



Mapping of the Danish knowledge system with focus on the role and function of the GTS net



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1.1 Abstract and main results

The net of nine Authorised Technological Service institutes (GTS institutes) is overall constituted as a central actor in the Danish knowledge and research system. This analysis presents the results of a comprehensive mapping of the knowledge and research system in Denmark with focus on the role and function of the GTS institutes. The objective of the analysis is to illustrate the role and labour sharing between the actors in the knowledge and research system. A particular objective is to look at what challenges are connected to the way the GTS net is organised today and the GTS net's position in the knowledge and research system. The analysis is based on existing data and statistics regarding the knowledge and research system and the GTS institutes, as well as completely new knowledge about the research and knowledge system's actors, including their participation in research- and innovation programs, and the GTS institutes' assignments and interaction relations.

The analysis forms part of an international evaluation of the GTS net initiated by The Danish Agency for Science, Technology, and Innovation. The evaluation frames the background for a strategy for the GTS net which sets out the direction and the priorities for the authorised technological service in Denmark towards 2012. The evaluation will also be seen as part of the action plan "InnovationDenmark 2008" from The Danish Council for Technology and Innovation as well as the government's globalisation strategy.

The main message in the analysis is that the research and knowledge system in Denmark is changing and takes up a larger part of the economy concurrently with new demands for knowledge in the business enterprise sector and the use of new innovation forms. At the same time, the analysis illustrates that there, in certain areas, can be created more and stronger incentives for collaboration between the actors in the research and knowledge system. On the bases of the analysis three overall challenges can be pointed out:

- To ensure increased coherence and visibility amongst the actors in the knowledge system in order to give the companies an easier access to the offers of the knowledge system
- To create the best frameworks for an increased development effort broadly among other things to direct the effort towards smaller companies and the knowledge service businesses
- To create a better framework for the internationalisation of the knowledge system and the business enterprise sector to strengthen the optainment of knowledge from abroad.

Looking specifically at the GTS institutes, the analysis presents a range of new understandings of the roles of the GTS net, which supplements those we already know today. A central point in the analysis is that the net of GTS institutes performs an important task within the society. This is not necessarily just as a bridge builder between universities and the business enterprise sector or as the consultant of the consultants. It is to a large degree also with an independent role

in relation to building specialist knowledge within business related fields and in relation to boosting the needs of the business enterprise sector as regards the research through networks and partnerships.

The table below provides an overview of the challenges for the research and knowledge system as a whole and of special challenges for the GTS net.

Table 1.1: Challenges for the knowledge system and for the GTS net

Knowledge system	GTS net
Coherence and visibility	
<ul style="list-style-type: none"> – More incentives and funds for cooperation across actors and larger coherent endeavours – national and regional. – Increased coordination between actors in the knowledge system related to the contact to the businesses. 	<ul style="list-style-type: none"> – More coherence in the GTS Institutes effort. The institutes must strategically work as a joint network. – The GTS net should be more active in the regional innovation and business development policy. Must contribute to regional growth. – Continuing to secure dynamics in the GTS net and increase dialogue between GTS and private consultants to avoid distortion of competitiveness and secure the build-up of business relevant competences.
Better framework for increasing knowledge in larger parts of the sector	
<ul style="list-style-type: none"> – Securing frames to ensure that the knowledge systems activities are supporting private research and development. – Preparing research and innovation grants and projects to make it attractive for more businesses to participate. 	<ul style="list-style-type: none"> – Ensuring increased focus on SMEs and on business firms within knowledge service. – Ensuring increased participation for the GTS net in more business oriented research and innovation projects. – Ensuring the development of more models of cooperation between GTS and universities. E.g. on research infrastructure to make sure a wide section of the Danish business enterprise sector is reached.
Strengthened internationalization	
<ul style="list-style-type: none"> – More incentive for the actors in the knowledge system to participate in international innovation cooperations. – Utilize the possibilities in the existing regulation to attract environments of knowledge from abroad to Danish cooperative projects. 	<ul style="list-style-type: none"> – Increased GTS participation in EU Framework programmes. Both regular participation and with coordinating function. – Support the GTS institutes strategy for internationalisation – especially related to international cooperation on research and bringing home knowledge. – Secure national research of the GTS nets internationalisation to benefit most Danish companies.

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

The investigation points out that the GTS institutes deliver technology and research based knowledge, but not necessarily from universities. The GTS institutes are to an increasing extent international but their international interaction with the research has been decreasing and could be strengthened. The GTS institutes have a broad interaction with the Danish business enterprise sector but within the last couple of years they have lost focus on the smaller companies and companies within the knowledge service businesses (the knowledge service is eg. communication, IT-services and financial businesses).

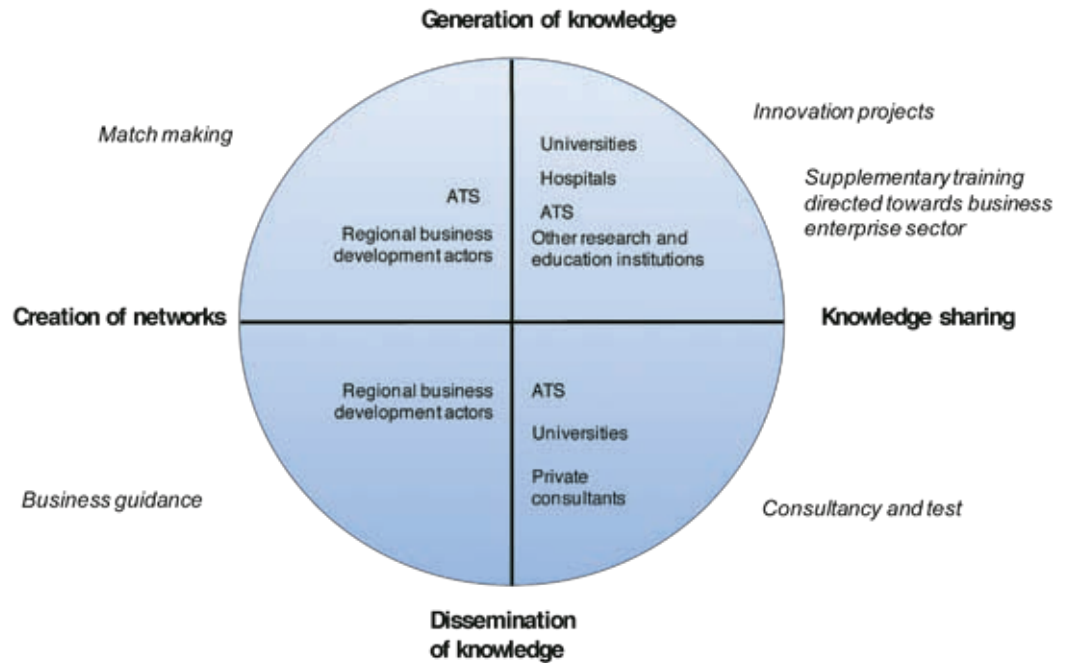
The investigation also points out that the extent of the GTS institutes' effort throughout the years has been challenged in the Danish research and knowledge system. This is possibly due to fact that public investment to the institutes has been reduced. But the GTS institutes' traditionally large interface with the Danish business enterprise sector and strongly increasing contact to international markets constitute a solid starting point to further develop and enlarge the GTS institutes' role in the research and knowledge system.

What is the knowledge system in Denmark?

Today, there is no one unequivocal commonly accepted definition of the concept of the research and knowledge system. In this analysis a broad focus regarding the research and knowledge system will be taken. Within that understanding the research and knowledge system consists of a long range of actors – both public and private – who have in common that they develop and mediate knowledge to the society; more precisely the business enterprise sector. The analysis indicates that the research and knowledge system covers almost 700 public actors as well as a large number of actors within private knowledge consultancy. This applies to:

- *Public research institutions:* Universities, university hospitals, sector research institutions, and public knowledge centres.
- *Other education institutions:* Multidisciplinary- and Engineering university colleges, other higher educations and labour market courses (AMU).
- *Regional business policy actors:* Regional Hothouses, local business councils, development parks, research parks.
- *Private knowledge actors:* Private consultants, private business foundations.
- *Authorised technological service institutes:* The nine authorised technological service institutes.

Figure 1.1: Tasks and overall division of labor in the knowledge system



Source: DAMVAD, Mapping of the Danish knowledge system, 2008

The analysis shows that the actors in the research and knowledge system each in their own way support the companies' innovation through a wide range of services within knowledge building, knowledge sharing, dissemination of knowledge, and networking. But the analysis also shows that there are large areas in which the actors throughout time have approached each other's roles and functions. The analysis has specifically placed focus on the labour sharing between the GTS net and the universities, private knowledge consultants, regional business policy actors and multidisciplinary and engineering university colleges. Hence, it has not been all actors in the research and knowledge system that have been equally relevant for this analysis.

In the following we will give a closer presentation of the results of the mapping of the Danish research and knowledge system with focus on the GTS net's tasks and functions.

The knowledge system's scale and development

The knowledge system occupies more in the economy

The analysis illustrates that the research and knowledge system today constitutes a large share of the Danish economy measured by the number of employees, and that this share has increased through time. A special report from Statistics Denmark shows that 381,000 persons in 2006 were employed in the sectors which to all intents and purposes can be said to comprise the research and knowledge system. If we go back to 1997 the employment in these sectors were

279,000 persons, and the number of employed has thus increased by 36 per cent in just nine years which equals an annually increase of 3.5 per cent. Compared to the total Danish labour market, it means that the employed in the research and knowledge system in 2006 comprise 14 per cent of all employees in Denmark. The reciprocal number for 1997 was 10 per cent.

Overall, there is a high degree of labour sharing between public and private actors. Within the area of education and competence building, 98 per cent are e.g. employed in the public sector, while the majority of areas such as company consultancy and competence mediation are located within the private sector.

Changing framework for the knowledge systems' actors

The analysis demonstrates that many actors in the research and knowledge system have been under significant structural reforms and renewals within the last couple of years, which in many cases have strengthened the frameworks for the actors' business oriented interaction. Among the most significant reforms are university and sector research mergers, the establishing of multidisciplinary university colleges, and reforms of the local business policy. The research and knowledge systems' public actors are anchored in many different parts of the central administration, including The Ministry of Science, The Ministry of Education, The Ministry of Economic and Business Affairs, and The Ministry of Culture.

Simultaneously, the analysis explains that there are large differences in the actors' formal ties to the business enterprise sector. While e.g. AMU has a close business connection in boards and councils, the public museums, libraries and many public knowledge centres have no business ties or commitments to interact with the business enterprise sector. There are concurrently significant differences in the actors' incentives for collaboration with the business enterprise sector. Some actors, e.g. the GTS institutes, have a strong steering-incentive mechanism in their result contracts, while others have a very weak incentive structure, e.g. educational institutions under the Danish Ministry of Culture. Moreover, there are significant differences in the actors' strategies for business collaboration. A number of actors prepare strategies for business collaboration, e.g. universities and particularly the GTS institutes, while other actors do not work strategically on developing their business collaboration at all.

Increased resources to research and development in the knowledge system

The research and knowledge system has become more knowledge heavy within the last 10 years pari passu with more public funding for research, development and education being allocated – lately as part of the government's globalisation strategy. If looking at the public part of the research and knowledge system, the public sector's R & D activity has increased from a little more than 10 billion DKK in 1997 to nearly 14 billion DKK in 2006 which equals an increase of 30 per cent in the period. The analysis shows that the universities account by far for the largest share of the public research (72 per cent). The second largest share is done by the the university hospitals, which stands for 11 per cent of the public research. The GTS net accounts for 5 per cent of the public research.

Users of the knowledge system have also become more knowledge oriented

R & D results do not come from the universities and other actors in the research and knowledge system alone. The business enterprise sector is also a producer of knowledge and knowledge development in close interaction with public research. In 1997 the business enterprise sector conducted R & D for almost 14 billion DKK. This number had increased to 27 billion DKK in 2006. The R & D activity has particularly increased in the production industries and the knowledge service industries which also are among the sectors that do most research overall. Concurrently with the increasing R & D effort, there has become an increased focus in the business enterprise sector on new innovation forms as e.g. user driven innovation, non-technological driven innovation, and employee driven innovation.

This development indicates complete new ways of interacting in the research and knowledge system where many companies develop knowledge on equal terms with the research institutions like the GTS institutes and universities. Meanwhile, it implies a more qualified demand for unique and highly qualified knowledge, technology, and competences widely in the business enterprise sector. This makes completely new demands for the research and knowledge system to be able to offer the companies a broad range of services that support the companies' multifarious demands for knowledge and innovation.

Overall patterns of interaction in the knowledge system

A significant element in the analysis has been to uncover the interaction activity between the actors in the research and knowledge system – and the interaction between the actors in the research and knowledge system and the business enterprise sector. This reveals something about the cohesive forces and the potential for dissemination of knowledge in the research and knowledge system. The analysis indicates that there exists a major collaboration between actors in the research and knowledge system. The universities are among the most collaborative actors in the research and knowledge system which obviously correlates with the size of the universities.

In a questionnaire survey among approximately 300 actors in the research and knowledge system 68 per cent points to the universities as a central collaboration partner while 47 per cent points to regional business policy actors, 44 percent points to multidisciplinary university colleges and 38 per cent points to the GTS institutes. There is likewise a major share that points to private consultants, including consulting engineers (40 per cent), consultancy companies (38 per cent) and management consultants (37 per cent) as being central collaboration partners. When it comes to interaction measured on the basis of data from the research statistics there also seem to be a broad interaction.

A concrete interaction form is participation in joint R & D projects. As a part of the survey data were collected, concerning the knowledge institutions and the companies' participation in national, regional, and international innovation projects from 2003-2007. These data encompass information about more than

1,400 projects and 3,200 Danish project participants. The figures show that there often is a broad composition of participants in the investigated research and innovation project, but that the universities are among the most dominating partners in the projects and participates in all 55 consortia of innovation (100 per cent) and almost all of the strategic research projects, cf. the below table. The GTS institutes' participation is generally below average compared to other actors in the research and knowledge system. Especially when it comes to participation in R & D within the EU, the GTS institutes are not prominent despite the fact that the purchasing of knowledge from international research environments is a significant task for the GTS net.

Table 1.2: Participation in research and innovation projects

Participation in projects (share)						
Type of Actor	User-driven innovation (n=38)	Consortia of innovation (n=55)	The Danish Council for Strategic Research (67)	Danish National Advanced Technology Foundation (n=60)	Regional grants (n=96)	EU's Sixth Framework Programme (n=1.141)
Institutions of higher education	22 (58 %)	55 (100 %)	51 (76 %)	52 (87 %)	53 (55 %)	620 (54 %)
Sector research	0 (0 %)	7 (13 %)	21 (31 %)	6 (10 %)	1 (1 %)	199 (17 %)
GTS	2 (5 %)	51 (93 %)	6 (9 %)	4 (7 %)	12 (13 %)	38 (3 %)
Other public	12 (32 %)	2 (4 %)	9 (13 %)	5 (8 %)	52 (54 %)	138 (12 %)
Business firms	35 (92 %)	55 (100 %)	41 (61 %)	57 (95 %)	48 (50 %)	331 (29 %)
Organization	8 (21 %)	4 (7 %)	8 (12 %)	5 (8 %)	38 (40 %)	72 (6 %)

Source: DAMVAD. Mapping of the Danish knowledge system. 2008

Looking at the share of the project, where the GTS institutes are part the figures show that the GTS institutes in total participates in 29 per cent of the national projects (User-driven innovation, consortia of innovation, strategic research, and projects under the Danish National Advanced Technology Foundation). 13 per cent of the projects in the regional project and 3 per cent of the EU projects with Danish participation.

Even though there seems to be a comprehensive collaboration between actors in the research and knowledge system, particularly as regards R & D collaboration, there is still a challenge in strengthening the interaction further if the companies' need for knowledge is to be supported optimally. The analysis reflects that the actors in the research and knowledge system demand more collaboration and see potentials for such collaborations. Simultaneously, the

actors demand more incentives for collaboration between the actors, particularly now in a situation where there have been reforms in various places in the research and knowledge system, and where new actors, e.g. the Regional Hothouses, are established.

The GTS net in the knowledge system

Does the GTS net have a particular role in the knowledge system?

The GTS institutes are non-profit institutes who deliver technological service to private companies and the public sector. This is done by the GTS institutes in two ways: Partly through services financed with public funds, partly through services sold to customers on commercial conditions. The aim of the GTS institutes' effort is to strengthen the technological service in Denmark as a basis for developing and exploiting the technological, managerial and market knowledge as well as increase the innovation effort in the companies. The GTS institutes must deliver research and technology based consultancy, purchase knowledge from abroad, and offer consultancy broadly to the Danish business enterprise sector.

Despite the fact that the individual GTS institutes are under a common regulatory foundation and forms part of a 'net' (the GTS net), the institutes are mutually very heterogeneous. Some institutes are owned by universities and others are organised as independent private institutions. There is also a very big difference in the size of the institutions, from less than 20 employees to almost 1,000 employees. Some are strongly dependent of public result contract funds, other are to a much higher degree self-sustaining. Some are almost solely targeted towards the private business enterprise sector, while other are targeted towards public institutions. Some are very research heavy with a research effort at the level of universities, while others have a very limited research activity.

The GTS net has traditionally been a central part of the innovation policy. An interesting question is how the other actors in the research and knowledge system perceive the GTS net. Based on a questionnaire survey among approximately 300 actors in the research and knowledge system, the perceived role of the GTS net in the research and knowledge system is being examined. The analysis indicates that even though the different actors in the research and knowledge system have very different interfaces with the GTS institutes, they have apparently a very homogeneous perception of what role the GTS institutes have. Regarding the question concerning whether the GTS net has a special role in the research and knowledge system, only four per cent thinks that the GTS institutes' tasks can not be handled by other actors. A further 20 per cent thinks that the GTS institutes' tasks only in few cases can be handled by other actors. It is thus over 75 per cent of the survey's participants that think that the GTS institutes' tasks in some or in many cases can be handled by other actors.

In other words, the GTS institutes are not perceived as having a natural monopoly but are regarded as one among many possible collaboration partners by many actors in the research and knowledge system. The GTS institutes'

position in the research and knowledge system is thereby dependent on their continual perception as attractive collaboration partners – not because they are the only ones to handle their tasks but because they are the best to handle their tasks. It is, however, important to remember that the GTS institutes are responsible for a number of official tasks, eg. in regards to standardisation and testing. A transfer of these tasks would be difficult within a short timeframe and the legal framework regarding technological service.

Contributions of the GTS net

The GTS net offers a variety of activities and services. Some of the GTS institutes are specialists in narrow fields and others cover technologically broad. Most of them have a wide spectrum of services within technological service while others provide service narrowly in e.g. standardization and testing. There are not only big differences among the activity profile between the different institutes but there is also often significant heterogeneity within the individual institutes.

It is a widespread perception that the GTS net primarily offers traditional technological consultancy and testing but the survey points towards another scenario. The analysis shows, on the background of data from the GTS net, that the main part of the GTS net's commercial turnover is based on unique and knowledge heavy services (61 per cent) while a smaller part of the turnover comes from standardized services (39 per cent). These data are supported by the questionnaire survey among the GTS consultants which shows that the consultants first and foremost deliver consultancy in specialist areas (82 per cent), development of services (68 per cent) and implementation of innovation projects (51 per cent). Only a smaller part of the GTS consultants' work concerns testing of products (30 per cent) and certification (6 per cent).

The GTS net's development and results

If looking at the GTS net's development in the last 10 years, the general picture is that while the net has experienced an increasing turnover, it has at the same time experienced a decrease in central activities within competence building and the dissemination of knowledge. This has happened simultaneously with several parts of the research and knowledge system having experienced increased activity and resource consumption. The figure below illustrates the development for GTS net in a number of central areas as comprised by the analysis.

Figure 1.2: Development in central areas of the ATS net, 1998-2007



Kilde: DAMVAD. Mapping of the Danish knowledge system, 2008.

Increase in overall turnover

The GTS net has an annually turnover of nearly 2.5 billion DKK which makes the GTS a fairly big actor in the consultancy market in Denmark. The GTS net has in the last couple of years had a moderate growth in turnover. In the period 1998-2007 the total turnover for the GTS net has grown by 19 per cent. The turnover covers requisition of R & D and commercial sale to private and public clients in Denmark and abroad. As a comparison the total turnover for the private knowledge consultants, e.g. private consultants and consultancy companies, is approximately 130 billion DKK. The turnover in this industry has increased by 44 per cent in the period 2003-2007.

Decrease in research and development activities

The R & D effort of the GTS net has generally been decreasing in the period from 1998-2007. However, an increase of 15 per cent took place from 2006-2007. That tendency is followed up by the GTS net's participation in R & D collaborations in Denmark has decreased significantly from 580 projects in 1997 to 328 projects in 2007. Hereby, a nearly 50 per cent decrease in the GTS net's participation in R & a D project has taken place.

If looking at the increasing knowledge effort in the remaining research and knowledge system and in the business enterprise sector generally, there are many things that indicate that it is absolutely necessary for the GTS institutes to pay more attention to their own R & D than is seen today. Firstly, the GTS institutes have to be able to match the companies' new and increased demands

to knowledge and technology. Secondly, it is a major condition for being able to use the research institutions' research results in the companies, that the GTS institutes themselves research on a highly qualified level. Thirdly, it is an important prerequisite for strengthening the GTS institutes' collaboration with Danish and foreign research institutions that the GTS institutes are attractive and highly qualified collaboration partners.

A further challenge is to uplift the GTS net's effort in relation to EU participation which can be a noteworthy source of funding of research and acquisition of knowledge and technology from abroad. Today the GTS net has a limited EU participation compared to other Danish knowledge institutions. Particularly in relation to the coordinator role the GTS institutes could play a more significant role. Only one per cent of the total Danish project coordinators are an GTS institute. A coordinator role can be important in relation to exploit the Danish participation better and secure influence on the prioritisation of research within the EU. Many GTS institutes have downgraded the EU participation due to difficulties in co-funding but much indicates that increased EU participation now is part of more of the GTS institutes' strategies. It can be decisive to support these strategies and thereby create frameworks and incentives for increased internationalisation of R & D in the GTS net.

Constant Danish commercial sale—but increased international sale

The GTS net's national commercial turnover has not increased very much in the period 1998-2007. The growth in the GTS net's commercial turnover is on the contrary based on an increasing international turnover. If looking at the commercial turnover to private Danish companies, there has been a very small increase of 2 per cent from 841 million DKK in 1998 to 855 million DKK in 2007. A major part of the commercial turnover (197 million DKK) derives from the public sector even though there has been a fall in this turnover of more than 20 per cent in the period 1998-2007. The commercial international turnover has however more than doubled in the period 1998-2007; from 428 million DKK to 988 million DKK.

