Tumors – Personalized Prognosis via Medical Imaging

220,000 people annually are dying from malignant tumors in Germany alone. More than twice this number are diagnosed with cancer within the same timeframe. Despite these facts, recent "breakthroughs" in medical treatment with so-called immune therapy or with the understanding of the spatiotemporal progression of tumors and the effect of a therapy with mathematical models have been discussed. These models demonstrate the biological, biochemical and physical processes leading to tumor formation. Currently certain model parameters can be derived from medical imaging, e.g. Magnetic Resonance Tomography (MRT) and Positronic-Emissions-Tomography (PET) and enable a patient-specific calibration of the models. The numerically generated solution of the equations provides prognoses regarding the type and quantity of tumorous cells and their geometrical distribution.

Models of Tumor Growth

Instead of following the traditional classification of continuous and discrete models, hybrid multiscale models working on diverse scales have recently been examined simultaneously. For example, the biochemical reaction kinetics occur on the microscopic scale, while the cell division in the cell cycle and migration progresses occur on the mesoscopic scale. The formation of a tumorous structure is linked to the macroscopic scale of the tissue. The diagnostic tomography imaging, which currently provides the initial proof of an existing tumor with a resolution of approx. 0.5 mm operates on this scale as well.

For example, an avascular (without blood vessels) tumor consists of mobile cells which can proliferate and migrate. If the cell density is exhausted in one location, the cells migrate in a stochastic process (cellular automaton) in all neighboring directions and promote the tumor growth. The values of the model parameters can be derived from in-vitro experiments on cell cultures (proliferation) and from the patient's MRT- and PET images (diffusion, oxygen density). It is remarkable that the multi-scale model is able to reproduce the known macroscopic characteristics of avascular tumors: One, a necrotic core (dead tumor cells) surrounded by a halo proliferating or temporarily dormant (quiescent) in the G_0-Phase cells will form. Secondly, the avascular expansion in the model determined by the oxygen density stops at a maximum tumor size.

Model for (Radiation) Therapy

Diverse points for linking a therapy are available in a multi-scale model. For example, on the microscopic scale, the immune therapy approaches the phase transfers in the cell cycle (checkpoints), in contrast to radiation therapy, more specifically, radiation with an energy dose measured in Grey (Gy). Typical clinical time schedules (fractionations), diverse tumor types and empirical laws for the survival probability of the cells can be taken into consideration. For example, head-neck tumors respond rapidly, in contrast, prostate tumors respond slower to radiation therapy, which is reflected in the results of the model.

If the patient-specific oxygen density derived from PET and the cell cycle in the model is taken into consideration, the findings are that the survival probability of tumor cells in a hypoxic environment (e.g. necrotic tumor core) is higher. The results show that the consideration of oxygen in specific planning of radiation therapy is beneficial for not overevaluating the therapy results. This particularly applies to prostate tumors which have a high repair capability.

A Clinical Case – Glioma

The ultimate goal of modeling tumors is to support therapy decisions in a clinical environment. One approach is to use longitudinal PET and MRT time series. The model is calibrated with two images from neighboring stages. The personalized prognosis is calculated, e.g. tumor size, thereafter in a third stage. The model can be validated if images are available in the third stage as well. This approach was used for a glioma (brain tumor). Since radiation therapy was performed prior to the third stage, the comparison between the calculated and actual cells and the tumor size also reflects the effectiveness of the radiation treatment.

Challenge and Vision

In addition to the mathematical and numeric complexity, one of the most important challenges in modeling tumor growth is the availability of patient-specific data for calibrating the model. The data must contain anatomical, metabolic and functional information with sufficient spatiotemporal resolution.

Currently the prognoses of tumor growth is based on expectation values which are derived from population-extensive databases. If the models are successfully developed and clinically validated, the tumor models will contribute to changing the scenario and assist in making a prognosis based on the patient's specific data.

Current Publications on the Subject //

[1] Krebs in Deutschland 2011/2012. 10. Ausgabe. Robert Koch-Institut (Hrsg.) und die Gesellschaft der epidemiologischen Krebsregister in Deutschland e.V. (Hrsg.). Berlin, 2015.

[2] Roque, T.; Kalkan, Z.; Zylka, W.: Biological effectiveness in hypofractionation: Modeling tumor survival probability for large doses with a stochastic cell-cycle model. In: *Biomed Tech*. Volume 57 Suppl. 1, 2012, DOI: 10.1515/bmt-2012-4111.

[3] Roque, T.; Zylka, W.: Integration of Patient Specific MRI Imaging Data into a Stochastic Low-Grade Glioma Model. In: *Biomedical Engineering / Biomedizinische Technik*. Volume 58 Suppl. 1, 2013, DOI: 10.1515/bmt-2013-4342.

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The Institute for Internet Security – if(is) of the Westphalian University of Applied Sciences

The Institut für Internet-Sicherheit (Institute for Internet Security) – "if(is)" – was established in May 2005; it is an independent and scientific facility of the Westfälische Hochschule Gelsenkirchen, Bocholt, Recklinghausen. Under the leadership of Prof. Dr. (TU NN) Norbert Pohlmann, the modern research institute addresses current and relevant subjects for increased security and credibility on the internet. In addition, the institute is a creative service provider for internet security. The goal of "if(is)" is to establish an added value for internet security and credibility. The young research team has currently contributed to the institute's evolvement into one of the most recognized competencies for internet security in the past years.