It is natural to ask why we from the public side need to support the GTS net if it to such a high degree helps foreign companies with knowledge so they can compete with Danish companies,. At the same time, it can be feared that the increasing international effort leads to a disconnection from the national innovation system. In other words, there lies a challenge in securing that the internationalisation supports the Danish innovation system. However, the internationalisation can be used strategically to give the Danish research and knowledge system an advantage if it simultaneously provides uplift in the Danish services, economies of scale, access to knowledge environments, and sources for funding of competence building activities, including more R & D in Denmark.

Decrease in sales to small companies- but profits on the large companies

The GTS net's clientele reveals something about the contact the GTS net has to the Danish business enterprise sector. The GTS net has, compared to other

actors in the research and knowledge system, traditionally had a large interface with Danish companies through their consultancy and sale of services. However, many things indicate that the GTS institutes' interface with the business enterprise sector has become smaller the last couple of years if looking at the number of commercial clients. The analysis shows that the GTS net's clientele has decreased from almost 34,000 in 1998 to 26,500 in 2007 which equals a fall of 22 per cent in the period. The decrease in number of clients is applicable for all categories of company sizes, i.e. both large companies with more than 250 employees and smaller companies with less than 250 employees.

If looking at the constellation of the GTS net's turnover it appears that the big companies with more than 250 employees account for half of the turnover - against a third 10 years ago. Moreover, the figures show that the turnover per client for the smaller companies has been relatively constant with app. 20,000 DKK, while the turnover per client in the really big companies has doubled from app. 71,000 DKK to 140,000 DKK in the period 1998-2007.

There are distinct differences in which industries contribute to the turnover of the GTS net. The analysis illustrates that the national turnover in 2007 derives primarily from the high-tech production sectors (app. 300 million DKK) and the manual service trades (250 million DKK), and that the turnover from these industries has been increasing in the period 1998-2007. The turnover from the knowledge service businesses (173 million DKK) and other industries (189 million DKK) has been decreasing. The low-tech trades (60 million DKK) take up relatively less space in the GTS net's national turnover.

There is a challenge within lifting the GTS net's effort towards the smaller companies in Denmark. Especially in light of the decreasing turnover from this group of companies – despite that the GTS net has a special commitment towards the small and medium-sized companies in Denmark. Moreover, there lies a challenge in strengthening the relation to the knowledge service area and the low-tech business enterprise areas.

Decrease in mediation, networks, and dissemination

The GTS institutes must, besides their role as consultants, also enter into networks, councils, and commissions aimed at specific trades. This shall secure that the business enterprise sector can get access to knowledge via a general collective technology mediation. This trade function derives to a high degree from the fact that parts of the GTS net historically have roots in the trade organisations.

The survey shows that the participation in formal committees and networks has been significantly decreasing since 2001 where the number peaked with 1,135 participants within standardization work, councils, boards, committees and other external commissions. Today the number is 515 participants. A reason for the declining participation in networks can be related to a changed expense structure for the GTS institutes in participating in such activities. For example co-financing of these activities is discontinued and at the same time the expenses related to participation in networks within the standardization areas has increased. Despite of the falling tendency, participation in networks remains an important function in the GTS net. In the questionnaire survey among app. 300 GTS consultants, 67 per cent of the consultants also point out that they have participated in external committees and networks within the last couple of years.

Stagnation in resources from performance contracts

The GTS net's result contract funds have importance for an extensive part of the assignments the consultants handle. A total of 82 per cent of the GTS consultants have thus been involved in activities which were financed by result contract funds within the last year. 72 per cent of these consultants say that 1-24 per cent of their key activities are financed by result contract funds.

Meanwhile, there has over a longer period of time been major fluctuations in the GTS net's result contract funds. The long-term tendency has been a general decrease in the result contract fund's share of the GTS institutes' turnover. This can have resulted in increased focus on commercial activities and thereby less focus on R & D as well as less focus on the small and medium-sized companies. The result contract fund's decreasing share of the GTS net's total turnover can to a high degree be ascribed to the significant increasing international turnover. Looking exclusively at the national turnover, the result contract funds comprise a relatively constant part of the turnover.

The result contract funds can be a condition for the GTS institutes' participation in networks and development work, and for their ability to compete with the other actors, e.g. the universities, regarding innovation projects in the entire research and innovation system.

Division of Labour between GTS and central knowledge actors

A reasonable labour sharing between the actors in the research and knowledge system is key with regards to securing the efficiency of the system and thereby also in relation to getting the most possible out of the investments in the research and knowledge system. The question about labour sharing is particularly important seen in the light of the many reforms and the new actors within the system. The analysis has put special focus on the GTS institutes' interaction and roles in relation to the universities, the private consultants, the regional business policy actors, and the multidisciplinary and engineering university colleges.

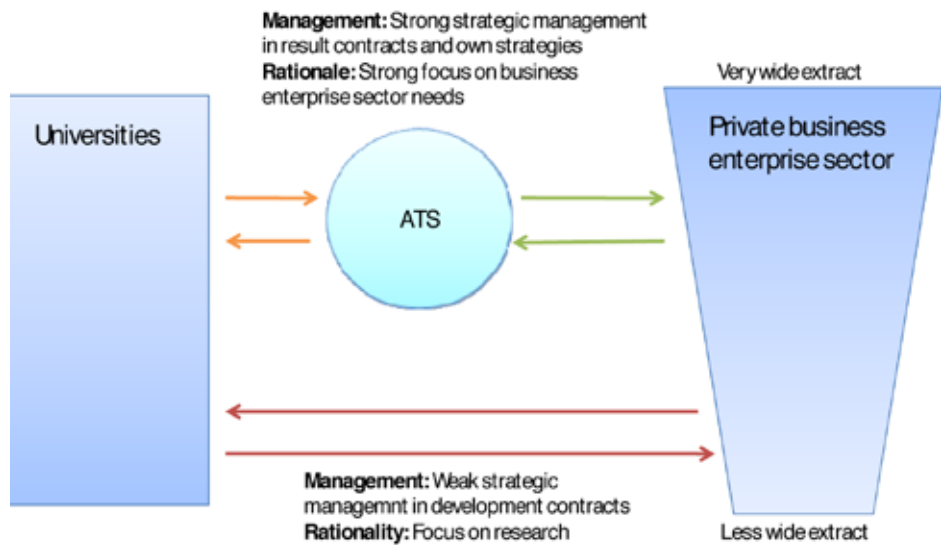
From bridge-builders to advanced technology screeners

At an entirely general level the universities and the GTS institutes are involved in many of the same tasks. The universities' key tasks are research and education – tasks which also to a certain extent are maintained by the GTS institutes. Furthermore, both universities and GTS institutes are involved in a wide range of different forms for collaborations with the business enterprise sector. And with the reform within the university field and the universities' wordings of their own strategies, the universities have become even more business oriented.

But there are fundamental differences between the two actors which also have significance for the actors' collaboration and possibilities in relation to the business enterprise sector. This refers to differences in their relations to the business enterprise sector, their incentives and steering mechanisms in relation to the interaction with the business enterprise sector and their research effort.

The overlaps between universities, GTS institutes, and the private business enterprise sector are illustrated in the figure below.

Figure 1.3: ATS net and universities in the knowledge system



Source: DAMVAD, Mapping of the Danish knowledge system, 2008

When looking at the research effort, there are clear differences in the framework and rationale for the GTS net and universities. For the GTS institutes, research is regarded as a necessary condition for them to be able to solve their tasks in relation to the business enterprise sector – and often the research is a by-product. For the universities, the research is in contrary a key function and a goal in itself. This means that production of scientific articles typically is not seen as creditable for the individual GTS consultant while scientific articles are an absolutely central activity for the university researchers.

Over half of the universities' R & D activities are characterised as basic research while the GTS institutes to a far higher degree are engaged in applied R & D work. At the same time, the universities have almost 6,000 PhD's enrolled, of which only 31 PhD's are affiliated with an GTS.

When regarding the business affiliation, the analysis shows that the most significant difference between the GTS institutes and the universities is that the GTS net is under far stronger strategic steering than the universities in relation to supporting the needs of the business enterprise sector. This strategic steering stems from both the GTS institutes' result contracts with The Danish Council for technology and innovation, but also to a large degree from the GTS institutes boards and managements. The survey points out that presently there are no figures regarding how many companies the universities interact with, but many things indicate that the universities are not at the same level as the

GTS net is overall. The GTS net has on an annual basis a direct interface with 30,000 companies. Concurrently the figures show that the total commercial turnover for the GTS institutes is 2,040 million DKK while the universities' total commercial turnover in comparison is 501 million DKK. Furthermore, it is characteristic that the GTS net's services primarily form part of a joint system (if we look at the GTS as a joint network) where the universities' services are more fragmented. This is because it often regards individual researchers who have the direct contact to the companies without it necessarily being tied up on determined strategic steering mechanisms. This means that the GTS institutes have a far greater knowledge than the universities concerning tendencies in the business enterprise sector and its need for knowledge and innovation.

The universities are to an increasing extent starting to work strategies for the interaction with the business enterprise sector, but at the same time the survey's interviewees point out that it should not be an assignment for universities to act as consultants and compete with the GTS institutes and private consultants. The premise for the universities' interaction with the business enterprise sector will often be that the interaction should strengthen the research in order to make the interaction interesting. It is an interesting result in the survey that the universities in absolute terms enter into far more research and innovation projects with the business enterprise sector than the GTS institutes. It appears that the universities meet the companies through such projects whereas the GTS institutes more often meet the companies through commercial oriented development activities.

Based on that, the analysis indicates that there is a basic labour sharing between the GTS and universities. However, it is not just a labour sharing in which the GTS net is a 'bridge builder' that conveys knowledge from the universities to the business enterprise sector. The survey points out that such a one-side linear understanding of the GTS net's role in the research and knowledge system is too simplistic, and at the same time it is also a role that is not possible to fill out for any individual actor in the research and knowledge system.

Firstly, the interaction between the GTS institutes and universities is more subtle than initially expected and *secondly* the universities have themselves a close interaction with (parts of) the business enterprise sector compared with many areas within education, research, and authority conduct. *Thirdly*, the GTS net can also play a role in relation to boosting the business enterprise sector's need for knowledge amongst the university research due to the GTS net's broad anchoring in and knowledge to the business enterprise sector. In other words, it can play the role of a kind of advanced 'technology screener'. *Fourthly*, it is clear from the analysis that when the GTS institutes do R & D, it is not necessarily with university research as a starting point. The research knowledge the companies might get from the GTS net is thus not necessarily produced at a university.

The basic differences between the GTS net and universities provide a potential for interaction. Though the figures show a decreasing tendency in the GTS net's participation in research projects, many things indicate that there is a

major collaboration between the GTS net and the universities after all. The analysis shows that 79 per cent of the GTS consultants have had interaction with researchers from Danish research institution (including universities) within the last year. If we look at the interaction relations broadly between the GTS institutes and the universities, it is in reality an interaction at many levels. This applies to everything from representation on boards, joint R & D projects, joint technological infrastructure, physical placement to participation in a long range of joint informal networks, conferences, articles, etc.

There are at the same time more GTS institutes which has a strong university affiliation. This applies to e.g. Bioneer which is a limited company with a university as owner. The analysis points out that a limited company construction between GTS and universities gives a number of advantages. On one hand, the GTS institutes are closer to the research at the universities. On the other hand, the GTS institutes are not under the universities internal research prioritisation and steering. This implies that the GTS institute has a special autonomy, in contrast to an institute at the university, in order to build those special competences it takes to support the knowledge need of the business enterprise sector.

The analysis points out that there, from many sides, can be a need for more collaboration overlap between the GTS institutes and universities, and that both systems to a greater extent can benefit each other, than we see today. The analysis points out that both universities and GTS institutes see huge advantages in exploiting each others' competences in order to better be able to support the innovation of the business enterprise sector. Meanwhile it is pointed out that the frameworks for collaboration between the parties should be extended and that there must be developed new models for collaboration, among other things through more incentives and increased resources for the collaboration.

An area identified by several of the interviews is the possibility of a more specific and systematic use of the GTS net's role as a kind of technology screeners. It is thereby pointed out that one could to a greater extent exploit the GTS net's knowledge about the business sector to inspire business relevant R & D in the universities. It has here been stressed that in connection with investments in research and technological infrastructure there could to a higher extend be incorporated interaction between universities and the GTS net. That will secure access for a larger group of companies to the expensive investments in research equipment and thereby a more effective use of the equipment. Another area which has been pointed out is the need for stronger incentives for joint R & D projects where universities and GTS institutes, besides in innovation consortiums, enter into R & D partnerships. E.g. it has been pointed out that the GTS net should be more visible in the strategic research.

From the "consultants' consultant" to specialised development partner

The GTS institutes' supply of commercial based activities means that they to a high degree are placed in the same part of the research and knowledge system as a number of private actors in the knowledge market. The questionnaire survey among the GTS consultants shows that many of them have had collaboration

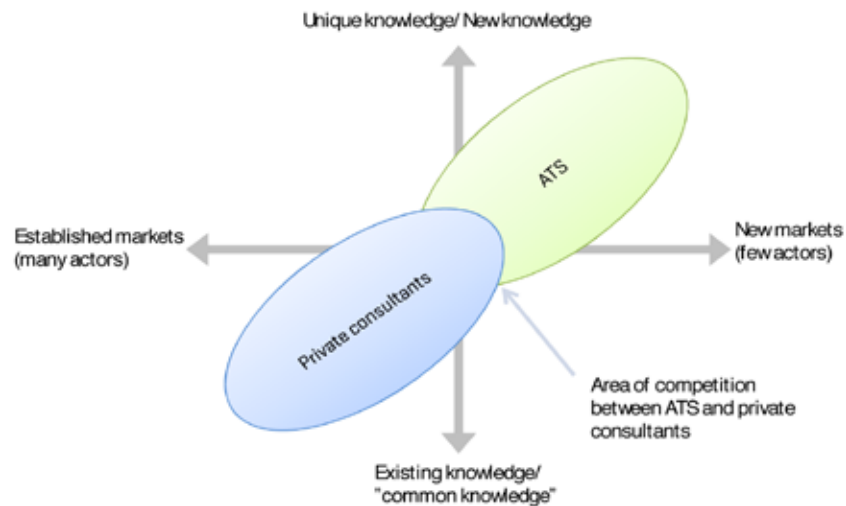
with consulting engineers within the last year. 31 per cent have had collaboration with analysis- and consultant companies. In this way a significant overlap can be seen between the GTS institutes and the private consultants. The most significant questions in relation to this overlap are whether it is characterised by collaboration or competition. At this point the analysis shows that there is often a double-sided relation to the GTS which is regarded as both a competitor and a collaboration partner. The interview survey shows however that the GTS institutes primarily are regarded as collaboration partners.

The analysis shows that there are major differences between the GTS institutes and private knowledge consultants. It is reflected in the two actors' R & D activities where the GTS institutes generally are more research intensive than the private consultants. The analysis shows here that where the GTS institutes on average research and develop for 343,000 DKK per employee, the figure for the private consultants is 149,000 DKK. At the same time, the GTS institutes have various forms for affiliation to the Danish universities and a number of foreign knowledge institutions. Moreover, the GTS net handles a long range of non-profit mediation activities which ordinary private commercial companies not would be able to handle. This includes access to testing facilities, trade functions and participation in standardization committees and technical committees in Denmark as well as abroad.

These differences means that the GTS institutes have a number of strengths which make them relevant collaboration partners for the private consultants. As several GTS institutes historically are 'born' from within a number of the business enterprise sector's organisations, there is a range of obvious collaboration areas in which the GTS institutes can mediate new knowledge and specialised knowledge to the private consultants. At the same time the GTS institutes can help create and cultivate new markets which often are too risky for the private consultants initially.

Despite the differences between the two actors there are however also such big overlaps in competences that GTS institutes and private knowledge consultants sometimes are in direct competition with each other. These competitive situations arise because of the constant development within the market. The GTS institutes' unique services of today are standard services by tomorrow, and among some private actors there is the perception that the GTS institutes sometimes focus too much on established markets where they compete against a long range of private consultants who have the same competences. This competitive situation is often seen as unfair and problematic by the private consultants.

Figure 1.4: Division of labour between ATS and private consultants



Source: DAMVAD, Mapping of the Danish knowledge system, 2008

The most important challenge for the GTS institutes in relation to the private consultants is that the institutes must develop themselves in the areas and markets the private consultants find relevant but at the same time move on when this knowledge, and matching competences, have rooted among the private consultants. The GTS institutes must in other words constantly try to be on the forefront with the services of the private consultants. This challenge is not getting smaller for the GTS institutes as the private consultants gradually to an increasing extent involve themselves in R & D and thereby faster than before can find and use new knowledge.

Another challenge, in the opinion of some private consultants, is to secure a wide range of services so that they are not alone targeted at technical specialities but also at the more 'soft' specialities. It is, among others, the humanistic and social science areas that become more important for many of the private consultants regarding organisational changes, management, user driven innovation and service development. But at the same time we refer to areas in which the GTS institutes are less and less active. If the GTS in the meantime should focus on building special competences within the non-technical areas, there is a challenge herein to avoid overlap with the private consultants in these areas, e.g. management consultants, analysis consultants and to an increasing extent also consulting engineers.

GTS, regional businesses policy actors and university colleges

The regional business policy actors are particularly relevant for entrepreneurs and new start-up companies. The local business centres and regional hothouses must first and foremost mediate existing knowledge to the companies and if necessary guide the companies towards more knowledge intensive actors - the private consultants and the universities.

In relation to universities and private consultants the regional business policy actors' relations to the GTS institutes are unsure. Today, there does exist collaboration between GTS and regional actors but the collaboration is not wide and does not seem to be systematic or coordinated. The GTS institutes' relations to the multidisciplinary- and engineering university colleges are still relatively limited and based on personal relations.

1.2 Data Basis for Analysis

The mapping is based on data and knowledge collected via questionnaires, qualitative in-depth interviews, existing public statistics and comprehensive desk research and literature gathering of Danish and international literature within research, innovation, and education.

More precisely the mapping will include performance accounts from the GTS net, evaluations, reports and ministerial websites, other authorities, organisations, and knowledge institutions. Likewise, the mapping is based upon significant statistical material from The Danish Centre for Studies in Research and Research Policy and Statistics Denmark. This material is being supplied with elaborate interviews of key persons in the research and knowledge system and data collected via questionnaire surveys.

DAMVAD has conducted two questionnaire analyses among GTS consultants (315 participants – corresponding to app. 10 per cent of the employees in the GTS net) and leading decision makers within the entire research and knowledge system (303 participants), including universities, other education institutions, regional business policy actors, and private knowledge advisors. The questionnaire surveys are partially forming the background to establish an overview of the GTS net's services and interactional patterns and for the construction of an actor evaluation index, which provides a unique overview of the roles and tasks in the Danish research and knowledge system.

The questionnaires are supplied with in-depth interviews of 15 central decision makers who represent a wide segment of actors in the research and knowledge system, including universities, other education institutions, regional business policy actors and private knowledge consultants.

Finally, DAMVAD has performed a mapping of the participation in innovation and research projects. The result is a comprehensive database with over 1,400 projects and 3,200 Danish project participants, which among other things can be used to map the interaction in the Danish research and knowledge system.

1.3 The Report's structure

Chapter 2 of the report gives an introduction to the survey, including the background for the survey and the overall tendencies in the Danish research and knowledge system.

Chapter 3 provides an up to date overview of the Danish research and knowledge system. The chapter focuses among other things on what types of actors the research and knowledge system consists of as well as the system's overall activity in relation to research, development, and innovation.

Chapter 4 maps the extent of the research and knowledge system and gives a description of the specific actors in the system. There will be a special focus on the actors' relations to the business enterprise sector.

Chapter 5 contains a mapping of the interaction in the research and knowledge system. The interaction is illustrated through data from the research statistics, the results of DAMVAD's questionnaire survey, and a comprehensive mapping of the participation in innovation and research projects.

Chapter 6 takes a closer look at the roles and tasks of the GTS net in the research and knowledge system. The chapter focuses among other things on the institutes' history, economy, management, and clientele. Furthermore, the chapter focuses on the GTS net's national and international interaction, participation in councils, and committees and the AST net's course- and mediation activities.

In chapter 7 the interaction between the GTS institutes and selected central actors in the research and knowledge system is analysed. The chapter focuses on the GTS institutes' interaction with the universities, private consultants, regional business policy actors and multidisciplinary- and engineering university colleges.

Chapter 8 sums up the actual challenges in the research and knowledge system on the basis of the previous chapters, with specific focus on the challenges in relation to the GTS net. The chapter focuses on the coherence in the research and knowledge system, internationalisation of knowledge, and stimulation of the public and private research.

Chapter 9 explains the survey's method and procedure, including questionnaire surveys, qualitative interviews, and the mapping of research and innovation projects.

An appendix in chapter 10 contains a range of background data and overviews.

2.1 Purpose and background

2.1.1 GTS – the core of the technological service

This analysis presents the results of a comprehensive mapping of the Danish knowledge system with focus on the role and function of the GTS net. The analysis forms part of an international evaluation of the GTS net initiated by The Danish Agency for Science, Technology, and Innovation.

Currently there are nine Authorised Technological Service institutes (GTS) (Danish: *Godkendte Teknologiske Serviceinstitutter – GTS*). The GTS institutes are non profit institutions which are run as private companies gathering, building and developing technological competences and disseminating this knowledge to the Danish economic trade. They also act as gateways to scientific institutions in Denmark as well as abroad. The Authorised Technological Service institutes primarily cooperate with the economic trade through their ordinary commercial activities.

A definition and delimitation of the activities of the GTS institutes was already given in 1972 in a report from the, at that time, Ministry of Commerce whereas technological service can be referred to as:

“...a range of activities through which knowledge is gathered, processed, developed and communicated for practical use in the economic trade, the public sector or the society overall. These activities enclose impart technological, economical and management knowledge through consultancy, through information and documentation and through additional and up to date education as well as development of new educational methods and new educational material. Besides this comes research, development and innovation in education intended to solve concrete, actual problems and for the gathering of knowledge for usage, control, standardisation and standard work, explanative business, participation in cooperation – and interest groups as well as networking and certain other functions.”¹

The description of activities of the GTS institutes is still relevant and adequate and it indicates that the concept of technological service has to be understood in a broad term and contains a varied range of activities. Common for all GTS institutes is that they are non-profit institutions whereby their income and capital only can be used for regulative social means. Therefore, the institutes cannot commit unilaterally to specific commercial interests.

In addition to that, it lies within the status of the GTS institutes that they are approved by the Minister for Science and can receive national support from The Danish Council for Technology and Innovation (DCTI) in the form of performance contract funding. The aim of the funding is to assist selected

¹ Handelsministeriets Udvalg vedrørende Teknologisk Servicevirksomhed (1972): Betænkning om “Teknologisk service”

knowledge development activities and the dissemination of knowledge within the institutes that generally benefit Danish trade and the society overall. In many ways the GTS net is therefore a unique system that moves in between market and public administration and increasingly also in between the national innovation system and the international innovation system.

The net of Authorised Technological Service institutes has throughout the last half century developed and adapted itself towards the economic trade and the society's need for technological knowledge. After a major restructuring in the last 20-30 years, the number of GTS institutes has been reduced from more than thirty to the present nine institutes.

In aggregate, the institutes appear today as a varied 'pool' of highly specialised trade-oriented knowledge that aim at supporting the productiveness in the economic trade and in the rest of the society. Previous examinations of the GTS net show that the GTS institutes contribute significantly to increased prosperity and welfare. User research shows that companies in the parts of the economic trade that use the services of the GTS institutes experience the most substantial effects economically as well as regards competence.² Moreover, the public investment in technological service results in positive welfare profits for the Danish economy.³

2.1.2 The GTS net is part of a total knowledge system

This analysis operates at two levels. Level one will have focus on the GTS net, its structure, development and ability to deliver technological services. Level two will have focus on the fact that the GTS institutes are an integrated part of the Danish knowledge system which consists of those institutions and companies that research and develop and deliver contributions to the knowledge and technological development.

As well as the GTS net has experienced changes throughout time so has the entire knowledge system of which the GTS net is a part of. Central actors in the Danish knowledge system – e.g. the universities or the regional business policy actors - have received new tasks and the companies' demand for knowledge and technological service is constantly developing along with new technologies and knowledge fields are developed.

Hence, a fundamental idea behind the mapping is that it is necessary to map the function of the knowledge system in order to evaluate the function, role and legitimacy of the GTS system. The mapping is therefore based on an insight in how the knowledge system works in the broadest sense. At the same time it is the basic idea of the mapping that if one have to judge the effectiveness of the actors within the knowledge system, one must also look at the internal work

² See user evaluations of GTS for example Oxford (2006):

"Brugerundersøgelse af GTS-institutterne"

³ See The Ministry of Business and Economics Denmark. "Effekten af teknologisk service i Danmark – viden, vækst og velfærd". Tæt på erhvervs politikken, 2000.

sharing of the actors and not analyse them separately. If there are problems as regards the contribution of the GTS net in connection to the technological service, the problems can either be due to circumstances in the GTS net itself or in the overall knowledge system and its functionality.

2.1.3 New strategy for GTS in the knowledge system

The technological service has in recent years been a focal point for the trade- and innovation policy in Denmark. This applies both to the government's globalisation strategy as well as DCTI's action plan "Innovation Denmark 2007-2010". It has not always been like that. Through out the eighties and nineties there was a limited focus on the technological service in the trade- and innovation policy. On the basis of an extensive evaluation in 1994 from the OECD regarding the Danish science, technology and innovation system, it was decided to change this situation⁴. Firstly, it was decided to comply with the advice from the OECD towards increasing the funding for the technological service. Secondly, a number of initiatives were started which aimed at securing quality and relevance in the technological service. The effort was basically the foundation of the GTS system as we know it today.

However, it is necessary to continuously adapt the GTS net to the new and changing needs for technological knowledge of the trade and the society. Therefore, The Danish Council for Technology and Innovation (DCTI) wants, as part of the action plan "Innovation Denmark 2008"⁵, to strengthen the general knowledge of the interplay between Authorised Technological Service institutes (GTS), private consultants, research and educational institutions, the regional business policy and companies in Denmark. Therefore, The Danish Council for Technology and Innovation is going to prepare a strategy that shall set out the direction and the priorities for the authorised technological service in Denmark towards 2012. The strategy for the GTS net is going to build on the key areas which already lie within the council's overall action plan for the innovation effort in Denmark.

⁴ See OECD, Science, Technology and Innovation Policies – Denmark", 1995.

⁵ See The Danish Agency for Science, Technology, and Innovation, "InnovationDenmark 2008 – The Danish Council for Technology and Innovation's Action Plan", 2008

Box 2.1: GTS net in InnovationDanmark 2007-2010

There exist a large number of initiatives in The Council for Technology and Innovations' strategy and action plan "InnovationDanmark", which includes a number of initiatives for The GTS net:

1. Renewal and opening of The GTS net.
2. User evaluation to increase the focus on user needs in The GTS net.
3. Open competition for GTS result contract.
4. Strategic initiatives within The GTS net.
5. International evaluation of The GTS net.
6. Involvement of the users in the future result contract process 2010-2012
7. Establishment of new centers on The GTS nets service areas based on technological foresight and analysis of renewal needs
8. Streamlining of the GTS structure based on the needs of the business enterprise sector
9. International knowledge obtainment and participation in bi- and multilateral research and innovation cooperation within and outside of Europe.

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

The strategy shall help clarifying whether there are emergent or completely new technology– or business areas which need a more central position in connection with the next generation of result contracts with the GTS net, and if there is a need for more new GTS institutes within new technology and business areas. This mapping of the knowledge system focussing on the role and function of the GTS net is part of the knowledge base for the strategy. The results of the mapping have to be viewed in connection with the other analyses from The Danish Agency for Science, Technology and Innovation of the GTS net, namely: Foresight of technological service in Denmark, the comparative analysis of Danish GTS institutes and GTS institutes in other countries as well as the user-survey of GTS.

2.1.4 Purpose of mapping

When evaluating the GTS net and the overall research and knowledge system it is a significant question how to ensure optimization of the interplay between the actors in the system, and how the companies' need for knowledge and competence continuously can be supported in the best possible way. In other words, how the GTS net and the research and knowledge system can be of most use for the society. As a part of that challenge it is evident that the GTS net also in the future is located where the demand for its output is found. Moreover, it has to be ensured that there continuously is a secure division of labour and a strong cooperation as regards other actors who is working with dissemination of knowledge in Denmark.

This mapping of the research and knowledge system shall contribute to the establishment of the factual research and knowledge base in order to evaluate the interaction between the actors in the research and knowledge system focussing on the role and function of the GTS net. It will therefore be a central task in the mapping to elucidate the role and the division of labour between the actors in the research and knowledge system and what challenges there are to be found in the way the GTS net is organised today, the location of the net in the research and knowledge system as well as the way the system works.

On the background of that it is the purpose of the mapping to:

- Carry out a fact based mapping of the Danish system. The mapping will establish the most significant actors, their roles and how the internal interplay and dynamics is between them.
- Illustrate how the GTS net overall is present in the Danish consultant- and research and knowledge system; that be national, regional as well as international. An objective account of the placement of the GTS net compared to the other knowledge actors in the research and knowledge system is given.
- Illustrate resources and possibilities for the research and knowledge system plus illustrate the incentive structures and the boundaries for the behaviour of the actors and their behavioural changes.
- Point out the challenges, visions and goals for the research and knowledge systems elements with focus on the GTS net.
- Point out the key areas for the trade, research and innovation policies to which attention has to be paid in order to secure optimal functions in the research and knowledge system, including optimal framework conditions and incentives compared to the GTS net.

The main focus of the mapping is primarily on the actors in the research and knowledge system –including the GTS institutes, the universities, other relevant educational institutions, regional business policy actors and private consultants. However, the mapping can not be carried out independently without taking into account the needs in the actual trade as it is the companies together with the public sector who are central users of the research and knowledge system.

It is equally decisive in the mapping to have focus at the research and innovation system, e.g. the research councils, the ministerial pools for innovation and research etc as this aspect plays a major role compared to the boundaries and incentives which are in place for the actors of the research and knowledge system and their behaviour.

2.2 Tendencies in the knowledge system

An essential boundary for the analysis is the understanding of the multi-faceted research and knowledge system in which the GTS institutes operates within. At the same time it is important to understand that the research and knowledge system is under continued structural changes and that it is not a constant entity over time. As mentioned, it is not only the GTS net which has undergone significant changes over time. It can also be said that the research and knowledge system as a whole has changed. It has happened concurrently with the fulfilment of new demands in the society, new challenges (e.g. the globalisation), the introduction of new political priorities, reforms and changes to own strategies by the individual actors in the research and knowledge system.

Generally, it can be stated that there through out the last 10 years have emerged various tendencies which have had fundamental importance for the actors of the research and knowledge system and the interplay between them. The following can be mentioned:

1. More R & D active actors and new innovation forms
2. New actors in the research and knowledge system – national, regional as well as international
3. New and increased political demands for the research and knowledge system and its interaction

These tendencies have steadily meant new terms, challenges and demands for the role, function and tasks of the GTS net. An important starting point for the understanding of the role of the GTS net in the research and knowledge system and for the functionality in the research and knowledge system as a whole, is to pay attention to such new tendencies. This is important as they reveal the rules, incentives for interaction and cooperation potentials, not to forget any overlap and conflict potentials there might be found in addition to the way the research and knowledge system as a whole and its actors work.

2.2.1 More research and development active actors and new forms of innovation

An increased democratisation of knowledge has taken place in which more actors than ever before are participating in the production of knowledge and competences. In the economical literature it is mentioned that we are part of a brand new modern knowledge production. The creation and use of knowledge should no longer be viewed as a linear process wherein knowledge isolated is produced by scientists in public research facilities and subsequently is used by the companies.⁶

The R & D results are not only coming from the universities. The trade is just as much producers of knowledge and knowledge development inter alia in close cooperation with public research. This is underlined in the statistics which show that the R & D contribution has increased significantly in the economic trade the last 10 years from 12 billion DKK in 1995 to more than 26 billion DKK in 2006. The democratisation of the R & D results in completely new interplays in the research and knowledge system where many companies develop knowledge on equal terms with the research institutions as for example GTS institutes and universities. At the same time it results in a more qualified demand for unique and highly qualified knowledge, technology and competencies through out the economic trade, which rests on a higher professional level than before seen.

⁶ See among others Gibbons (1994). "The new production of knowledge – The dynamics of science and research in contemporary societies" and OECD (2006). "Government R&D Funding and company behavior".

Concurrent with the growing R & D effort there are within the economic trade an increasing focus on new innovation forms like for example *user-driven innovation, non-technological-driven innovation and employee-driven innovation*.⁷ Today there are more and more companies that combine various innovation forms and endorse knowledge both from research as well as users and employees in a sort of ‘open innovation’.

This requires new demands for the GTS net. More and more indicates that it is absolutely necessary for the GTS institutes to place more emphasis on their own R & D than it is seen today. Firstly, the GTS institutes must be able to match the new and higher demands for knowledge and technology from the companies. Secondly, it is a significant prerequisite in order to be able to use the research institutions’ scientific results in the companies, that the GTS institutes do research on a highly qualified level themselves. Thirdly, it is an important condition in order to strengthen the GTS institutes’ cooperation with Danish and foreign research institutions, that the institutes are attractive and highly qualified collaborators.

2.2.2 New actors in the knowledge system

Within the last couple of years the research and knowledge system has experienced significant changes in its structure. New actors have arrived – national, regional as well as international – and at the same time central actors in the Danish research and knowledge system have received new tasks and roles.

On the national level there has first and foremost been established a new map of Denmark as regards universities and sector research institutions due to the mergers which have established fewer, stronger and more vocationally oriented universities. At the same time the universities are paying more attention to the ‘third leg’ where the universities more frequently than ever before have to cooperate with the economic trade and put theory into practice and hence implement scientific results for innovation in the companies.

At the national level there has additionally been established strong multidisciplinary university colleges on the background of the former Centres for Higher Education (CHE) which need a stronger presence in relation to science affiliation and trade oriented tasks. Within the research and innovation appropriation system there has been established a new strategic research council, the High Tech Foundation (Højteknologifonden), and new innovation pools like the pool for user driven innovation, which all are important for the possibilities for interaction on an innovative ground that is present in the research and knowledge system.

At the regional level the establishment of the new regions, including among others the new regional growth centres, has played a major role in the development of the research and knowledge system. As part of the regional trade development there is at the same time put emphasis on the ability of the

⁷ See The Danish Agency for Science, Technology, and Innovation, “InnovationDenmark 2008 – The Danish Council for Technology and Innovation’s Action Plan”, 2008

universities to more than ever act as ‘regional growth generators’⁸ which secures highly qualified knowledge and competences for the regional trade.

At the international level the EU plays an increasing role for the Danish research and knowledge system. The EU has set out visions for the establishment of a European single market for knowledge, where knowledge and competences must be able to move freely across borders in the EU countries similar to goods and services.⁹ Simultaneously there has been a distinctive lift in the EU research appropriations within the 7. framework programme which has given the Danish companies and knowledge actors new possibilities to be connected to the international research and knowledge system. Besides, there has been established a new European Research Council that has to contribute to set out the visions for the cooperation between national research and knowledge systems in the EU.

As concerns the GTS net the development results in increased competition for some of the GTS institutes’ traditional core competencies. However, it also creates new possibilities for partnerships and business areas. A major task in the problem solving will be to shed light on the new possibilities and the freedom of action for the actors of the research and knowledge system in the light of the new interfaces and work sharing’s between the actors – especially with focus on the role, functions and tasks of the GTS net.

2.2.3 New political demands towards the knowledge system

With the government’s globalisation strategy and the action plan of the DCTI, InnovationDenmark 2007-2010, there has for one thing been expressed new political demands to the research and knowledge system, specifically to the public part of the research and knowledge system.

An important political goal is to ensure that the public investments in competences, knowledge production and dissemination of knowledge through the research and knowledge system create most possible value for the society. In here, increased competition for the funds is a still more essential ground rule in the public funding in innovation and research where a larger part of the funds are distributed to the actors who perform best and create most value for the society. At the same time there are increasing demands that the research and knowledge system must be transparent and clear so it becomes easier for e.g. companies to make use of offers and opportunities as regards the research and knowledge system.¹⁰

⁸ See among other Reg Lab (2006), “Universiteter som regionale vækstmotorer”

⁹ See among others <http://vtu.dk/nyheder/pressemeddelelser/2008/eu-paa-vej-mod-et-indre-marked-for-viden/eu-paa-vej-mod-et-indre-marked-for-viden/?searchterm=EU%20indre%20marked%20for%20viden>

¹⁰ See The Danish Agency for Science, Technology, and Innovation, “InnovationDenmark 2008 – The Danish Council for Technology and Innovation’s Action Plan”, 2008

Further to this there has been put forward concrete political objectives for the research and knowledge system, for example the Barcelona objective where both companies and public knowledge institutions together have to contribute to lift the R & D investments in Denmark to 3 per cent of the gross domestic product (GDP). In connection to this there is an increasing demand that the research and knowledge system has to actively support and stimulate further private investments in R & D. This is particularly important now as a stagnation in the private investments in R & D has been registered the last couple of years.¹¹ At the same time on a regional level in the regional partnerships regarding regional development there has been put forward concrete objectives regarding, among other things, innovation, knowledge pooling and dissemination of knowledge. The new political demands and objectives create new challenges for the GTS net as well as for the other actors in the research and knowledge system. There is an increasing demand to be able to substantiate what is working and what is not working. This results in the fact that the individual actors have to be more visible in the research and knowledge system and that they to a greater extent than before must be able to clarify their value within the work sharing and the interaction with the remainder parts of the research and knowledge system. It is evident that the GTS net continuously is able to place itself where there is a demand for its output, and where they can create most possible social gain for the public investments in the GTS net. There must continuously be secured a socio-economic optimal division of labour and a strong cooperation between those actors in the research and knowledge system who work for the dissemination of knowledge to companies in Denmark. As mentioned, the continued development of the research and knowledge system creates new 'competitors' but also new edges and possibilities for cooperation which can turn out beneficial for the way the GTS net works in relation to its tasks.

2.3 Main elements in mapping

The mapping will be based on data and knowledge collected via questionnaires, qualitative depth interviews, existing public statistics and comprehensive desk research and literature gathering.

More precisely the mapping will include existing documentation, hereunder performance accounts from the GTS net, evaluations, reports and ministerial websites, other authorities, organisations and knowledge institutions. This material is being supplied with existing quantitative and qualitative surveys among the Danish GTS institutes and the other actors in the research and knowledge system. Moreover, elaborate interviews with key persons in the knowledge system have taken place. Likewise, the mapping is based upon significant statistical material from The Danish Centre for Studies in Research and Research Policy (Dansk Center for Forskningsanalyse) and Statistics Denmark (Dansk Statistik) as well as data collected via questionnaires.

¹¹ See The Danish Agency for Science, Technology, and Innovation, "InnovationDenmark 2008 – The Danish Council for Technology and Innovation's Action Plan", 2008

The mapping is to be considered a fact based report in which there on one hand will be gone into the mapping of the GTS net and on the other hand be given an in-depth analysis in relation to the overall research and knowledge system. The analysis of the GTS net requires in other words the in-depth analysis of the overall research and knowledge system

The mapping consists of the following four coherent elements:

A characteristic of the overall research and knowledge system and its **interactional relations** focussing on the GTS net. This happens on the basis of: Data from the research and innovation statistics as well as CIS (Community Innovation Survey) and desk research, including public available documents concerning organisational frameworks as well as funding and regulative frameworks and rules for the actors in the research and knowledge system. Furthermore, a mapping of the participation of the knowledge institutions in national, regional and international innovation network groups and projects. This is an extensive data collection which covers more than 3000 actor's participation in more than 1200 correlation projects within national, regional and international research and innovation programs.

Accomplishment of a **targeted mapping of the role and outputs of the GTS net** with the aim to go into depth with an analysis of the GTS net. A supply analysis of the GTS net's output has been performed on the back ground of data from a comprehensive questionnaire among GTS consultants. The questionnaire is conducted among 330 consultants (response rate: 93 per cent) in the GTS net corresponding to more than 10 per cent of the total number of employees in the GTS net in Denmark. Likewise, an analysis is being conducted of the GTS net's historic development and its resources, economy and customer base on the background of a desk research and key figures from the GTS performance account.

Accomplishment of a mapping of a **role and actor evaluation** based on questionnaires and qualitative interviews among key decision makers within the research and knowledge system, e.g. principals, deans, directors and managing directors. The questionnaire is conducted among 481 actors (response rate: 63 per cent). The questionnaire is supplied by qualitative depth interviews with selected key decision makers widely located in the research and knowledge system. 15 persons from universities, regional business policy actors, private consultants and multi-disciplinary University Colleges have participated in the interviews.

Illustrate the **challenges for the research and knowledge system** and its development with focus on GTS. This takes place on the background of the results from the other analyses as well as the qualitative depth interviews. The analysis has paid attention to the problems which are policy relevant and offers the possibility to evaluate where to put emphasis as regards a strengthening of the research and knowledge system with focus on GTS. Table 2.1 provides an overview of the data source of the mapping. The below table provides an overview of the mappings data sources:

Table 2.1: The mappings data source

Unit of analysis	Data source
Characteristics and interaction	Desk research – examination of public documents, strategies etc. Research and innovation statistics on the public and private sector. Business enterprise sector statistics. Counting of participation in research and innovation programs. Questionnaire data from mapping.
GTS	GTS performance account Desk research Qualitative interviews and business firm visits to GTS. Questionnaire data from mapping.
Role and actor evaluation	Desk research Questionnaire data from mapping. Qualitative interviews
Challenges	Results from the mappings other partial analysis. Desk research Qualitative interviews

3.1 Introduction

A major basis for this mapping of the Danish knowledge system is that there is a clear and operational definition of the research and knowledge system and its actors. In the following chapter we will discuss the delimitation of the research and knowledge system on which we have based the analysis; hereunder point out which central actors in the knowledge system that is part of the analysis. The chapter includes primarily data sources in the form of register data from the research statistics from The Danish Centre for Studies in Research and Research Policy as well as industry statistics from the OECD and Statistics Denmark.

The chapter looks upon the research and knowledge system in a broad perspective which means the knowledge system will be defined as a large entity of both private and public actors who deliver knowledge output and competences. However, it is not all actors in the research and knowledge system that are equally relevant in this analysis. The analysis will primarily focus on the actors who are the most business oriented which means that there will be a prioritisation of the actors in question through out the analysis.

The focus will obviously be on the GTS net, which is the main actor in the analysis, as well as universities, regional business policy actors and actors with short and intermediary educations. Focus will likewise be placed on the private consultants as they have overlapping functions as regards the counselling of the GTS net. Moreover, the chapter will focus on the users of the research and knowledge system which primarily is the business enterprise sector. The chapter will look at the need for knowledge as well as knowledge development in the form of innovation patterns and the R & D activity of the business enterprise sector. Furthermore, the chapter will look at the research activity of the research and knowledge system and besides focus on the financing of the research and knowledge systems research activity.

A significant point in the chapter is that the research and knowledge system consists of different actors who all in their own way can offer different types of knowledge to support the innovation in the companies. Another point in the analysis is that there through out the last couple of years has been an increasing R & D effort – not alone in the research and knowledge system but also in the business enterprise sector in general. This creates possibilities for cooperation regarding knowledge among the actors in the research and knowledge system and between the research and knowledge system and the business enterprise sector. It is different how the actors in the research and knowledge system finance their R & D activities. This can be important to look upon in order to get an understanding of the actors' roles in the research and knowledge system.

3.2 Identification of actors in the knowledge system

Today there does not exist one unambiguous commonly accepted definition of the concept of the research and knowledge system. The research and knowledge system can be understood in many ways, and an essential assumption for

this analysis is to give an operational, as well as an innovation- and industry political meaningful, definition and delimitation of the research and knowledge system and its actors. In the analysis we intend to understand the research and knowledge system as a system which consists of the public and private actors whose primary activity is to develop and disseminate knowledge to the business enterprise sector. These activities consist of both activities targeted directly at a specific company, for example within advisory and consultancy firms. But it also includes indirect performances to the business enterprise sector, for example further and higher education and ground research. In our understanding it is not key whether the actors' production is knowledge based but whether the actual product consists of a significant element of development and/or mediation of knowledge which (direct or indirect) support the innovation of the business enterprise sector.

In order to describe the overall research and knowledge system it is beneficial to identify its sub areas one by one. Figure 3.1 below shows a concept we suggest one can use in order to understand the research and knowledge system – a so-called 'Wheel of research and knowledge'. The concept is based on a division of whether the actors are R & D active. At the same time the Wheel of research and knowledge is based on a division of private and public actors. The centre of the Wheel of research and knowledge is the receivers of knowledge and competences, i.e. primarily the business enterprise sector. The remaining society, e.g. the public sector, can also be relevant users of the research and knowledge system.