Expertise in the Internet Security Field
The internet is significantly different from the other currently established medias: Besides the seemingly unlimited options and endless advantages, there are also great risks which must definitely be resolved in the future. After all, the internet has evolved into one of the most important infrastructures in our modern society and represents an omnipresence. The Institute for Internet Security recognizes its core competencies in this important area of application. The activities of the institute are focused in the pragmatic implementation of secure and creditable IT concepts. The relevant areas of responsibilities range from internet research to e-mail security and up to the legal aspects of the internet subject. The goal is to establish a long-term competency center for internet security in Germany through continuous development.

Service Providers for Industry and Commerce
"Companies should and must be able to utilise the internet in a secure manner", this is the goal of "if(is)". In addition to the traditional educational and research activities, the institute also offers broad-range services in cooperation with numerous key-players in the IT and internet industry, as well as other specialty areas of the university. Due to the option to utilise the infrastructure of the Westphalian university, the institute is able to provide a high volume of other services as well. This, for example, includes consulting services, training, or the prototype development.

Innovative Projects for a Secure Future
In cooperation with partners and sponsors, "if(is)" will initiate and implement numerous innovative projects. One of these project is the Internet-Kennzahlen-System (IKS) (Internet Key Performance Indicators System), which will ensure additional transparency and security on the internet by providing information regarding the use, risks, availability and performance ability in Germany. The durability of the internet and current risks on certain websites can be analysed by using these key performance indicators.

An additional project, the "Cyber Security Challenge", is an annual competition where students have the opportunity to test their expertise in internet security and subsequently compete against the best in Europe. The goal of this challenge is to counter the shortage of qualified professionals in the industry and to identify young hacker talents in the early stages. Other projects, for example are, Live Hacking Shows or the Market Place IT Security, which are non-commercial platforms addressing the field of IT security for private users and companies.

The Master's Program Provides Opportunities
The Westfälische Hochschule offers a Master's program for IT security which is closely connected to the Institute for Internet Security. All of the students are involved in research projects and project management in an effort to achieve a broad-range knowledgebase through practical experiences. This project-oriented direction is an optimal preparatory measure for future leadership tasks. Moreover, closely networking with partners from commerce and industry will offer the students multi-facetted career options after completing the 2-year Master's program.

Areas of Research //


Credible IT-Systems


Payment Methods and Bank Transactions


Project Zelia (Zuhause eigenständig leben im Alter) (independent living at home for senior citizens)


Security for Smart Car, Smart Grid, Smart Traffic, Smart Home and Internet of Things


Structural Internet Analysis


Bot Networks


Internet Key Performance Indicators Systems


Mobile Security


Identity Management


Internet Early Warning Systems

Cloud Computing

Social Networks

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Stephan Maas M.Sc., Christian Sobotta M.Sc.

Augmented Reality Ultrasound – BabyAR and AuRIS

In the project sponsored by "START-UP-Hochschul-Ausgründungen NRW" (START-UP University Spin-Off NRW) a company spin-off of the Westphalian University of Applied Sciences will be prepared. This project is not a traditional research proposal. The focus is on preparing a business plan and continuous development of the existing prototype up to the approximate market maturity.

Technology Status

The currently used imaging modalities (computer tomography, magnetic resonance tomography etc.) only enable an indirect view into the human body. The data recorded by these modalities are displayed on a monitor and the physician is responsible for reconciling these virtual images with the actual patient's anatomy.

The sonogram (ultrasound exam) is the only available modality capable of real-time display with more than 50 images and/or 30 volumes per second. The sonogram is also able to operate without harmful ionizing radiation (-> computer tomography) or problematic magnetic fields (-> magnetic resonance tomography) and is cost-effective in allocation and maintenance. This renders the sonogram the most frequently used imaging procedure worldwide.

Solution

Augmented Reality Ultrasound combines the benefits of a traditional sonogram with modern Augmented Reality (AR). In contrast to Virtual Reality (VR), whereby the user is fully emerged into a virtual world, AR is expanding the user's reality by certain virtual objects and/or information.

Fig. 1: An unborn infant can be observed in the womb via an ultrasound device, smartphone and BabyAR; a pregnant woman is simulated here with the aid of a ultrasound phantom.

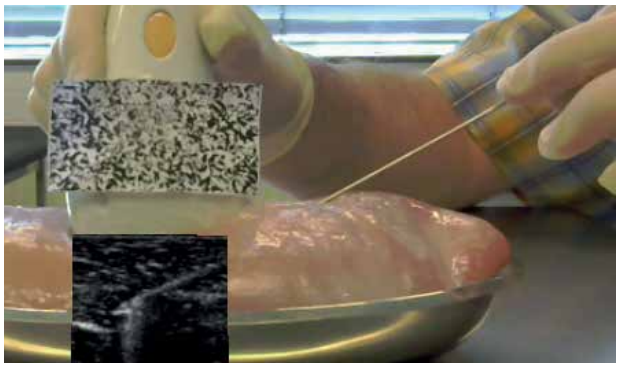

Fig. 2: A physician can review all relevant information with AR glasses and AuRis during a needle biopsy.