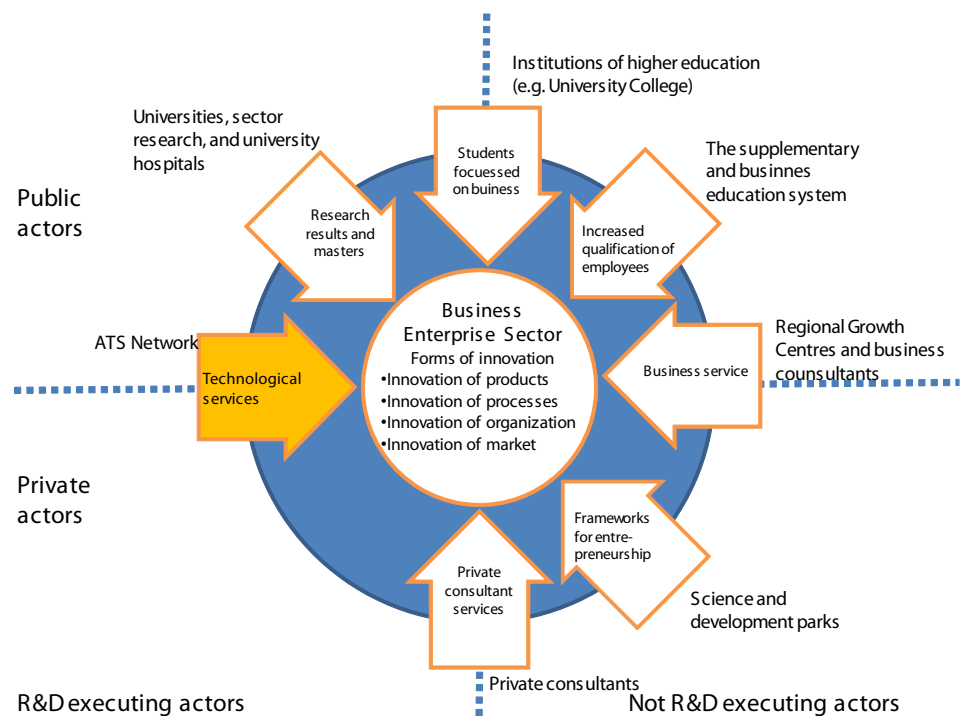
On the basis of that concept we can therefore list the following actors in the research and knowledge system:

- GTS institutes
- Universities
- University hospitals
- Sector Research Institutions
- Long-cycle higher education institutions
- Multidisciplinary University College and University College of Engineering
- Private consultants
- Vocational training centres
- Regional powerhouses
- Local business councils etc
- Centres for research and development and innovation environments
- Public knowledge centres
- Public museums and libraries

As can be seen in figure 3.1 the universities, sector research institutes and university hospitals among others belong to the group of public R & D active actors. The GTS institutes are to be found in the border area between public

and private R & D actors while the private consultants naturally is placed in the group of private actors. Among the actors who are not R & D active, we find a long range of institutions within the long-cycled higher education and the continued education (among these the Multidisciplinary University Colleges as they have research affiliations with the universities). Finally we find among the non R & D active actors, the regional powerhouses and the industry consultants as well as the development and research centres.

Figure 3.1: Wheel of Knowledge – overview of the knowledge system in Denmark



Kilde: DAMVAD, Mapping of the Danish knowledge system, 2008

The research and innovation funded system, including research councils and the ministerial pools for innovation and research, has significant importance for the way the research and knowledge system works. A major part of the public research is financed and prioritised by the research and innovation funded system. At the same time the research and innovation funded system establishes an important platform for a large amount of the interaction projects concerning research and innovation in which the actors in the research and knowledge system are part of – that be mutual in the research and knowledge system and together with the business enterprise sector. In that way the research and innovation funded system contributes to the dynamics and the incentives structure for the actors in the research and knowledge system.¹²

¹² See among others Research Council Economic Impact Group (2006); "Increasing the economic impact of Research Councils". Advice to the Director General of Science and Innovation, DTI

Even with the above definition of the research and knowledge system and the Wheel of research and knowledge there will naturally be a number of estimates and considerations when you have to decide upon just exactly what actors are part of the system. The specific actors in the Wheel of research and knowledge will be further described in chapter 4.

At the same time it must be stressed that even though the research and knowledge system in principal looks well-regulated with clearly defined tasks for each part of the system, there is a long list of overlap and border area problems and the various parts will to a certain extent cross over. Some GTS institutes do basic research, e.g. Bioneer, and some universities and university entities offer technological service and testing for industrial enterprises, e.g. The Technical University of Denmark. It is therefore in practical terms difficult to establish a complete unequivocal picture of the research and knowledge system in that the research and knowledge system is diverse and develops organically and overlapping within the various tasks.

3.3 The innovation pattern of the business enterprise sector

Before highlighting the actors in the research and knowledge system it is relevant to take a closer look at the users of the research and knowledge system, i.e. primarily the companies within the Danish industry. In the following we will illustrate the innovation pattern of the Danish industry in preparation for uncovering what kind of knowledge cooperation with the research and knowledge system the business enterprise sector is part of.

3.3.1 Innovation in the Danish business enterprise sector

A significant question is what need for knowledge the Danish companies have in relation to their innovation and renewal processes. This question can help to point out what relations and qualifications the actors in the research and knowledge system should offer the companies. The competitiveness of the Danish industry is highly dependent of the innovation ability of the companies. As it is seen from the below figure 3.2, the business enterprise sector has focus on many types of innovation. Innovation in this respect should be understood as the introduction of a new or significant improved product (goods or services), a new or significant improved process, a significant new organisational method or a significant new marketing method.¹³

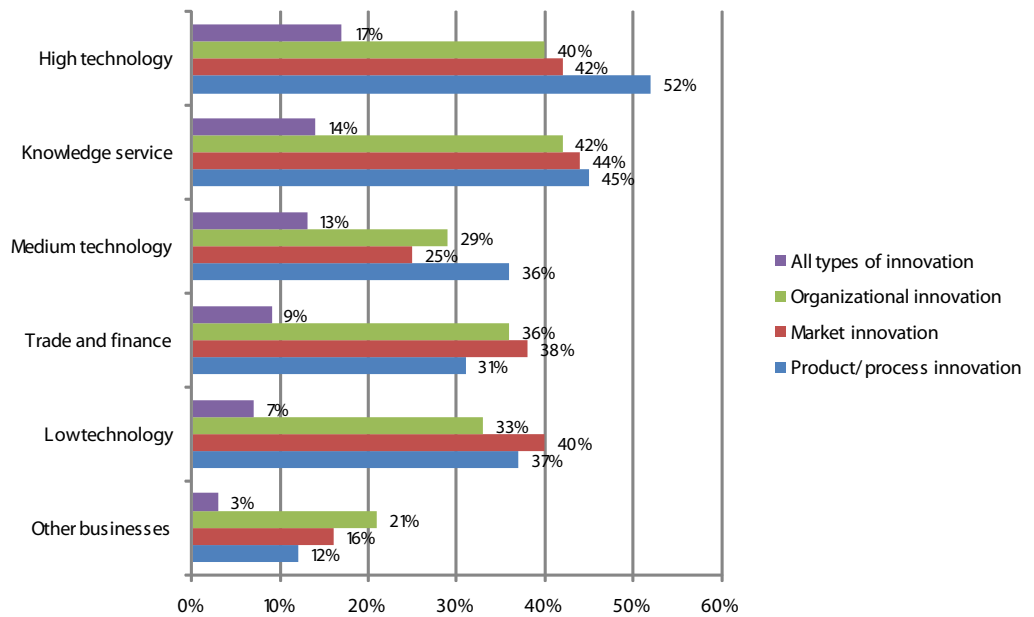
Approximately half of the companies within the high tech sectors and knowledge service enterprises have had at least one of the three forms of innovation. And the same applies for almost one third of the companies within the low tech sectors. However, the figures show simultaneously that it is only few companies which have had all three forms for innovation. About a sixth of the companies within the high tech sectors have had both product/process

¹³ Dansk Center for Forskningsanalyse: Innovation I Dansk erhvervsliv – Innovationsstatistik 2004-2006

innovation, market innovation and organisational innovation while it only applies for seven per cent of the companies in the low tech professions.

It can be a decisive parameter for the efficiency in the research and knowledge system that it is able to support the companies' different needs for knowledge in their innovation process. It applies to knowledge that not alone supports ordinary product and process innovation but also to a higher extent broader and non-technological forms for innovation like organisational development, employee driven innovation and market driven innovation where the customers of the companies systematically are involved in the innovation process.

Figure 3.2: Business enterprise sector innovation distributed on types of innovation and lines of business, 2006



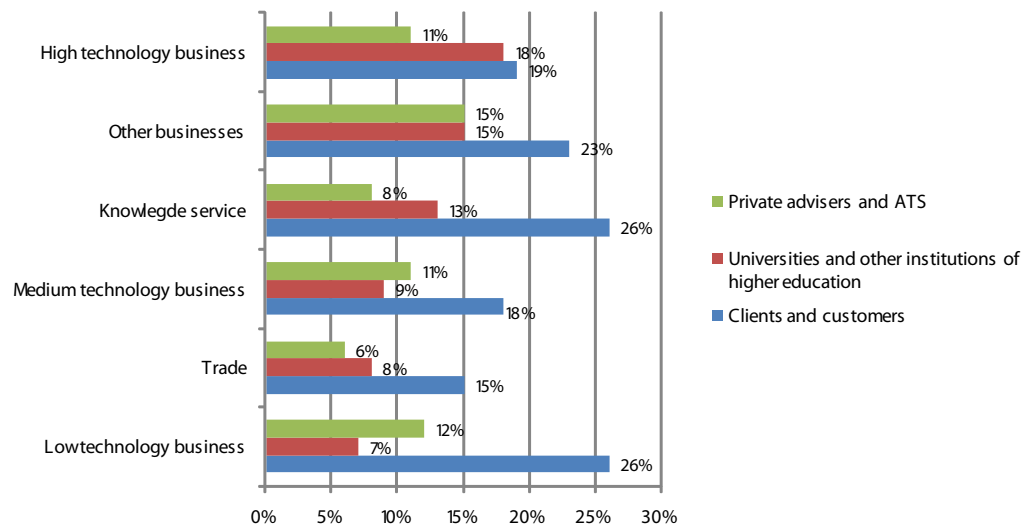
Kilde: Mapping of the Danish knowledge system, 2008; Customized data, CFA, Innovationsstatistikken (CIS 2006), 2008

3.3.2 Cooperation on innovation in the Danish business enterprise sector

The companies often carry out innovation in cooperation with external parties, e.g. customers, suppliers, consultants and knowledge institutions. That is exactly why it is decisive to many companies that there exists an effective research and knowledge system which can support the companies in their innovation, and complement with knowledge the companies themselves do not possess. Figure 3.3 below shows that the companies involve different actors in their interaction. The greater part of the companies cooperate more with customers than with private consultants or universities and other research institutions when carrying out innovation.

Meanwhile, there is big difference in the cooperation pattern across the line of businesses. Where companies within high tech areas cooperate a lot with both universities (18%) and customers (19%), the companies within low tech areas cooperate a lot more with customers (26) and less with universities (7%). Between 6 per cent and 15 per cent of the companies across the line of businesses cooperate with private consultants, such as the GTS institutes.

Figure 3.3: Business enterprise sectors innovation interaction distributed on parties and lines of business, 2006



Source: Customized data, CFA, Innovationsstatistikken (CIS 2006), 2008

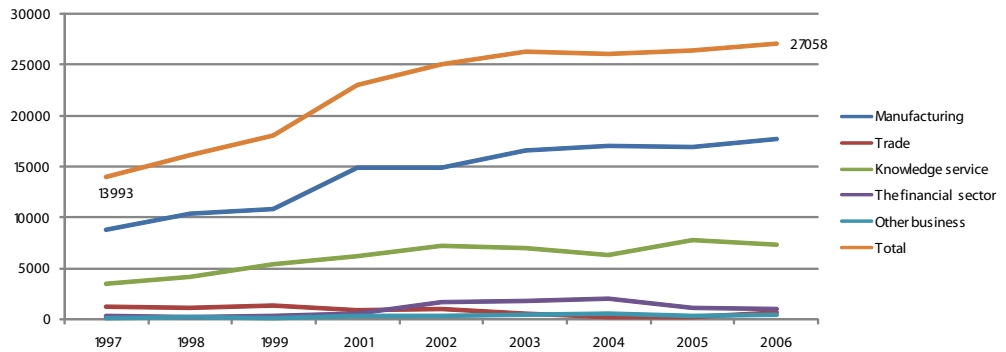
3.3.3 Research and development in the private business enterprise sector

For many companies innovation involves actual R & D activity – i.e. 'the creating of work on a systematic basis with the aim to increase the scientific and technical knowledge as well as exploitation of the existing knowledge in order to point out new practical uses'¹⁴. The R & D level in the public and private sector reveals something about how systematic the companies work with their renewal processes and how knowledge 'heavy' the innovation of the company is.

The numbers in figure 3.4 shows there have been a clear increasing R & D activity in the public and private sector. In 1997 the business enterprise sector researched and developed in the region of 14 billion DKK. That number had increased to 27 billion DKK in 2006. The R & D activity has especially increased in the production industries and the knowledge service industries which also are the sectors doing most research overall.

¹⁴ Dansk Center for Forskningsanalyse: www.forskningsanalyse.dk/Definitioner/definitioner.htm

Figure 3.4: Private research and development, 1997-2006, 2006 prices

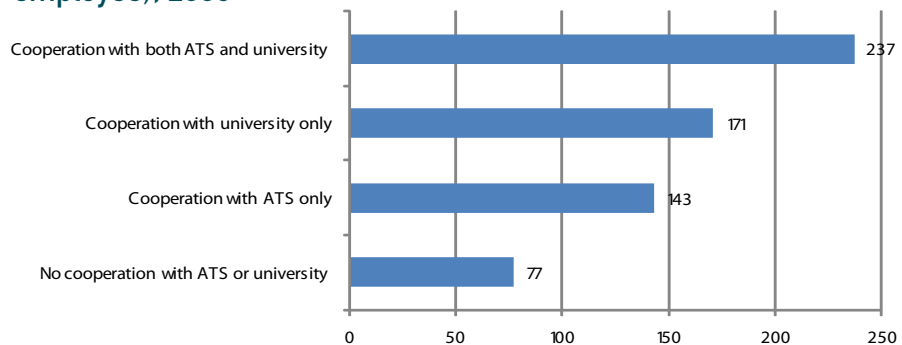


Source: Customized data, CFA, Innovationsstatistikken (CIS 2006), 2008

The major part of the R & D is carried out by large companies (48%) with more than 1000 employees. But the R & D is also more and more carried out by small companies with less than 250 employees, which today accounts for 36% of the total private research – that figure was 27% in 1997. When the companies have a high R & D level it implies how well prepared the companies are to cooperate with research institutions, for example universities in Denmark or abroad. In order to cooperate with the research institutions it is often necessary to do research and development on their own if they want to convert research into innovation. If we look at the companies’ interplay regarding R & D the statistics indicate that 75% of the companies in Denmark have some form of interplay with external partners.¹⁵

In connection with this it is interesting to look at what characterise companies with an external interplay. The figures from the business enterprise sector show that companies which cooperate with the GTS net as well as the universities also research intensely (measured as R & D per employee). Furthermore, they invest on average 237.000 DKK on R & D per employee as compared to 143.000 DKK for companies that only cooperate with GTS institutes. Companies that do not cooperate with universities and GTS institutes only invest 77.000 DKK on R & D per employee.

Figure 3.5: Patterns of interaction and R&D intensity (1.000 DKK pr. of employee), 2005

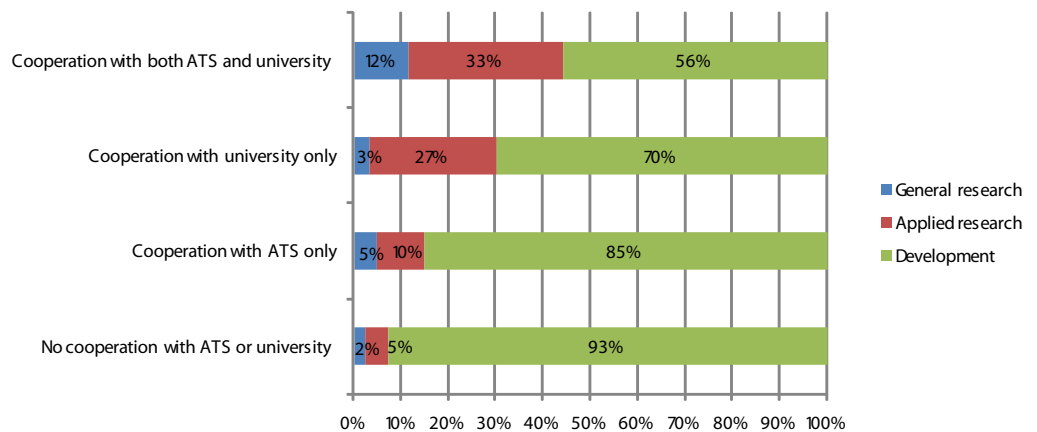


Source: Customized data, CFA, Forskningsstatistikken, 2008

The differences in the research intensity reveals that it is important for the ability of the companies to cooperate broadly with actors in the research and knowledge system – especially the more knowledge intense parts of the system – that the companies themselves invest in knowledge. On the other side, the figures can also indicate that interplay itself with the research institutions can contribute to stimulate the companies’ R & D effort.

Another parameter for research intensity can be the nature of the research the companies perform. In other words, if it is basic research, applied research or solely developmental work.¹⁶ The figures from the business enterprise sector show that the share of the basic research and applied research on average is far higher for companies (44% basic research and applied research) which cooperates with GTS institutes as well as universities than companies that only cooperates with GTS institutes (15 per cent basic research and applied research) and companies that cooperates neither with GTS institutes nor universities (7% basic research and applied research). This emphasizes once more that a broad cooperation between companies and knowledge institutions often can be linked to their own systematic focus on knowledge production in the companies.

Figure 3.6: Type of research and patterns of interaction, 2005



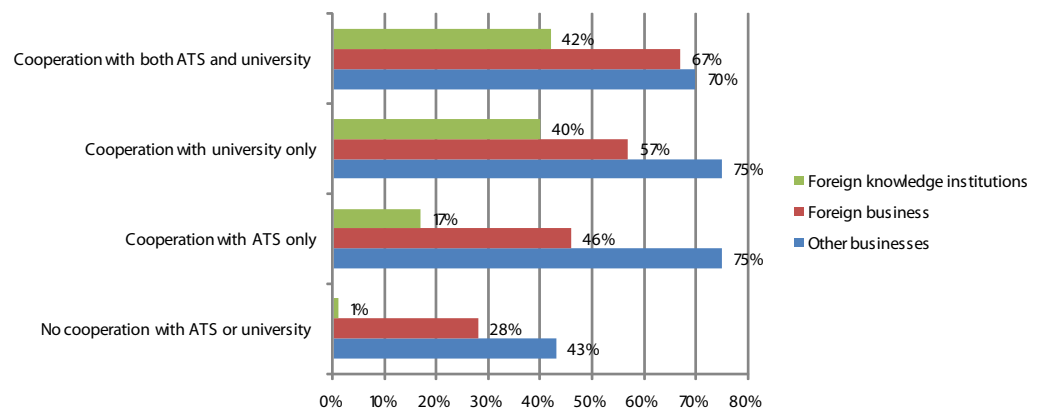
Source: Customized data, CFA, Forskningsstatistikken, 2008

¹⁶ Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective. Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed. (Frascati Manual).

If we look at the companies' external cooperation pattern with other actors – understood as companies and foreign actors – there are clear differences between the companies that cooperate with GTS institutes as well as universities and the companies that do not cooperate with any of those actors in the research and knowledge system.

Generally, companies with a broad interplay with the actors of the research and knowledge system have a higher tendency to cooperate broadly – with both foreign actors and businesses – than other companies, cf. figure 3.7 below. The figures specifically show that e.g. companies that cooperate with GTS institutes as well as universities have far more cooperation with foreign knowledge institutions (42%) than companies which cooperate neither with GTS institutes nor universities (1%).

Figure 3.7: R&D cooperation related to pattern of cooperation with the knowledge system, 2005



Source: Customized data, CFA, Forskningsstatistikken, 2008

3.4 Public R & D

The research and development of the public knowledge actors plays a central role as regards the innovation of the business enterprise sector. And often the research of the public sector can also support and stimulate the R & D effort in the private sector.

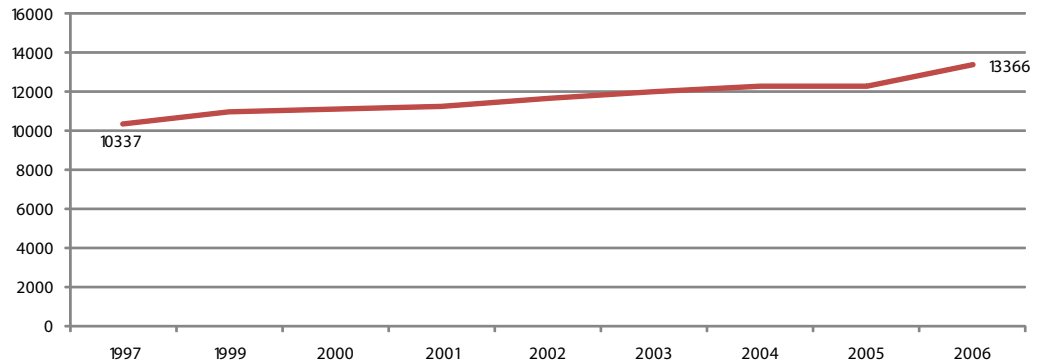
A survey from The Danish Centre for Studies in Research and Research Policy shows that there is a major so-called *spill over* effect from the public research to the private R & D.¹⁷ Likewise a recent assessment shows that companies which participate in projects by The Danish Council for Strategic Research often get their research stimulated due to their participation in the projects.¹⁸ As well as the R & D of the private sector has increased so has the R & D of the public

17 See Carter Bloch and Ebbe Krogh Graversen (2008): "Additionality of public R&D funding in business R&D", The Danish Centre for Studies in Research and Research Policy.

18 See DAMVAD (2008): "Effekten af strategisk forskning". Det Strategiske Forskningsråd

sector – albeit not as much as in the private sector. The R & D activity of the public sector has increased from just over 10 billion DKK in 1997 to almost 13.5 billion DKK in 2006 which is an increase of 29% in the period, cf. figure 3.8 below.

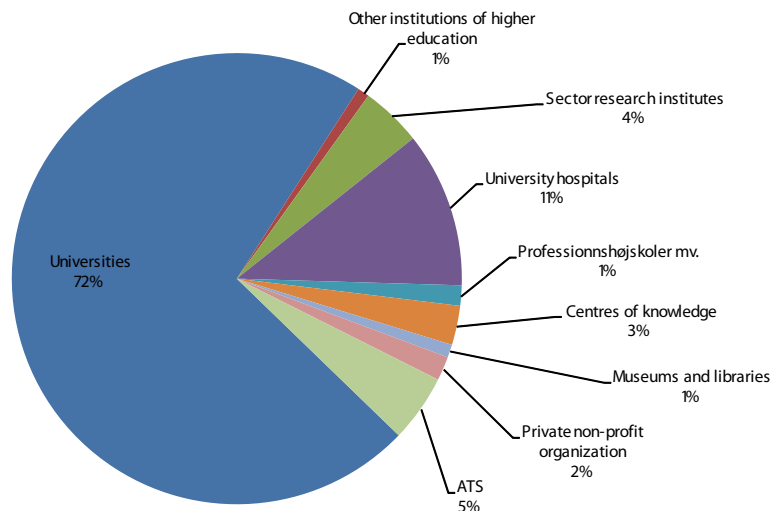
Figure 3.8: Public expenditures to R&D, 1997-2006, mill. DKK, 2006 prices



Source: Customized data, CFA, Forskningsstatistikken, 2006

Meanwhile, there are big differences regarding the research effort across the actors in the research and knowledge system. Figure 3.9 below shows a breakdown of the central actors in the survey from the research statistics. In the survey the GTS institutes' R & D activities are included.¹⁹ The biggest actor by far within the area are the universities which account for 72 per cent of the R & D activity.

Figure 3.9: R&D expenditures by public actors and ATS, 2005/2006



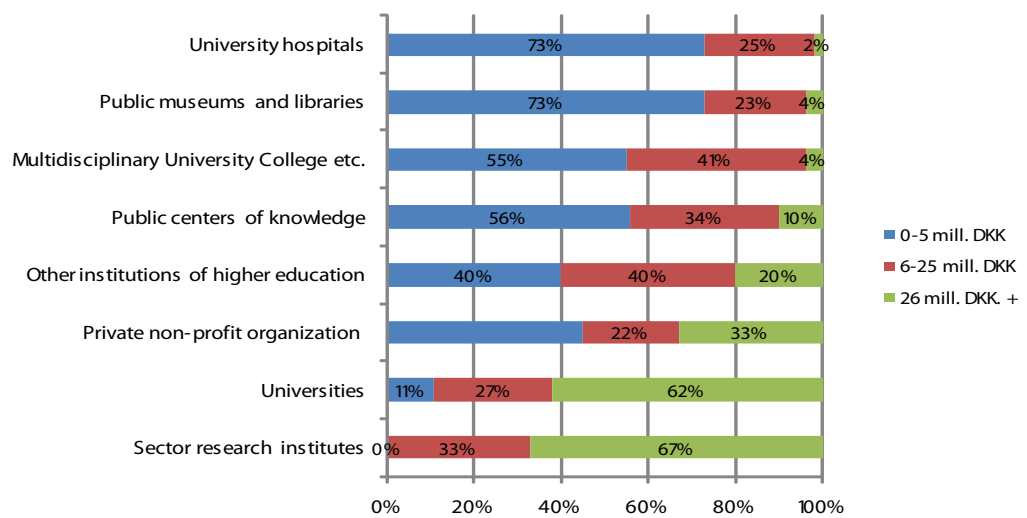
Source: DAMVAD, Mapping of the Danish knowledge system, 2008; Customized data, CFA, 2008

Remark: The fusion between universities and sector research institutes has been taken into account – making the relevant integrated sector research institutions part of the university category.

¹⁹ The investigation is based on customized data from CFA. The GTS institutes are usually not included in the public research budget, but is here because of the report's focus on GTS institutes in the innovation policy.

The size of the universities also manifests itself when looking at the actors' R & D units. The below figure 3.10 shows how the R & D active units vary significantly in size. As it appears from the below figure, the majority of the R & D active units at universities and sector research institutes are relatively large units with annually R & D activities in excess of 26 million DKK. The remainder public R & D actors are characterised by far smaller R & D units. The majority of these units have R & D activities for 5 million DKK at the most.

Figure 3.10: R&D unit size, 2006

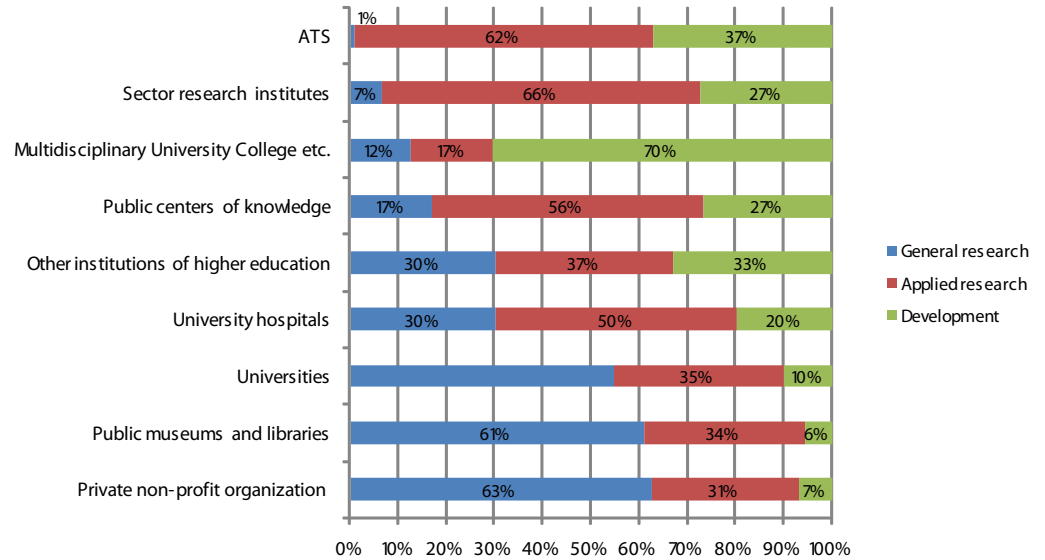


Source: DAMVAD. Mapping of the Danish knowledge system, 2008; Customized data, CFA, 2008

The public R & D actors do not only vary in size but also compared to what kind of R & D they perform. The below figure 3.12 shows how the R & D activity of the actors is divided among basic research, applied research and developmental work respectively.

As can be seen from the figure the basic research accounts for more than half of the total R & D activity at universities, public museums and libraries as well as private non-commercial institutions (private non-commercial institutions are e.g. The Danish Cancer Society). Among the other actors the applied research and developmental work takes up more room than the basic research. Especially among the GTS institutes the share of the basic research is limited because it only accounts for one per cent of the institutions' total R & D activities.

Figure 3.11: Types of R&D activities, 2005/2006



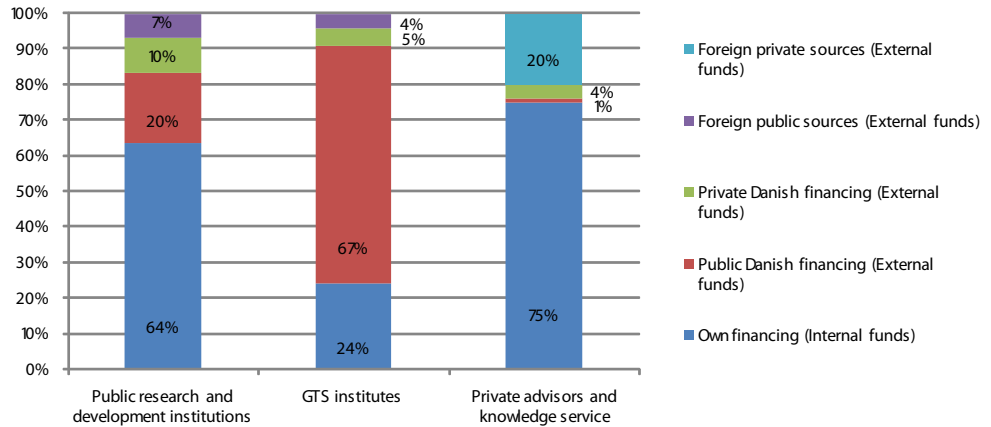
Source: DAMVAD, Mapping of the Danish knowledge system, 2008. Customized data, CFA, 2008

3.5 Financing research and development in the knowledge system

A major aspect regarding the research and knowledge system’s R & D effort is how the systems R & D effort is financed. It can be important to shed light on this in order to understand the role of the actors in the research and knowledge system. Figure 3.12 below shows the financial sources for public research institutions (i.e. mainly universities), GTS institutes and private consultants respectively. The figures show that there are major differences on the financial structure concerning the R & D activity of the actors.

There should be distinguished between internal and external funding of the research. By internal funds is referred to funds the organisations set aside from their own operating budgets for R & D, and of which the organisation has full power. For a university it will correspond to the basis funding for research, while it for an GTS institute will correspond to those research funds the GTS institutes chose to spend from their own budget (i.e. not research contract funds). By external funds is referred to the funding which derives from parties outside the organisation, e.g. from companies, the public sector or foreign actors. For an GTS institute it will include the result contract funds from the Danish Council for Technology and Innovation (DCTI).

Figure 3.12: Financing research and development activities, 2005/2006



Source: CFA, Forskningsstatistikken for offentlig (2006) og privat sektor (2005)

As regards the public research institutions the far majority of their research is internally funded (64%), which when it comes to universities is made up by the basis funding from the government. The rest of the funding for the research institutes derives from alternate public Danish funding (20%) – primarily from the research councils and from private companies and funds (10%). The foreign funding comprises of 7 per cent of the public research institutions’ funding which primarily are funds from the EU’s framework programs.

When it comes to the GTS net’s R & D, the major part (67%) is funded by public sources – it includes primarily result contract funding from the DCTI as well as participation in various innovation programs, e.g. Innovation consortia. Approximately 25% of the GTS net’s R & D funding takes place through internal funds, i.e. resources which the institutions via their own operational budgets set aside for R & D. A lesser part of the GTS net’s funding comes from private companies and funds (5%) as well as international sources (4%) – primarily the EU.

Common for the funding of the public research institutions and the GTS net’s R & D is that it primarily takes place via public resources. However, there tend to be differences in the research statistics as regards what is perceived as internal funding at universities and GTS institutes. This means that it is not possible directly from the research statistics to compare the universities’ basis funds with the result contract funding from the GTS institutes. In chapter 7.4 we will take a closer look at the differences in the funding of the R & D in the universities and the GTS institutes. Characteristically for the funding of the research by private consultants is that it primarily happens via internal private funds (7%) or via a foreign part of the company (20%). Only one per cent of the private consultant’s research funding takes place via public sources.

4.1 Introduction

This chapter provides a description of the actors in the Danish research and knowledge system. The description is based on a major desk research of public available material concerning the actors of the research and knowledge system and special reports from Statistics Denmark about the extent of the research and knowledge system.

Chapter 4.2 focuses on the extent of the research and knowledge system overall. It is evident that the research and knowledge system plays a noteworthy role within the Danish economy. The research and knowledge system has experienced substantial growth through out the last years, and today approximately 14 per cent of the employment in Denmark is within industries which are a part of the research and knowledge system.

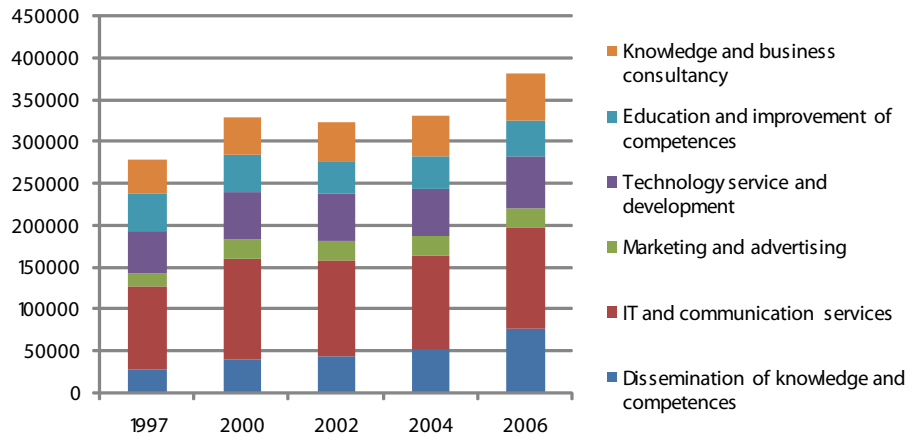
Chapter 4.3 gives a systematic and comprehensive reading of the most important actors in the Danish research and knowledge system. It is evident from the reading that the actors in the Danish research and knowledge system represent a substantial diversity as regards size and competences. At the same time there are large variations in the way the actors interact and in the intensity of the interaction with the business enterprise sector.

4.2 The extent of the knowledge system – a statistical assessment

Today the research and knowledge system constitutes a major share of the Danish economy. A special report from Statistics Denmark shows that 381,000 persons in 2006 were employed in the sectors which are a part of the research and knowledge system²⁰. As can be seen in figure 4.1 the amount of jobs in these sectors has increased significantly within a relatively short period of time. Looking back at 1997 the employment in the sectors was 279,000 persons and the number of employed has as such increased by as much as 36% in just nine years, equivalent to an annually growth of 3.5 per cent. Compared to the total Danish labour market this means that the employees within the research and knowledge system in 2006 amounts to 14 per cent of all employees in Denmark. The equivalent number for 1997 was 10 per cent.

²⁰ The estimation is based on the selection of certain branches (NACE classification). The chosen branches appears in section 10.3 in the appendix of the report.

Figure 4.1: Number of jobs in the knowledge system in Denmark, 1997-2006

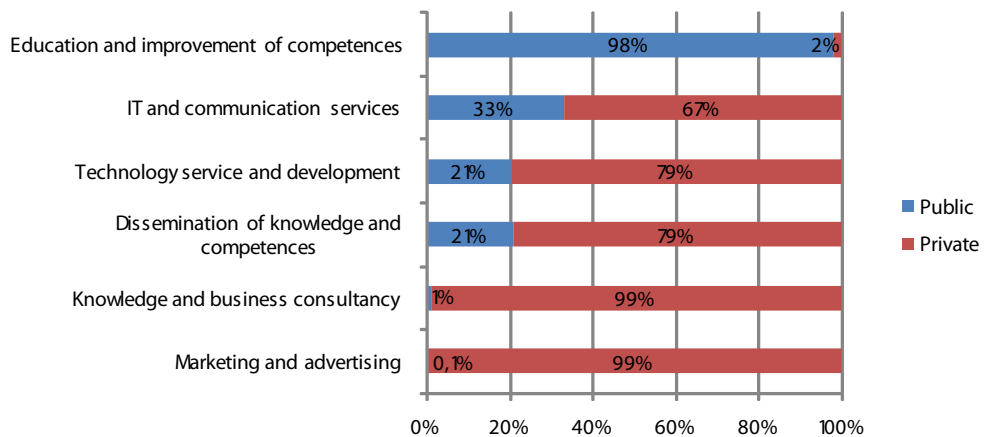


Source: DAMVAD, Mapping of the Danish knowledge system, 2008; Customized data, Statistics Denmark, 2008

The area of “Education and improvement om competences” has as the only area had a minor decrease of 5% in the number of employees from 1997-2006. Opposite this, the area “dissemination of knowledge and competences” has had a sizeable increase of 167 per cent in the same period. Measured by persons the growth in this area has been 47,000 persons equivalent to 46 per cent of the total growth of 102,000 persons.

Overall, there is a high degree of labour sharing between public and private actors. In the area “Education and competence building” 98 per cent are employed in the public sector whereas the remaining areas primarily are located within the private sector. The allocation of public and private employees in the research and knowledge system can be seen in figure 4.2.

Figure 4.2: Distribution of jobs in the knowledge system between the public and private sector, 2006



Source: DAMVAD, Mapping of the Danish knowledge system, 2008; Customized data, Statistics Denmark

4.3 Characteristics of the actors in the knowledge system

In this chapter the most important actors in the research and knowledge system are described, hereunder their primary official role in connection with development and dissemination of knowledge to the business enterprise sector. The characteristic of the actors is focussing at the formal frames, funding and incentives compared to the interaction with the business enterprise sector. Moreover, the focus will be on the actors' current development, hereunder political reforms within the area. The momentous desk research and characteristic of the actors of the research and knowledge system has uncovered a number of overall points about the Danish research and knowledge system:

- There are big differences in the actors' formal anchoring in relation to the business enterprise sector. Whilst for example the Vocational training centres have a close business affiliation within boards and councils, this is not the case for public museums and libraries, as well as public knowledge centres, as they do not have any business related anchorings or commitments to interact with the business enterprise sector.
- There are big differences in the actors' impetus to cooperate with the business enterprise sector. Some actors, e.g. the GTS institutes, have a strong regulative incentive mechanism in their result contracts while others have a very loose incentive structure, e.g. the institutes of education under the Danish Ministry of Culture.
- There are big differences in the strategies of the actors concerning business cooperation. A number of actors have within the last couple of years composed strategies for business cooperation while other actors do not work strategically at developing their business cooperation at all.
- Many actors in the research and knowledge system have been exposed to large structural reforms and renewals in the last couple of years which have had impact on their business oriented interaction. Among the most considerable reforms are the university and sector research mergers, the establishment of Multidisciplinary University Colleges and the reform of the regional enterprise promotion.
- The actors of the research and knowledge system are anchored in many different parts of the central administration. The universities and GTS institutes are anchored in the Ministry of Science, the sector research institutions are among others anchored in the Ministry of Social Welfare, the Multidisciplinary University Colleges and the Vocational training centres are anchored in the Danish Ministry of Education while the development parks are anchored in the Ministry of Economic and Business Affairs.

The description of the actors in the research and knowledge system is summarized in the table below.

Actor	Volume	Formal frames for business- and research cooperation	Incentive and management related to business connection	Services and interactions directed towards the business enterprise sector	Strategies for business connection	Newer political reforms	Financing
Universities	8 universities with a total of 25.207 full year's work for one person	Business cooperation in the University Law and in development contracts.	Development contracts income and commercial business.	Research cooperation, commercial business, consultancy services etc.	Yes, to different degrees.	Fusions, a new University Law	Mainly public (state) funding.
GTS	9 GTS institutes with a total of 2.915 employees.	Determined in result contracts.	Result contracts and commercial activity.	Test, certification, consultancy etc.	The institutes have a natural connection to the business enterprise sector.	Law on Technology and Innovation opened in 2002 for letting private companies become GTS institutes.	Mainly private funding.
Private consultants	A large number of advisory consultants and engineers (more than 1.000 actors).	Part of the private sector.	Part of the private sector.	Part of the private sector.	Part of the private sector.	No	Private financing (with public sector as customers).
Sector research institutes	Four sector research institutes with 1.660 full year's work for one person.	Sector research institutions law.	Commercial business	To different degrees.	To a limited degree.	Infusion into universities.	Mainly commercial financing (e.g. SSI's sale of vaccines).
Multidisciplinary University College	10 institutions (including the University College of Engineering) with a total of 6.500 employees.	It's a requirement in the law that they must have a relation to the research institutions.	Limited	Supplementary training	To a limited degree.	The new frame of the Multidisciplinary University Colleges was put into force in 2008.	Mainly public (state) financing.
Vocational training centre	121 institutions	Close connection to the parties of the labor market through boards and education committees.	Sale of educational services to the business sector.	Business educations	Yes	New law on Vocational training centers was put into force January 1st 2004.	Public financing and participants fees.

Actor	Volume	Formal frames for business- and research- cooperation	Incentive and management related to business connection	Services and interactions directed towards the business enterprise sector	Strategies for business connection	Newer political reforms	Financing
Regional Growth Centres	Five regional growth centres. One in each region of Denmark. A total of 124 employees.	Originate in The Law on Business Development from July 2005.	Result contracts with The Danish Enterprise and Construction Authority.	Consultancy	Yes	The Regional Growth Centres was established in 2007.	The Danish state provides financing from 2007 to 2010.
Local Business Development Centres etc.	Approximately 70 local business counsils in Denmark.	Organiseret i DEF. Dansk Erhvervsfremme.		Consultancy	Yes	-	Municipal financing and participants fees.
Science and development parks etc.	More than 50 development parks. 7 innovation environments and 7 science parks.	Cooperation with the business enterprise sector is a core object.	Cooperation with the business enterprise sector is a core object	Offer of shared facilities (offices etc.)	Yes	-	Public and private financing.
Other institutions of higher education	21 education institutions within The Danish Ministry of Culture.	None/limited cooperation with the business enterprise sector.	None/limited cooperation with the business enterprise sector.	None/limited cooperation with the business enterprise sector.	To a limited degree.	New agreement for 2007-2010.	Public financing.
University hospitals	Three university hospital centers with a total of 4.000 full year's work for one person.	Limited formal frames.	Limited/non-existing management of area.	Research project with private business firms.	-	-	Public financing.
Public centers of knowledge	47 institution	Large variations between actors.	Large variations between actors.	To different degrees	To different degrees.	-	Public financing
Public museums and libraries	300 museums and more than 600 libraries.	None/limited cooperation with the business enterprise sector.	Limited/non-existing	Limited	No (no public strategies with focus on businesses)	-	Public financing

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

4.1.3 The universities

The eight Danish universities' contribution to the business enterprise sector is to a high degree taking place through their primary tasks – research and education.

The University Act establishes that a university: *”shall aim at undertaking research and provide research based education at the highest international level within its subject areas. The university shall ensure an equal interaction between research and education, undertake a continuously strategic selection, prioritisation and development of its research– and educational subject areas and disseminate knowledge of scientific methods and results”*²¹

The universities are private foundations within the public administration under supervision of the Minister for Science. The universities agree on three-year development contracts with the Minister for Science concerning the universities activities. These development contracts lay down terms regarding the individual university's direct cooperation with the business enterprise sector. However, the development contracts have not built-in mechanisms for sanctions, and any potential missing fulfilment of the result contracts has therefore no economical consequences for the universities directly.

However, the universities do contribute directly with knowledge to the business enterprise sector through, among other things, income covered activities and the university employees' private consultancy work. Throughout the last couple of years the universities have to an increasing extent worked strategically with business enterprise cooperation and established separate units with responsibility for research and business enterprise cooperation.²² The direct cooperation between the universities and the business enterprise sector is described thoroughly in chapter 7.4 of this report.

In recent years the universities have been influenced by two noteworthy reforms: the passing of a new university Act (2003), which introduced boards with external majority, and mergers between universities and sector research institutes (2007). The passing of Law of technology transfer etc at public research institutions in 2004 (the Tech-Trans Law) meant furthermore that the universities now are able to found companies with the aim to encourage the circulation of new knowledge and technology between public research institutions and the business enterprise sector, hereunder the establishment of new research based companies, and to support the cooperation between public research institutions and funds and societies²³. The Technical University of Denmark has now a number of companies: Bioneer (GTS), DFM (GTS), Dianova, DTU Innovation and Scion DTU²⁴.