In the prototype BabyAR (Baby Augmented Reality; see fig. 1) and AuRIS (Augmented Reality Intervention System; see fig. 2), developed by Maas and Sobotta, the virtual ultrasound images are superimposed beneath a real ultrasound head. The images are displayed exactly where they are recorded and not on a separate monitor. This affords the user a direct view of the interior human body.

BabyAR

BabyAR offers future parents a unique view of their unborn infant during prenatal diagnostics. They will have an opportunity to photograph or videotape the child inside of the mother body per say.

AuRIS

AuRIS enables the medical staff to fully concentrate on the intervention site during a needle biopsy. They are able to see the ultrasound image at the exact location it is recorded with the augmented reality glasses. It increases the workplace ergonomics, accelerates the intervention and therefore is able to decrease the risk of infection.

Detailed information regarding the scheduled spin-off is available at www.somaview.glass.

Project Information //

Project Partners:

The project partners solicited are:

- Alpinion Medical Deutschland GmbH, Hallbergmoos
- Augusta Krankenanstalten, Bochum
- Elekta Nucletron Operations B.V., Veeneendaal/NL
- Erler-Zimmer GmbH & Co. KG, Lauf
- Esaote Biomedica Deutschland GmbH, Köln
- Littlerock GmbH, Düsseldorf
- MR:comp GmbH, Gelsenkirchen

Project Sponsorship:

The project is sponsored "START-UP-Hochschulausgründungen" des Landes NRW, (START-UP University Spin-Off of the State North Rhine-Westphalia),
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Xaptec – Sensor Technology Following Nature's Example

Cameras are amongst the basic equipment used for every system using optical test processes. Their picture sensors can identify the slightest imprecisions in products or production processes and pass the information to the user fully automatically via image processing programmes.

But anywhere where complex manufacturing processes require very detailed records, the technology poses problems for the user: often the cameras needed are too big or the processing of the quantities of image data takes too long. The Xaptec company (founded as Xapt) from Gelsenkirchen has solved this problem and developed a new kind of camera technology. Despite being small, it inspects an extremely wide field of view, even from several angles. Xaptec has been inspired in this by Nature.

Many Eyes See More

The start-up company of the Westfälische Hochschule (Westphalian University of Applied Sciences) has been manufacturing optical sensors and high-tech measurement systems since 2011 which are being used for industrial image processing. Their specialist area is multi-sensor technology. This functions in a similar way to the compound eyes of an insect.

A compound eye is made up of many small image sensors with low resolution. Each sensor covers a small area of view, each from a slightly different angle. By contrast to the human eye, which has only one large image sensor in the retina, the compound technology in the overall image has many advantages in the optical representation of a scene. All the sensors process the information recorded at the same time and with the same intensity so that a very broad field of view is created with a constant resolution.

With the technology recreated from the compound eye, a single camera system can record extensive image data, that can show every product detail in the test process. It is also possible to link as many sensors as desired together and so extend the field of view as required.

"This flexibility results in a real added value to industrial installations which have to check different products in a short time for their quality features", says Marco Brinker, director and co-founder of Xapt (now Xaptec). Together with two co-workers from the Westfälische Hochschule, in 2011 he went independent with the innovative measurement technology, which in the meantime is now in use in the metal, paper, glass, plastic, printing and packaging industries and is in demand from installation builders and operators like Thyssen-Krupp or Salzgitter AG.

Fig.1: Typical construction for the inspection of band and track goods. A choice of either two illumination systems above and below the band or a light source below and a sensor unit above the band can be built as a transmitted light system.

Success through Cooperation

Working together on the university's research projects close to industry has been ground-breaking for the development of their product idea, says Brinker. The experiences gained there were the initial inspiration for their step to founding a company. Through contact with industry, the then scientific colleagues of the university gained insights into current processes – and the certainty that their own solutions were completely new. Brinker's founding team received support from the Westfälische Hochschule for the spin-off start-up. The university made cheap infrastructure available for the development work and supported the new entrepreneurs in the application process for the elite funding "EXIST-research transfer".

"The university's support was one thing", says Brinker about the factors of the company's success. Another was that the detailed market knowledge of the founding team and their life and professional experiences made a positive contribution. Brinker would like to see the specialist universities in NRW invest more resources in research cooperation with industry and information made more accessible to interested parties in the preliminary stages of starting up a company.

Cameras made in Germany

Xaptec, Brinker is sure, will continue to contribute to making quality control and process control in industrial measurement and testing technology more efficient with its innovations. Also, the fact that all technical components of their measurement systems are manufactured and assembled here in Germany marks the country out as an innovative site for technology. Progress then, with many facets – and Nature as ideas pool.

Creator of the Text //

Sustainable research at specialist universities in NRW, Eva Helm.

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