21 Departamental order on law on universities (universitetsloven), LBK nr 1368 af 07/12/2007

22 See for example <http://www.forskerkontakten.dk/> and <http://www.ku.dk/erhverv/>

23 http://www.dtu.dk/Om_DTU/Organisation/Datterselskaber.aspx

24 Lov om teknologioverførsel m.v. ved offentlige forskningsinstitutioner, LOV nr 483 af 09/06/2004

4.3.2 Approved Technological Service Institutes (GTS)

The GTS institutes are among the actors in the Wheel of knowledge and research that have the most direct contact to the business enterprise sector. The GTS net consists presently of nine Acknowledged Technological Service institutes, and in 2007 they had almost 3,000 employees altogether and an annual turnover of almost 2.5 billion DKK.²⁵ The Danish GTS net consists of the following GTS institutes:

- The Danish Institute of Fire and Security Technology
- Danish Technological Institute
- Danish Fundamental Metrology
- DELTA Danish Electronics, Light & Acoustics
- DHI
- VFORCE Technology
- Bioneer
- AgroTech
- The Alexandra Institute

The GTS institutes must formally function as a link between the research environments and the business enterprise sector in that they collect, build and disseminate knowledge to Danish companies (and to a less extent to public authorities). The cooperation primarily takes place on commercial terms but in addition the GTS institutes form part of a range of non commercial cooperations concerning research and innovation.

The aim is to contribute to a better and more effective knowledge and technology use in companies and hence increase innovation, productivity and growth within the society. An important element in that objective is that the GTS institutes provide a comprehensive technological infrastructure to the companies. This is the case regarding highly advanced accredited equipment for test activities, which is greatly important for a lot of companies' innovation processes. The GTS institutes has a particular aim, which is to develop and provide technological knowledge to small and medium-sized companies which do not have the same possibilities as the larger companies to develop new knowledge themselves. About half of the commercial turnover derives from cooperation with small and medium-sized companies.²⁶

The Minister of Science can, if applied for and if recommended by The Danish Council for Technology and Innovation, approve non-profit private foundations or non-profit limited companies as authorised technological service institutes. The GTS approval is valid for a maximum of three years. The Danish Council for Technology and Innovation enters into result contracts with the

²⁵ Performance Account 2007

²⁶ Performance Account 2007

GTS institutes and co-funds in this connection chosen knowledge development and knowledge dissemination activities that are of general use for the Danish business enterprise sector as well as the society. The result contract funds constitute approximately 10 per cent of the GTS institutes' total turnover.²⁷

The GTS institutes have developed from being predominantly public funded research and testing institutions to being market driven knowledge service companies with a fairly limited public funding²⁸. Concurrently, the number of GTS institutions has decreased from 36 in 1973 to the current nine. As something new the Technology and Innovation Act, which was passed in 2002, opened up for the organisation of the GTS institutes as non-profit limited companies. It is therefore no longer a necessity that the institutes are non-profit private foundations.

4.3.3 Private consultants

The private consultants are themselves a part of the private business enterprise sector and deliver a number of knowledge based products to other business enterprises. The category includes among others consultants from within engineering, IT, marketing and management. A large proportion of these consultants are members of the Danish Industry (DI) knowledge consultants. The knowledge consultants have almost 700 companies as members.²⁹

The DI knowledge consultants have three trade organisations affiliated which represent various parts of the knowledge consultancy segment: The Danish Association of Consulting Engineers, The Danish Management Board and The Association of Market Research Institutes in Denmark.

The Danish Association of Consulting Engineers has 385 companies as members who in total employ more than 20,000 people in Denmark and more than 6,000 people abroad. The trade's turnover in Denmark is more than 9.4 billion DKK. The Danish Association of Consulting Engineers' members cover a broad spectre of consultancy work that spans quality- and risk management, building contractor consultancy, process techniques, design etc. The most considerable market segments for the private consultants are building and design which together amount to 56% of the trade's turnover. Private companies and private customers amount to 54% of the turnover.³⁰

The Danish Management Board (DMB) is a trade organisation for 175 management consultancy companies in Denmark. The members sell consultancy output within IT, HR, strategy, organisation and change management. The trade had in 2006 a total turnover of almost 15 billion DKK. However, this also comprises a large share of consultancy companies who are not members of DMB. It is estimated that there are approximately 7,500 consultancy companies in Denmark.³¹

²⁷ The GTS institutes result contract funds is further disussed in section 6.3.4

²⁸ Regeringens Videnstrategi – viden i vækst, baggrundrapport (p. 25)

²⁹ <http://viden.di.dk/>

³⁰ DI knowledge advisers (2007): FRI's årsberetning 2007

³¹ Dansk Management Råd, Brancheanalyse 2006/2007

The Association of Market Research Institutes in Denmark comprises nine companies as members who among other things undertake different forms of market- and opinion polls and analyses.³²

4.3.4 Sector Research Institutions

The contribution of the sector research institutions to the business enterprise sector takes place indirect via the institutions research as well as direct via the selling of output. The law on sector research institutions maintains that the sector research institutions shall undertake research with the aim to consult, carry out authoritative tasks, carry out developmental work with a clear societal scope and disseminate own research to relevant public and private partners.³³

The law on sector research institutions currently covers four institutions: The Kennedy Centre, The National Research Centre for the Working Environment, The Danish National Centre for Social Research and Statens Serum Institut.³⁴ A number of institutions are not ascribed to the law on sector research institutes but can nevertheless be regarded in line with proper sector research institutions. E.g. this is valid for the Danish Institute for International Studies (DIIS). The sector research's Management College (SEDIRK) has in fact also a far more extended membership than the four 'proper' sector research institutions.³⁵

The sector research institutions deliver to a varied extent output directly to the business enterprise sector. The National Research Council for Welfare draws up statements and evaluations at commercial terms,³⁶ while the Statens Serum Institut – the by far largest sector research institution – sells vaccines etc.³⁷ The objective of the government's globalisation strategy was that the sector research institutions had to be integrated with the universities.³⁸ As a part of the merger in 2006-2007 the majority of the at that time independent sector research institutions therefore got merged with the universities.³⁹

4.3.5 Institutions of higher education of short and medium cycle (Multidisciplinary University Colleges etc.)

The educational institutions for short and medium higher educations provide first and foremost educated manpower to the public and private labour market. The most significant actors compared to the medium higher educations are the eight Multidisciplinary University Colleges as well as the two University Colleges of Engineering which in time shall be part of the structure of the

32 www.fmd.dk

33 The sector research institutions are also given the task of practical issues in conjunction with the tasks mentioned

34 <http://www.ubst.dk/institutioner-og-okonomi/sektorforskning>

35 http://sedirk.dk/om_os/medlemsliste/index.html

36 See e.g. <http://www.sfi.dk/sw8629.asp>

37 <http://aarsrapport.ssi.dk/Beretning/%c3%98komomiske+resultater+i+2007>

38 Regeringens Globaliseringsstrategi – Fremgang, fornyelse og tryghed (s. 65)

39 Videnskabsministeriet: Nyt danmarkskort på universitets- og sektorforskningsområdet (notat af 20. Juni 2006)

Multidisciplinary University Colleges. However, short and medium higher educations are being offered at a long range of institutions, among these the business enterprise academies.

The set goal for the Multidisciplinary University Colleges is to offer and develop higher educations which at an international level comply with the need for qualified labour in the private and public sector⁴⁰. Opposite to the universities the research is not an independent key assignment for the Multidisciplinary University Colleges. However, the Multidisciplinary University Colleges have to secure their knowledge basis by cooperating with relevant research institutions.⁴¹

The Multidisciplinary University Colleges offers also output targeted directly towards the business enterprise sector and public institutions, in the form of courses and other forms for continued- and further training. The cooperation has though a limited role in the strategies of the Multidisciplinary University Colleges.⁴² The present eight Multidisciplinary University Colleges were established 1 January 2008 when the merger took place of the by then 17 Centres for Higher Education (CHE) into larger entities. The aim with the mergers was to strengthen the medium higher educations.

4.3.6 Regional Growth Centres

The hothouses offer free impartial problem delimitations for entrepreneurs and companies and refers hereafter to private consultants and other actors in preparation for the actual problem solving. The regional hothouses, which were founded in 2007, substitute the previous business service centres.

The hothouses cooperate with the local business service which offers basic guidance about establishment and the running of a company. The hothouses are established as occupational funds and have the aim to create one unified entry to all sorts of relevant consultancy for new and smaller companies with ambitions of growth. The hothouses have to challenge the companies and prepare them to look for the competences they do not possess themselves, and which are necessary to create growth. With the companies' concrete and actual needs as a starting point the hothouses shall advise on possibilities and offers. Moreover, they shall refer to private consultants in preparation for the actual problem solving. The ambition is that the business service system appears coherent and unified towards the companies. Moreover, the hothouses have to play an active role in creating an effective and dynamic interaction between public and private consultants. The hothouses have – evidently – composed strategies for the cooperation with the business enterprise sector.⁴³ A hothouse has been established in each of the Danish regions. Along this come a number of satellites in chosen areas. The hothouses are nationally funded in the period

40 See e.g. http://www.ku.dk/kommunikation/pdf/samarbejdsaftale_professionshøjskoler.pdf

41 Lov om professionshøjskoler for videregående uddannelser

42 E.g. <http://ucc.dk/omprofessionshøjskolen/Documents/Strateginotat.pdf> og http://phrh.info/fileadmin/filer/Godkendt_udviklingsplan.pdf

43 E.g. <http://www.startvaekst.dk/vhmidtjylland.dk/strategivhmidt>

from 2007-2010. The total grant is all in all 89.7 million DKK in 2008. The grant is administered by The Danish Enterprise and Construction Authority in the transitional period from 2007-2010, cf. the law on enterprise promotion.⁴⁴

4.3.7 Local Business Development Centres

The key task for the local trade councils is to accommodate the local business community with advice and counselling. At the end of 2007 there was a total of 76 local trade service centres spread out in 5 regions and 85 municipalities.⁴⁵ The local trade councils interact closely with regional hothouses, and often they guide companies in need of specialised counselling to the hothouses.

The local trade councils have an important role in securing a close and personal relation to the business enterprise sector in the locality and in identifying those companies that would be relevant participants in various projects. Besides this, the local trade councils must act as mediators between the knowledge institutions and the companies, e.g. to secure that relevant knowledge from the universities reaches the local business community. Finally, a noteworthy role of the trade councils is to act as project generators whereas the right partners must be brought together, the funding must be secured and the actual application must be written.

4.3.8 Development and science parks, and environments of innovation

Development parks are development environments which actively seek to encourage the business development of companies, and which lets out business premises to completely new companies. The target group of the development parks are entrepreneurs and/or growth oriented companies that struggle to get the growth going. Development parks focus on business development and differ themselves as such from the science parks which primary focus is commercialisation of research results. The first development park in Denmark was established in Silkeborg in 1990. According to The Danish Business Incubation Association there does currently exist more than 50 development parks in Denmark.⁴⁶

It is the key assignment of the science parks to let out facilities to new and innovative companies. Often the science parks work closely with an innovation environment. The goal with the innovation environment agreement is to create and develop more knowledge heavy entrepreneurial companies. The innovation incubators identify and evaluate business proposals with a commercial potential, and help with capital and consultancy to entrepreneurs and new innovative companies. Five of the innovation incubators are located in science parks with a university affiliation. The two other innovation incubators are located

⁴⁴ Lov om Erhvervsfremme (LOV nr. 602 af 24/06/2005)

⁴⁵ Members of Dansk Erhvervsfremme, DEF.

⁴⁶ <http://www.danskeudviklingsparker.dk/> A new evaluation of the development parks puts the number of parks at 16-20. The difference is based on a different delimitation between development parks and office parks (Danske udviklingsparker - Evaluering af danske udviklingsparkeres eksisterende ydelser og deres effekter for iværksættere og mindre virksomheder)

in Taastrup at The Danish Technological Institute and in Herning at the Birk Centerpark respectively. Initially the innovation incubators were established on a trial basis with a budget of 310 million DKK in the years from 1998 to 2000. Due to an evaluation the arrangement was prolonged to 2004 and then again till the end of 2008 – and each of the years with a national budgetary frame of approximately 120 million DKK. The state has over the period from 1998 to 2006 put 1 billion DKK in total into the innovation incubators.

The Science Parks and Innovation Incubators in Denmark (FOIN) comprise all science parks and innovation incubators in Denmark. The membership counts seven science parks and seven innovation incubators.⁴⁷

4.3.9 Vocational Training Centres

The vocational training centres provide adult- and further education to the business enterprise sector. The vocational training centres have a broad and flexible range of business oriented adult- and further education which consists of labour market courses and selected single subject courses from vocational trainings, agricultural educations and basic social- and health educations. In principal there is an open intake at the vocational training centres and it is possible for employee teams with different educational backgrounds to join courses together, e.g. when new technology is introduced or when new routines are implemented in the companies.

The main target group is unskilled and skilled workers. It is with this target group in mind the educations are developed, and it is this target group that can receive adult- and further education remuneration (VEU). The educational institutes determine themselves the number of training places in the labour market courses, although within the activity frameworks which are lawfully appointed by the Danish Ministry of Education.

The vocational training educations are being offered at a wide range of institutions. In 2006 the vocational training educations were offered at 121 institutions, spread out on vocational training centres (6 institutions), technical schools (78 schools), SOSU schools (16 institutions), CVU (5 institutions), private inviting tenders (13 institutions), University law institutions (2 institutions) and one medium higher education institution. The vocational training centres have a close relationship to the parties of the labour market via boards and education committees. Likewise, the strategies, visions etc. of the centres reflect a considerable focus on business related educational activities interacting with the clients.⁴⁸ In 2003 the law regarding the new vocational training centres was passed with effect from 1 January 2004. The purpose of the law was to strengthen the focus of labour market relevant competences, flexibility in the education supply and coherence between education and the individual teacher in his/her job.⁴⁹

⁴⁷ www.forskerparkforeningen.dk

⁴⁸ E.g. <http://www.amu-vest.dk/vis/vision> og <http://www.amu-djursland.dk/html/profil.php>

⁴⁹ Lov om arbejdsmarkedsuddannelser mv. (lov nr 446 af 10/06/2003) og Bekendtgørelse af lov om arbejdsmarkedsuddannelser mv. (LBK nr 190 af 18/03/2008)

4.3.10 University hospitals

The university hospitals primarily supply knowledge to the business enterprise sector through their research and educational activities. Besides research and education clinical activities are a main task for the university hospitals. A major part of the university hospitals' research projects take place in direct cooperation with private companies.⁵⁰ In the Capital Region alone the hospitals has more than 400 agreements of cooperation with the business sector, and the hospitals of the region in this instance therefore plays a major role for biotech and pharma companies in the region, and are also very influential in creating the medico-cluster.⁵¹ At the same time the university hospitals are important actors compared to the overall public research budget (cf. chapter 3.4). The Danish hospitals are formally placed under the Ministry of Health and Prevention. The university hospitals' assignment is, as the name indicates, based on cooperation between hospitals and the faculties of medical science at the universities in Aarhus, Odense and Copenhagen respectively. We will not focus on the university hospitals as an independent actor in the remaining parts of the report.

4.3.11 Public museums and libraries

Public museums as well as libraries have a very limited role as regards developing and delivering knowledge to the business enterprise sector. The public community-, central-, and national libraries serve to encourage information, education, cultural activity and research by providing books etc. to citizens, educational establishments, institutions and the research.⁵² The public museums serve to ensure the Danish cultural and natural heritage, shed light on the cultural, natural and art history, to develop collections and documentation within their field of responsibility, to make collections and documentation public available and to supply the research with collections and documentation as well as to disseminate the knowledge of research results.⁵³

Today there exist more than 300 museums or museum-like institutions of which approximately half are national or state certified (and receive government subsidies of various amounts).⁵⁴ The Danish library system consists of more than 600 libraries of which about 350 are research libraries.⁵⁵ Museums and libraries do generally not have public strategies, action plans or similar ways of cooperation with the business enterprise sector. Because of the limited interaction with the business enterprise sector we will not focus on the role of the museums and libraries in the search and knowledge system in the remainder of the report.

50 Dansk Sundhedsforskning – Status og perspektiver (Ministeriet for Sundhed og Forebyggelse, Sundhedsstyrelsen, Ledelsesforum for Medicinsk Sundhedsforskning og Forsknings- og Innovationsstyrelsen)

51 Region Hovedstaden m.fl. (2008): "Bio-sundhedsklyngen - Klinisk forskning og kliniske forsøg med lægemidler i Danmark: Analyse og anbefaling af indsGTSområder"

52 Lov om biblioteksvirksomhed (Lovbekendtgørelse nr 914 af 20/08/2008)

53 Museumsloven (Lovbekendtgørelse nr 1505 af 14/12/2006)

54 <http://www.kum.dk/sw387.asp>

55 <http://www.kum.dk/sw603.asp>

4.3.12 Public centres of knowledge

The public knowledge centres provide knowledge within a long range of different areas to public authorities, private companies and citizens. The term 'public knowledge centres' covers various things, dependent on in what connection it is used. In this report's R & D statistics the term covers a long range of public institutions and organisations that do not come under the other categories but which nevertheless can be seen as a part of the research and knowledge system. Public knowledge centres are e.g. the Danish Working Environment Authority, The Danish Meteorological Institute and The Danish Language Council.

The public knowledge centres are a very heterogeneous entity which can not be seen directly as a joint group of actors as concerns development and dissemination of knowledge to the business enterprise sector. In the rest of the analysis focus will therefore not be on the public knowledge centres' role in the Wheel of research and knowledge.

4.3.13 The Ministry of Cultures' educational institutions (other institutions of higher education)

The educational institutions under the Danish Ministry of Culture educate candidates for parts of the business development sector and for the public sector, but besides that the institutions have a very limited role in the research and knowledge system compared to the private companies. Examples of the educational institutions of The Danish Ministry of Culture are Aarhus School of Architecture, The Danish Design School and The School of Visual Arts. The purpose of the educational institutions is to educate and research within their subject area (architecture, design, visual arts, preservation, music, movies, theatre, dance as well as library-and information theory).⁵⁶

The educational institutions incur result contracts with the Danish Ministry of Culture. As with the universities the result contracts have not built-in sanctional mechanisms, and the economic incentives for cooperation with the business enterprise sector is therefore as a starting point low. A broad majority of the Danish Parliament stand behind a multiannual agreement regarding the higher educations under the Danish Ministry of Culture for the period 2007-2010. It is clear from the multiannual agreement that the occupation of the fully-fledged must be improved and the development of the educations must take place in cooperation with the business enterprise sector.⁵⁷ However, it should be expected that these educational institutions also in the future will play a relative limited role as concerns the business enterprise sector. Due to limited interaction with the business enterprise sector there will not be focus on the role of these educational institutions in the research and knowledge system in the rest of this report.

⁵⁶ Bekendtgørelse af lov om videregående kunstneriske uddannelsesinstitutioner under Kulturministeriet (LBK nr 889 af 21/09/2000).

⁵⁷ <http://www.kulturministeriet.dk/graphics/kum/downloads/Kulturomraader/uddannelser/Fleraarsaftale%20udd%202007-10/Fleraarsaftale%2018122006.pdf>

5.1 Introduction

By reviewing the cooperation between the actors of the research and knowledge system it is possible to evaluate the research and knowledge sharing and the coherence in the research and knowledge system. While chapter 4 is focussing on the individual actors in the research and knowledge system, chapter 5 will therefore illustrate the relations between the actors in the research and knowledge system. Hence, the analysis in this chapter will be moved to system level where the interaction and the coherence between the elements in the research and knowledge system will be put into focus.

There are many ways to illustrate the cooperation between the actors in the research and knowledge system. There can be distinguished between formal cooperation relations as e.g. binding agreements or common R & D projects, or informal cooperation relations as e.g. informal networks, participation in conferences etc. In this chapter we will primarily focus on formal cooperation relations between the actors in the research and knowledge system.

The chapter's source material is first and foremost based on a questionnaire among almost 300 central decision makers in the research and knowledge system which has been conducted as part of this mapping. The survey population has been chosen in cooperation with a number of business organisations and interest groups and consists of both public and private actors. The survey population covers the following public sector actors: Universities, sector specific research institutions, higher education institutions, vocational training centres, other educational institutions, regional growth centres, communal business development centres, research- and science parks. Within the private sector, the survey population covers technical advisors, as well as management consultants.

Besides that, the mapping includes data from the research statistics concerning interaction among R & D active public actors. Furthermore, the analysis is founded on a mapping of the participating actors from within a large segment of central research and innovation programs.

An important result of the analysis is that there exists a large cooperation between the actors in the research and knowledge system. The universities are among the most cooperating actors in the research and knowledge system, which of course also is due to the size of the universities. Simultaneously, the universities are the most dominant partners in central national and regional research and innovation projects, e.g. strategic research, innovation consortiums, projects funded by The Danish National Advanced Technology and the 6th framework programme of the EU. The GTS institutes participation is higher in consortia of innovation than in other central research and innovation programs. The GTS institutes' participation is for example lower in programs such as strategic research, user-driven innovation, and in the regional program funds. Particularly when it comes to participation in R & D within the EU the GTS institutes are not prominent even though the gathering of knowledge from international research environments is a sizeable assignment for the GTS net.

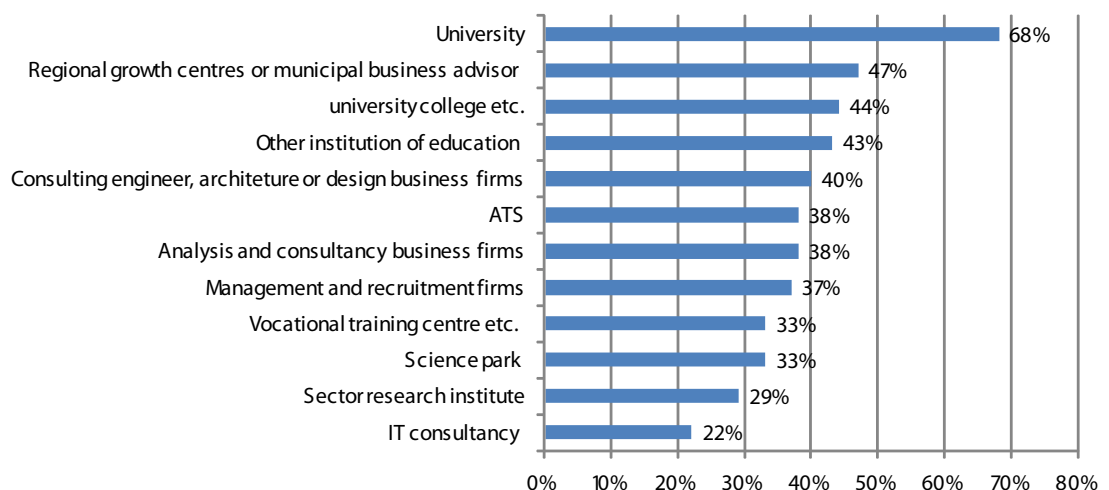
5.2 The interaction between actors in the knowledge system

There does not exist a complete overlook of the interaction between the actors in the research and knowledge system today. Hence, as a part of this mapping there has been conducted a questionnaire among a large part of the actors in the research and knowledge system. Almost 300 central decision makers in the research and knowledge system participated in the investigation (see chapter 7 for a further presentation of the investigation).

The participants in the questionnaire were asked which central collaborators their organisation has had within the last 2 years in connection to development, production or providing knowledge output. Figure 5.1 presents the results of this question. The numbers show that there overall is a broad interaction among the different actors in the research and knowledge system.

Meanwhile, there are some actors who are particularly central in the research and knowledge system. 68 per cent of the respondents point at the universities as a central collaborator while 47 per cent point at regional enterprise promotion actors. 44 per cent point at the multidisciplinary university colleges and 38 per cent point at the GTS institutes. Likewise, a large number of respondents point at private consultants (40 per cent), consultancies (38 per cent) and management consultants (37%) as being central collaborators.

Figure 5.1: The interaction between chosen actors in the knowledge system



Source: DAMVAD. Mapping of the Danish knowledge system, 2008

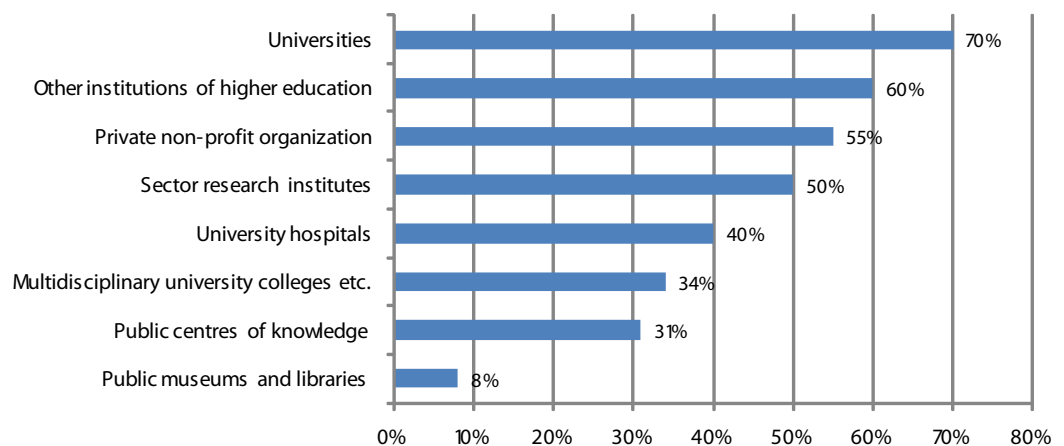
5.3 Interaction on research and development

Whereas the questionnaire among the actors in the research and knowledge system have focus on the actors' internal interaction regarding development and delivery of output, the focus in the following will be on the interaction concerning R & D. Focus will in this connection be at public actors in the research and knowledge system. Collaboration regarding R & D activities is especially relevant in a mapping as we are talking about a very knowledge intensive collaboration between the actors in the research and knowledge system. The data presented from the research statistics includes almost 700 R & D units (i.e. institutes, centres and departments).

Figure 5.2 shows how big a proportion of the public R & D units that have had formalised interaction regarding R & D activities with private companies. A relatively large proportion of the research units at the universities (70 per cent) have had interaction with private companies concerning R & D. Among the other long-cycled higher education institutions, the non-trading organisations and the sector research institutes, it is also at least 50 per cent of the units which have had R & D interaction with private companies. The share is somewhat lower among university hospitals, multidisciplinary university colleges and public knowledge centres where 31 per cent and 40 per cent have had R & D interaction with private companies. The public museums and libraries clearly have the most limited interaction with the business enterprise sector. Only eight per cent of the research units within this group have had interaction with private companies regarding R & D.

In interpreting these figures it is of course important to be alert to the fact that the size of the R & D units varies significantly among the different actors. As could be seen in chapter 3.4 the units of the universities and the sector research institutes are for example far bigger than the units at university hospitals and multidisciplinary university colleges.

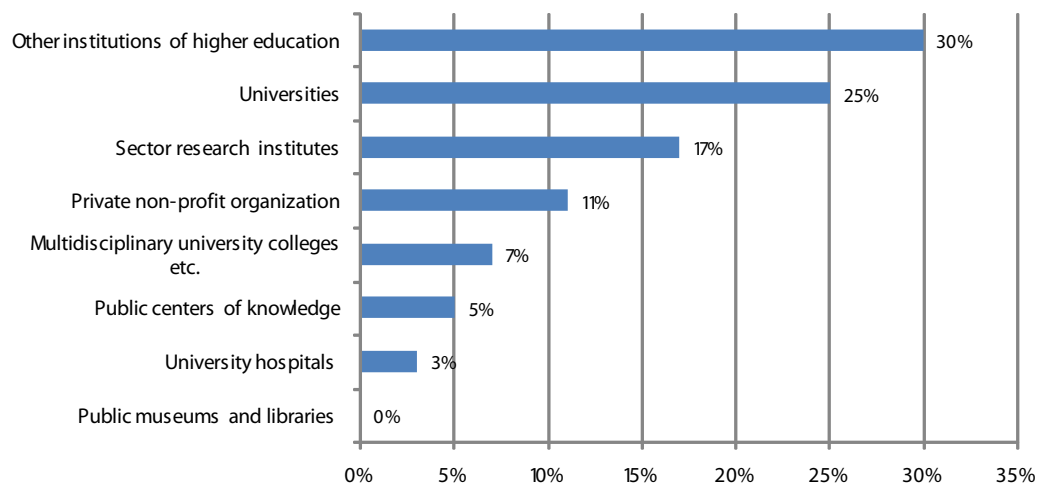
Figure 5.2: Public R & D units' interaction on R & D, 2005



Source: DAMVAD, Mapping of the Danish knowledge system, Customized data, CFA, Forskningsstatistik, 2005

It appears from the below figure 5.3 that a relatively small share of the public R & D unit have had interaction with the GTS institutes. The share is highest among other long-cycled higher education institutions (institutions under the Danish Ministry of Culture) where 30 per cent of the units have had interaction with GTS institutes. Nonetheless, this number has to be looked at with the proviso that the statistics for this group is based on only 10 long-cycled higher education institutions. Among universities 25% of the units have interaction regarding R & D with the GTS institutes. The share is somewhat lower for the other actors, and among the public museums and libraries there is no interaction at all with the GTS institutes.

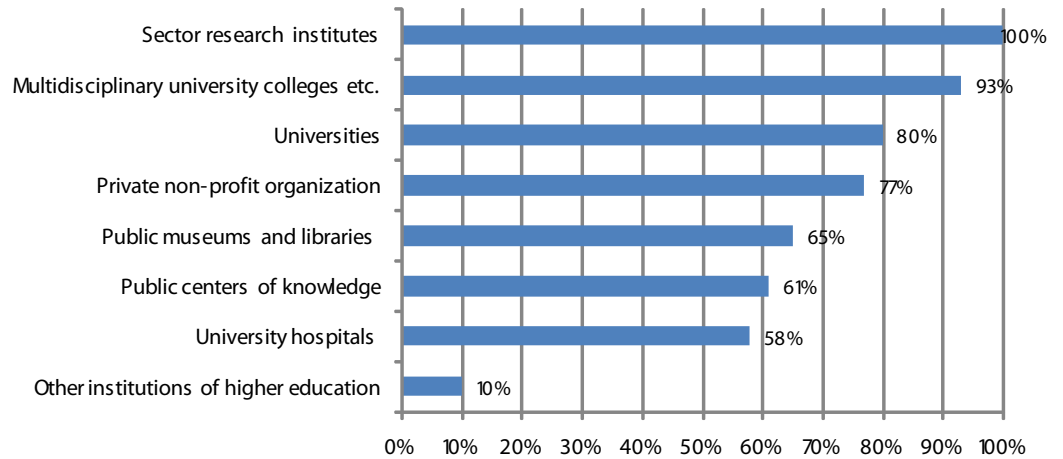
Figure 5.3 Public R & D units' interaction with ATS Institutes on R & D, 2005



Source: DAMVAD, Mapping of the Danish knowledge system. Customized data, CFA, Forskningsstatistik, 2005

The cooperation between higher education institutions as regards R & D is handled by a spectre of public actors, cf. figure 5.4. All sector research institutions have had interaction with higher education institutions. The multidisciplinary university colleges and the universities have also, not surprisingly, many units that have had interaction with higher education institutions. Disregarding the other long-cycled higher education institutions it turns out that over half of the R & D environments within all groups have had interaction with higher education institutions regarding R & D.

Figure 5.4: Public R & D units' interaction with other R & D units, 2005

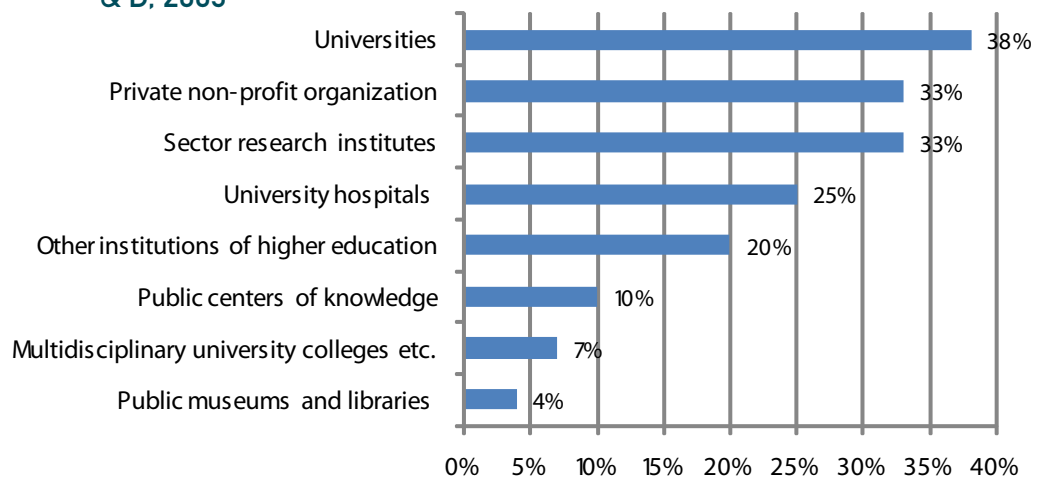


Source: DAMVAD, Mapping of the Danish knowledge system, 2008; Customized data from CFA

5.3.1 International interaction on research and development

The public R & D units have also to a certain extent formalised R & D interaction with foreign actors. Yet, interaction with foreign actors is less common as opposed to interaction with corresponding Danish actors. The below figure 5.5 shows in this way that 38 per cent of the units at the universities have interaction concerning R & D with foreign companies. The same applies to 33 per cent of the private non-business operated institutions and the sector research institutes. It is not surprising that it is the public museums and libraries which have the most limited interaction with foreign companies (4 per cent).

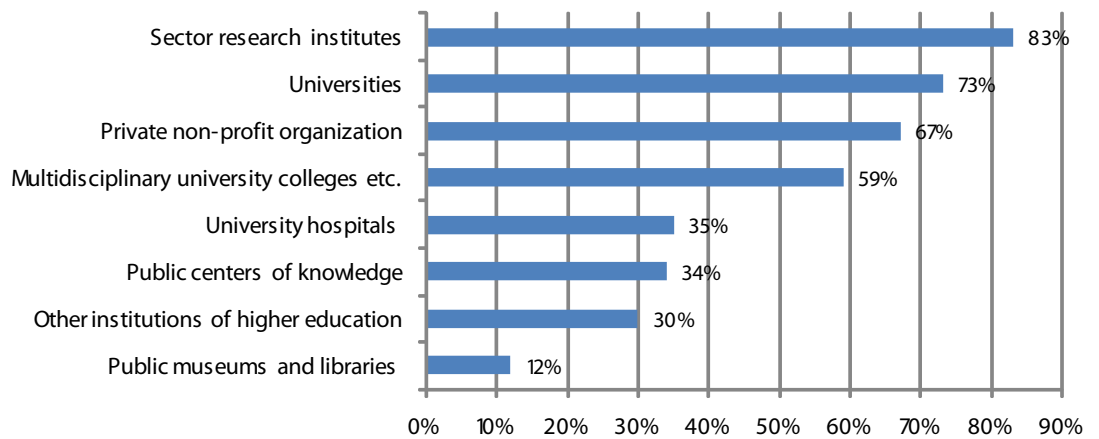
Figure 5.5: Public R & D units' interaction with foreign companies on R & D, 2005



Source: DAMVAD, Mapping of the Danish knowledge system, 2008; Customized data, CFA, Forskningsstatistik, 2005

Figure 5.6 provides an overview of the public R & D units' interaction with foreign higher education institutions. The cooperation with foreign higher education institutions is far higher than it is for foreign companies. On the national level the units of the sector research institutions are remarkably well represented within the international interaction (83 per cent) and so are the units of the universities (73 per cent). The units of the multidisciplinary university colleges do also to a high degree cooperate with foreign higher education institutions (59 per cent) while the extent of cooperation is more modest when looking at university hospitals (35 per cent) and public knowledge centres (34 per cent).

Figure 5.6: Public sector interaction with foreign institutions of higher education on R & D, 2005



Source: DAMVAD, Mapping of the Danish knowledge system, 2008; Customized data, CFA, Forskningsstatistik, 2005.

5.4 Interaction in research and development projects

With reference to illustrate the interaction in the research and knowledge system even better; DAMVAD has undertaken a momentous mapping of the knowledge institutions' participation in innovation networks – and projects. The analysis is based on a manual counting of the various actors' participation in:

- National innovation projects (primarily DCTI funds)
- Regional innovation project (Regional growth forums)
- International innovation projects (the 6th framework program of the EU)

Data has been collected from national and regional innovation projects from 2003-2007. For the international subject a reading of the 6th framework program of the EU, which is valid from 2002-2006, has been undertaken. On aggregate, more than 1,400 projects have been analysed which includes more than 3,200 Danish project participants. We are in this case talking about a huge set of data material, and the investigation's results can therefore be considered as well founded and very relevant for Danish innovation policy.

Research- and innovation programs are an important funding source within Danish research and funding as they constitute a significant supplement to other funding sources like e.g. basis funds at universities and result contract funds at GTS institutes. The programs are at the same time important elements in the interaction between knowledge institutions and the business enterprise sector, and besides that they show something about the interaction that is taking place among the knowledge institutions themselves. In box 5.1 a description of various research and innovation programs can be seen.

Box 5.1: Description of different research and innovation programs

National research and innovation programs:

Innovation consortia. Innovation consortia are concrete cooperation projects between business firms, research institutions and technological service institutes that usually last from two to four years. The parties cooperate on research and development projects, with the object of developing new knowledge or technology, which not only is beneficial to the company, but also entire lines of businesses within the Danish business enterprise sector.

Danish National Advanced Technology Foundation. The foundation offer business firms and universities risk capital and frames for undertaking research and development project, where business potential and high technology are combined. The purpose is to create value for Denmark by investing in markedly high technological initiatives that unites businesses and public research institutions. Since 2005 the Foundation has invested in 60 high technological projects and platforms with a total budget of 1.6 billion DKK. The Foundation covers up to half of the project expenses and has granted a total of 807 mill. DKK. Current high technological projects are positioned within energy/environment, bio/medico, information/communication, construction, foods and manufacturing.

The Danish Council for Strategic Research. The Danish Council for Strategic Research provides funding for research and consults within politically prioritized and thematic limited research areas. The object is to secure the competitiveness of Denmark internationally and contribute in solving substantial societal problems. This is done through research and development projects, which includes both private and public institution. The Danish Council for Strategic Research granted in 2006 approximately 440 mill. DKK to strategic research and in 2007 and 2008 approximately 700 mill. DKK.

User-driven innovation. The purpose of The Danish Enterprise and Construction Authority's program for user-driven innovation is to strengthen the development of new products, services, concepts and processes in businesses and public institutions based on an improved knowledge of client and user needs. The program has a yearly budget of 100 mill. DKK in a four year period aimed at projects in businesses and public institutions. The program supports research and development projects within four focus areas: The strategic area, the regional area, employee-driven innovation and other areas deemed as having perspective.

Regional growth forums. The regional growth forums' object is to strengthen the regional business development by securing a coordinated business promotion effort. This is done by formulating regional growth development strategies and commence initiatives that determine the strategies. The initiatives are very different e.g. as research and development projects, and network projects. The six regional growth forums has in 2007 initiated more than 280 initiatives, which contain investment of more than 1.2 billion DKK over a number of years for regional business development. For innovation the investment has been 319 mio. DKK, which is 25.9 per cent of the total investment.

International research and innovation programs:

FP6 – The Sixth Framework Programme. The EU's Framework Programme for Research and Technological Development. EU's Framework Programme is EU's support to transnational research and development activities. The Sixth Framework Programme runs from 2002 to 2006 and has a total budget of 19.113 mill. euro. The framework programme has two main objectives: First to strengthen the scientific and technological base of the EU industry, secondly to strengthen EU's international competitiveness by promoting research activities that support other EU policies. To promote these goals the programme operates with three types of means: Integrated Projects and Specific Targeted Research Projects, Networks of Excellence, and Coordination Actions, and Specific Support Actions. The Sixth Framework programme focuses on a number of thematic priorities, e.g. technologies in the information society and food controls and security.

5.4.1 National projects of interaction

When it comes to national innovation programs the investigation places focus on the larger pools as well as general national pools which are not sector oriented. It applies for The Danish National Advanced Technology, The Danish Council for Strategic Research and The Innovation consortiums as well as the program for User driven Innovation. However, there exists also other national innovation programs under DCTI, e.g. advanced technological networks but these are not included in the investigation as it focuses on direct development activity and not on networks as such.

Table 5.1: National business oriented pools for innovation, 2007

Ministry	Pool	mill. DKK
The Ministry of Science, Technology and Innovation	Danish National Advanced Technology Foundation	273.9
	Strategic Research	644.9
	Innovation Consortia	130.6
The Ministry of Economic and Business Affairs	Program for User-driven Innovation	92
	Reserve for entrepreneur and innovation activities	35.8
	Innovation and productivity in construction	4.7
Ministry of Transport and Energy	Grants to research in energy	68.4
Ministry of the Environment	Action Plan for eco-efficient technology	35.6
Ministry of Food, Agriculture and Fisheries	Innovation and development in primarily agriculture	25.0
	Innovation and development in the processing sector	30.0
	Innovation, research and development in the agriculture and fisheries sector	125.4
Total		1466.3

Source: The Danish Agency for Science, Technology, and Innovation

For each of the four chosen pools an investigation has been undertaken concerning which actors participate in the individual innovation projects that has been granted money from the pools, cf. table 5.2. The investigation of the national innovation programs is based on a total of 220 national cooperation projects with participation of 1,217 actors. Of these the GTS institutes participate in 63 projects. This equals that there is an GTS participation of 29 per cent in all national projects with Danish participation.

The following main results of the mapping can be pointed out:

Firstly, there are many different types of actors represented in the national innovation projects. It is therefore representatives from both the more research

heavy parts of the research and knowledge system, in the form of higher education institutions and sector research institutions, and from the more market- and interest based parts of the research and knowledge system in the form of GTS institutes, other public institutions and organisations. Thus, the projects are creating a framework for many forms for cooperation across the research and knowledge system.

Secondly, it is interesting to see that there within all pools are a clear predominance of actors from higher education institutions (primarily universities) and companies. The high participation of the universities can be explained by the fact that they generally are dominating within Danish research as they constitute 75 per cent of the total public research. The high participation of the companies can be explained by the fact that all four national pools which are mentioned in the investigation are business oriented schemes.

Thirdly, it is interesting to see that the GTS institutes are not as dominating within the projects as the universities and the companies. The GTS institutes participates thus in 4 per cent of the the programmes for User driven innovation and 9 per cent of the projects in strategic research and The Danish National Advanced Technology. However, the GTS institutes' participation in Innovation consortiums are somewhat higher (93 percent) than the other programs which is connected to the scheme being traditionally affiliated to the GTS net. At the same time the individual GTS institutes often use the scheme as a supplement to the result contract funding they receive from the DCTI.

Table 5.2: Participation in national projects of innovation

Type of actor	Number of projects (share)			
	User-driven innovation (n=38)	Innovation Consortia (n=55)	The Danish Council for Strategic Research (n=67)	Danish National Advanced Technology Foundation (n=60)
Institutions of higher education	22 (58 %)	55 (100 %)	51 (76 %)	52 (87 %)
Sector research	0 (0 %)	7 (13 %)	21 (31 %)	6 (10 %)
GTS	2 (5 %)	51 (93 %)	6 (9 %)	4 (7 %)
Other public	12 (32 %)	2 (4 %)	9 (13 %)	5 (8 %)
Private businesses	35 (92 %)	55 (100 %)	41 (61 %)	57 (95 %)
Organizations	8 (21 %)	4 (7 %)	8 (12 %)	5 (8 %)

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

5.4.2 Regional projects of interaction

On a regional as well as on a national level significant amounts for interaction projects are being spend. Regional funds are implemented by The Regional Growth forums in connection with regional growth strategies. It is interesting to focus on these funds and their use as they represent a comprehensible funding source for business development and innovation as a supplement to national funds. The regional growth forums invest as such in 2007 more than 1.2 billion DKK in over 280 concrete business development initiatives. The funding of the many business development initiatives is procured by the regions' own funds for regional business development as well as EU's Structural Funds (the Regional fund and the Social fund). Adding to this is co-funding from the participating parties themselves.

In the mapping focus has been placed on the share of the funds which are financed by the EU's Structural Funds. Table 5.3 shows that the annual grants from the EU's Structural Funds for the Regional Growth forums amount to more than a third of the regional growth forums' total 2007 investments. The EU's current Structural Funds program covers the period 2007-2013. Through out the entire period of the program Denmark is being allotted almost 3.7 billion DKK which amounts to 512 million DKK annually.

Table 5.3: Yearly grants from the EU Structural Funds to the Regional Growth Centres compared to the Regional Growth Centres total investments in 2007

Funds (mill. DKK)	The North Denmark Region	Central Denmark Region	Region of Southern Denmark	Region Sealand	Capital region of Denmark	Born-holm	Total
Total EU funding	112	72	102	72	70	15	443
- The Regional Foundation	56	36	51	36	35	7,5	221,5
- The Social Foundation	56	36	51	36	35	7,5	221,5
Regional Growth Centres	260,6	385,7	137,0	160,6	270,6	19,2	1.233,6

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

The mapping of which actors participate in the individual regional innovation projects shows that funding has been given to 96 regional projects with 356 participating actors. The GTS institutes participate in 11 of the projects which equals approximately 11 per cent of all projects.

The mapping also shows that there, just like with the national programs, is participation of many types of actors in the regional projects, cf. table 5.4. The higher education participates in more than half (55 per cent) of the projects. The GTS institutes participate in 13 per cent of project. The companies are not as active in the regional projects as in the national and they participate in 50 per cent of all projects. It is interesting that the interest groups participate in 22 per cent of the regional projects which is remarkably higher than in the national projects.

Table 5.4: Participation in regional innovation projects

Type of actor	Number of projects
Institution of higher education	53 (55 pct.)
Sector research	1 (1 pct.)
GTS	12 (13 pct.)
Other public	52 (54 pct.)
Private businesses	48 (50 pct.)
Interest organizations	38 (40 pct.)

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

5.4.3 International projects of innovation

On an international level funds for interaction projects are granted, just as on a national and regional level. The EU's framework programs for research and technological development are on this occasion centrally placed as they are an important source for new and better knowledge as well as international networks for Danish companies and research institutions. The framework programs are therefore significant for the evaluation of the Danish actors' participation in international research, and they constitute as such the foundation for the investigation's counting of the Danish actors in international projects. More specifically focus is placed on the EU's 6th framework program which is valid from 2002 to 2006. It has been chosen over the EU's 7th framework program because the 6th framework program currently has been terminated, which permits an overall evaluation. The 6th framework program has a total budget of 19,113 million EUR, and it is thus substantial research funds the actors in the Danish research and knowledge system are able to get hold of.

It is important to stress that Danish research institutions, authorities, organisations and companies also have the possibility to participate in a long range of other international research and innovation programs. This could be EUREKA, ESA and The Nordic Council of Ministers to mention a few. These programs are in the meantime not included in this investigation.

The Danish Agency for Science, Technology and Innovation has made an overall summary of the Danish participation in EU's 6th framework program, cf. table 5.5. Measured on the absolute subsidy Denmark is well ranked, namely as

number 12 regarding countries which receive most support from the framework program. The table also shows that Denmark has experienced a decreasing participation from the EU's 4th framework program to the 6th framework program when looking at the number of projects with at least one Danish partner, Danish coordinator and the share of money Denmark is granted.

Table 5.5 Assessment of Denmark's participation in EU's Sixth Framework Programme

	All projects	Projects with minimum one Danish party	Danish coordinators	Budget (Mill. EUR)	Danish share (pct.)
FP4 (1995-1998)	15.545	1.587	458	13.215	3.10
FP5 (1999-2002)	16.889	1.606	414	14.960	2.67
FP6 (2003-2006)	10.091	1.123	210	19.113	2.38

Source: The Danish Agency for Science, Technology, and Innovation: "Tal om Danmarks deltagelse i EU's 6. Rammeprogram for forskning og teknisk udvikling."

This mapping illustrates more in-depth the Danish participation because a more detailed view is taken on the individual participants in the various projects under EU's 6th framework program. It therefore gives a more balanced statement of Danish participation in the framework program. The investigation is based on a total of 1,141 projects with Danish participation⁵⁸. There is participation by GTS institutes in 38 of the projects with Danish participation which accounts for 2 per cent of the projects with Danish participation.

Figure 5.6 shows the share of the Danish participation in projects under EU's 6th framework program. It is distinctive for the Danish participation that the participating actors consist of many different types of actors. This can be explained with the framework program being organised in order to secure latitude by applying a range of different means which aim at various types of actors.

As regards the Danish allocation of actors in the EU's 6th framework program, the same tendency is seen as for national interaction programs. Higher education institutions and companies participate in 54 per cent and 29 per cent of the projects while the sector research institutions, other public institutions as well as societies and organisations all participate in between 6 and 17 per cent of the projects. The GTS institutes only participate in 3 per cent of the projects. Though a major assignment for the GTS institutes is to ensure knowledge from abroad to the Danish industry, e.g. through participation in international

⁵⁸ This number is slightly higher than the tally from Danish Agency for Science, Technology and Innovation. This could be due to the fact that more projects have been added at a later date.

R & D projects⁵⁹, it is remarkable that the GTS net does not have a stronger participation in the EU's framework program.

Table 5.6: Participation in innovation projects withing EU's Sixth Framework Programme

Type of actor	Number of projects (share)
Institution of higher education	620 (54 pct.)
Sector research	199 (17 pct.)
GTS	38 (3 pct.)
Other public	138 (12 pct.)
Private businesses	331 (29 pct.)
Associations and organizations	72 (6 pct.)

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

In connection with the mapping of the Danish participation in projects under the EU's 6th framework program it is interesting to look at the number of projects with Danish participation in which a Danish actor is coordinator. The project coordinators are appointed by the other project participants and have enlarged areas of responsibility, e.g. in distributing funds to the other participant and report to the Commission. It is as such the coordinator who has the broad overview and the managing function in the projects.

This investigation shows that a Danish actor is coordinating 19 per cent of the projects with Danish participation. Table 5.7 shows the Danish distribution of actors compared to project coordinators. It is by far the higher education institutions that take on the responsibility as project coordinators as these comprise more than half of the all Danish project coordinators. The sector research institutions comprise the second largest group of 18 per cent of the Danish project coordinators. The research oriented part of the Danish research and knowledge system, consisting of higher education institutions and sector research institutions, is therefore in total accounting for as much as 73 per cent of the Danish project coordinators. For a comparison the companies make up 16 per cent of the Danish coordinators while other public actors and societies and organisations make up 7 per cent and 2 per cent respectively of the Danish coordinators. The GTS institutes comprise the smallest part of the project coordinators with only 1 per cent.

⁵⁹ See The Danish Agency for Science, Technology, and Innovation, "InnovationDenmark 2008 – The Danish Council for Technology and Innovation's Action Plan", 2008

Table 5.7: Project coordination distributed on type of actor

Type of actor	Number of project coordinators	Share of project coordinators
Institution of higher education	117	55 %
Sector research	38	18 %
GTS	3	1 %
Other public	15	7 %
Private businesses	34	16 %
Associations and organizations	5	2 %
Total for all actors	212	100 %

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

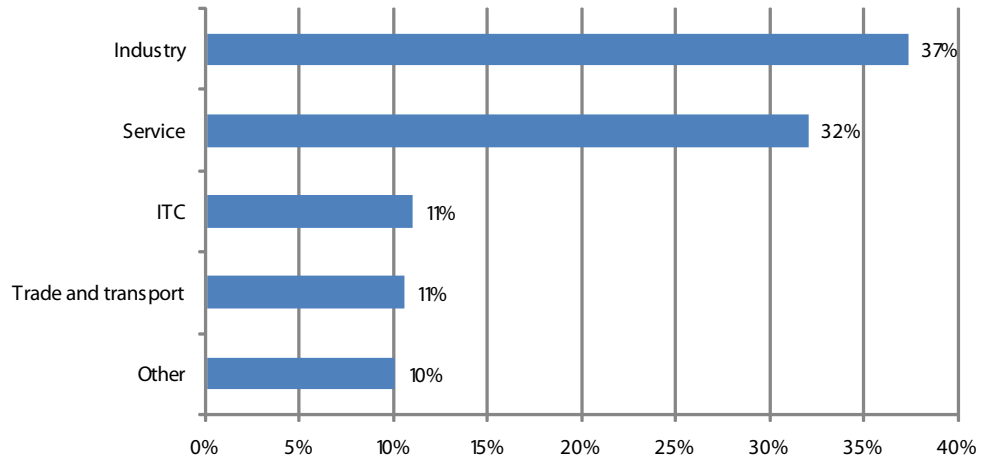
There can be major advantages in that more of the Danish actors are coordinators for the research projects in the EU's framework program. Danish scientists, who are coordinators for EU projects, have good possibilities to influence the content of future calls, e.g. through their project officers or at meetings in Brussels with the Commission to which the project coordinators often are invited.⁶⁰ A job as coordinator can therefore contribute to getting the most possible from the participation in the EU's framework program.

5.4.4 Distribution on lines of business, size of business and geography

It is interesting to look at the division upon trade, size of companies and geography in connection with the private participants in the investigation as it provides an insight of where an extra effort to strengthen Danish innovation can be done. Figure 5.7 shows the division upon trade for the private participants in all of the investigation's innovation programs. It can be seen that there are especially many participants from the industry but also a big share from the service industries. Together these two industries accounts for almost 70 per cent of all actors in as the industry accounts for 37 per cent of the actor and the service industries accounts for 32 per cent. IKT, Trade and transport and other industries account each for 10-11 per cent of the private actors.

⁶⁰ Arne Jensen, "Hvorledes sikres, at dansk fødevarerforskning opnår en større andel af forskningsmidlerne i EU's rammeprogrammer?", Syddansk Universitet.

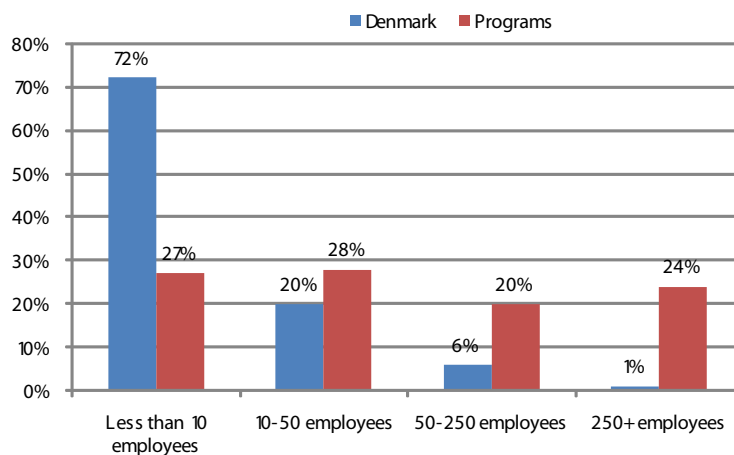
Figure 5.7: Distribution of participants in innovation programs, lines of business



Source: DAMVAD, Mapping of the Danish knowledge system, 2008

Figure 5.8 shows the allocation of private participant in the innovation programs compared to company size. The numbers clearly show that it is not only large companies that take part in innovation programs. As can be seen from the figure, 55 per cent of the participants are hence smaller companies with less than 50 employees. Compared to the overall company structure in Denmark, the medium size and large companies are over represented in the innovation programs. While only 7 per cent of the companies in Denmark have more than 50 employees, these companies account for 44 per cent of the participating companies in the innovation programs.

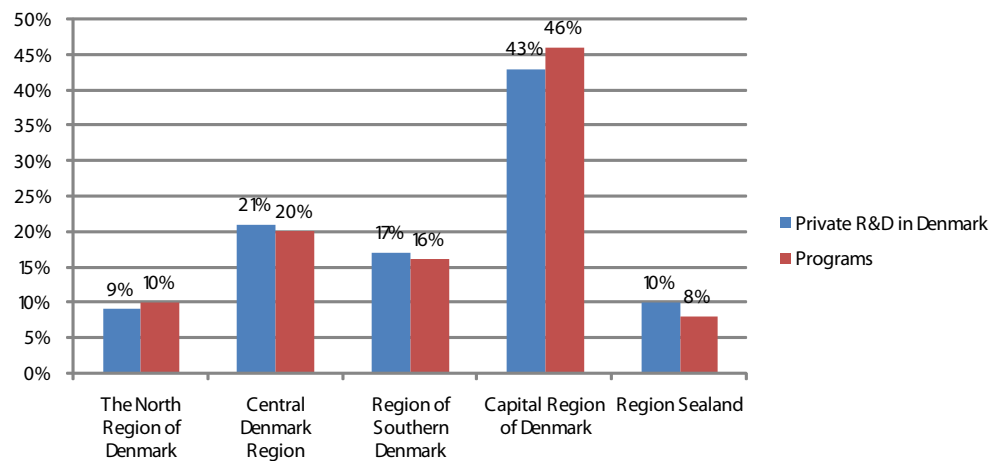
Figure 5.8: Distribution of participants in innovation programs on sizes of business



Source: DAMVAD, Mapping of the Danish knowledge system, 2008.

Figure 5.9 shows the allocation of private participants in the innovation programs compared to regions. Companies from all regions in Denmark participate but there is an excess of participants from the Capital Region of Denmark in as 46 per cent of the participants are from that area. The other regions all comprise a significant lower share of companies in as Central Denmark Region accounts for 20 per cent of the companies, South Region Denmark accounts for 16 per cent, North Region Denmark accounts for 10 per cent and Region Sealand accounts for 8 per cent. The geographical distribution of the participant in the innovation programs correspond well with the geographical distribution for the participants of private R & D in Denmark as 43 per cent of the participants within private R & D derives from the Capital Region of Denmark while the other regions account for between 9 and 21 per cent.

Figure 5.9: Distribution of participants in innovation programs, regional



Source: DAMVAD, Mapping of the Danish knowledge system, 2008; CFA, Forskningsstatistikken for den private sektor, 2005.

6.1 Introduction

Even though the individual GTS institutes are subject to a common regulatory requirement and form part of a 'net' (the GTS net), the institutes are mutually very heterogeneous. This concerns size, organisation and research effort. The basis for the chapter is a historical retrospect of the development of the GTS net. It will be outlined that two basic tracks are identifiable in the historical anchorings of the GTS net; the technological and research based track and the trade oriented track. These tracks have an enormous importance for the close relations to the research world and to the actors of the business enterprise sector, which the GTS net has currently.

In this chapter we will besides that look closer at the roles and tasks of the GTS net within the research and knowledge system. The chapter focuses on the GTS institutes economy, management and clientele. Furthermore, focus will be on the GTS net's national and international interaction, participation in councils and committees as well as the course- and mediation activities of the GTS net. Finally, the chapter takes an in-depth look at the mapping of the GTS net's broad range of consultancy services and activities.

If looking at the development of the GTS net through out the last 10 years, the general picture is that while the net on one hand has experienced an increasing turnover, it has on the other hand experienced a decrease in central activities within competence building and the dissemination of knowledge. It has happened at the same time as several parts of the research and knowledge system have seen increased activity and increased usage of resources. The documentation throughout the chapter is besides a desk research concerning material about the GTS institutes also an extensive questionnaire among approximately 300 of the GTS nets consultants. Moreover, the chapter is founded on statistical data from the GTS net's performance account.

6.2 The historical context of the GTS net

6.2.1 The dynamics of the GTS net – from 34 to 9 institutions

A closer analysis of the GTS net requires an understanding of the historical background and development of the net. In following there both be focus on the institutes' history and the GTS net's history. Generally it can be said that the institutes' history is much older than the GTS net's history itself, but in line with the system being law regulated and being co-financed by basic- or contract funds from the state, the GTS net as we know it today starts to take shape.⁶¹ The GTS institutes' historic anchoring can be divided into three categories:

- Trade anchored institutes, e.g. Technological Institutes
- ATV institutes, e.g. Force, Delta and DHI.
- Other institutes, e.g. The Danish Fundamental Metrology as well as newer institutes, e.g. The Alexandra Institute and Agrotech

⁶¹ Institutrådet (1996): "Teknologisk Service: Tendenser og udfordringer – En diskussion af GTS-institutternes værdi for Danmark"

The trade oriented institutes are rooted in service- and educational activities initiated and financed by the trade organisations, the house owner associations and the industries in the beginning of the century. E.g. The Danish Technological Institute was established in 1906 in connection with the founding of The Confederation of Danish Employers and The Confederation of Danish Industry (formerly known as Industrirådet). Back then the institutes mainly took care of the educational activities regarding the business enterprise sector which in time has been taken over by the technical schools. Other institutes were established in order to handle the standardization work in connection to The Danish Society of Engineers and Industrirådet. The trade oriented institutes' focus on trade specific needs for knowledge has through out time to an increasing extent been supplemented with generic specific technological competences. In that way it has been possible to develop a broad interface to especially small and medium-sized companies.

The ATV institutes are born as research and technology driven organisations. It comprises e.g. the institutes Force, Delta and DHI. The Danish Academy of Technological Sciences (ATV) was established in 1937 with the aim to encourage the technical-scientific research and the usage of its results to benefit the Danish business enterprise sector. The institutes' originally and primary funding source was by self-earning via ordered assignments and subsidies from private and public funds. A number of institutions are established in very close connection to The Technical University of Denmark (DTU), and some of them were physically located at DTU. The institutes were back then not only established in order to secure technological transfer but in several cases it was about strengthening the university resource-wise in selected areas.⁶²

The remainder of the institutes consist of national established institutes like e.g. The Danish Fundamental Metrology (the only one which today was established by the state) and more recent institutes as e.g. The Alexandra Institute and Agrotech. Interesting institutes which previously have been part of the GTS net are The Danish Design Centre and Institute for Service developments (ISU) which both are characterized by being very targeted at the service field. Both institutions work today as independent actors but are no longer a part of the GTS net.

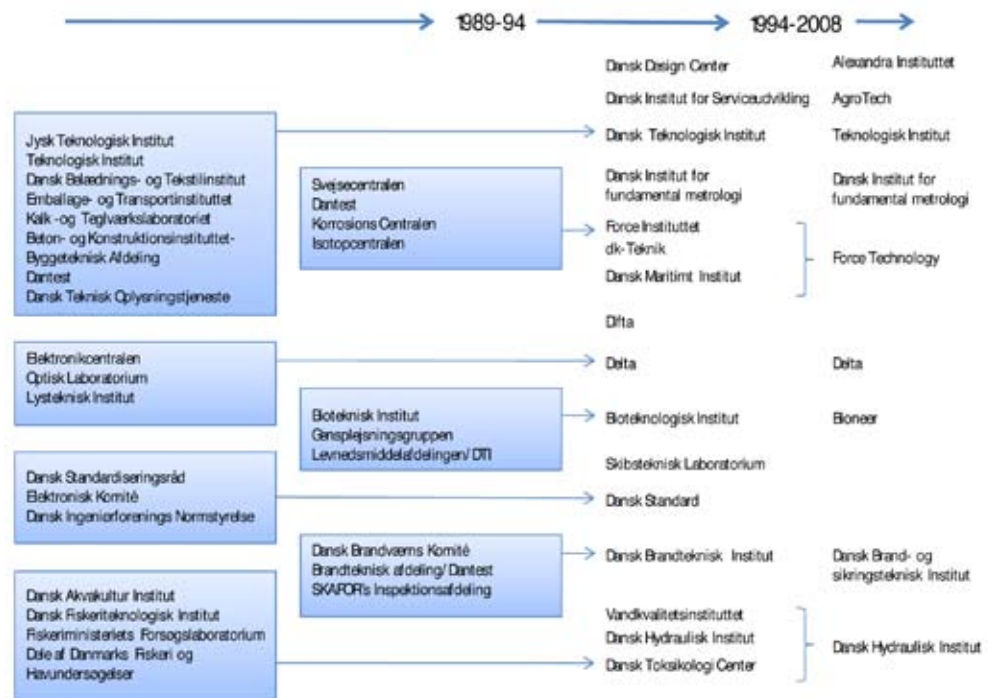
Through the GTS net's history extensive organizational changes and change of names have taken place via mergers, new establishments, bankruptcies and abolishment's of institutes. In the 1980's there were more than 30 institutes and since then there have been several structural changes which aimed at reducing the number of GTS institutes.⁶³ The structural changes which in time have taken place in the GTS net tells something about the dynamics and adaptability of the

⁶² Institutrådet (1996): "Teknologisk Service: Tendenser og udfordringer – En diskussion af GTS-institutternes værdi for Danmark"

⁶³ Vinnova (2007): "The role of industrial research institutes ind the national innovation system", OECD (1995): "Science, Technology and Innovation – Denmark" and Erhvervsfremme Styrelsen (1998): "Strategi for Teknologisk Service"

GTS net in relation to the needs there are within the society and in the business enterprise sector. Figure 6.1 below shows the structural changes in the GTS net from 36 institutes 20-30 years ago to the present 9 institutes.

Figure 6.1: Reconstruction of the ATS net – from 36 to 9 institutes from 1989 to 2008



Source: DAMVAD, GTS og OECD

It is distinctive for the GTS institutes' history that the institutes not always have been publicly funded or been under public regulation. The GTS institutes are already described in the law on technological institutes in the late 1960's but it was not until the 1970's the GTS net actually was described in a common law on technological service.⁶⁴ Today the GTS net is regulated by Law on Technology and Innovation which is administered by The Danish Council for Technology and Innovation.

Another remarkable characteristic of the GTS net is that the institutes, compared to other actors in the research and knowledge system, are under a strong strategic regulation in the form of result contracts which the GTS institutes enter into with The Danish Council for Technology and Innovation. Looking at

⁶⁴ Handelsministeriets Udvalg vedrørende Teknologisk Servicevirksomhed (1972): Betænkning om "Teknologisk service"

this from the perspective of the society the result contracts are a decisive tool in order to secure a desired development in relation to build special business oriented competences and knowledge in the GTS net. A major rationale for the result contracts is that they help securing the building of knowledge and competences which the market can not build itself – either because we talk about non-profit objectives or because the competence building is too risky an investment for the individual company.

The result contract funds are given for a 3-year period in order to secure coherence in the efforts and to be able to prioritise between contribution areas. With the result contracts the council can for one thing co-fund effective forms of knowledge building, dissemination of knowledge, development of new services and participation in standardization work.

6.3 The GTS institutes' economics and management

Though the GTS institutes are under a common lawful foundation and form part of a 'net', the GTS institutes are internally very heterogeneous. Some institutes are organised in close relation to universities and others are more independently organised. The professional width varies very much and there are big differences in the individual institutions activities. There is also a great difference in the size of the institutes; from almost 20 employees to nearly 1,000 employees. Some are heavily dependent on public result contract funds while others to a high extent are self-sustaining. Some are almost primarily targeted against the business enterprise sector, while other also are targeted public institution. Some are very research heavy with a research effort in line with universities, while others have a very limited research activity.

The diversity among the GTS institutes is closely connected to the various historical anhorings and the structural changes the net has experienced where mergers and abolishments have taken place, and new actors have been incorporated in the net.

Table 6.1: Overview of GTS institutes' size, target group, competences and management

	Size	Target group and focus area	R&D and competences	Result contract funds	Management and ownership structure
AgroTech1 64.1	Employees: 48 Turnover: 34 mill. DKK.	Agriculture business, Agro-industry, Foods-industry, foodstuffs-industry, and the gardening sector.	Total R&D: 5.4 mill. DKK Number of employees with a higher education: 39 R&D pr. employee: 112,500 kr.	Total funds: 5.4 mill. DKK Share of turnover: 16 per cent	Board: 4 from private sector, 3 from Danish Agricultural Advisory Service, 1 from an institution of higher education, 1 employee director. Ownership structure: Public company with Danish Agricultural Advisory Service as owner and founder.
Alexandra Institutet2 64.2	Employees: 49 Turnover: 37 mill. DKK	Delivers IT based services across different sectors and therefore does not have one specific target group.	Total R&D: 15,2 mill. DKK Number of employees with a higher education: 42 R&D pr. employee: 310,204 DKK	Total funds: 2.5 mill. DKK Share of turnover: 7 per cent	Board: 6 from private sector, 1 from an institution of higher education, 1 from other educational institutions, 1 from associations/ organizations Ownership structure: Public company owned by the IT-Association Alexandra.
Bioneer	Employees: 36 Turnover: 39.1 mio. DKK	Biotechnological businesses, the pharmaceutical and medioco-industry, foods and ingredient industry.	Total R&D: 28.1 mill. DKK Number of employees with a higher education: 20 R&D pr. employee: 780,555 DKK	Total funds: 1.6 mill. DKK Share of turnover: 32 per cent	Board: 4 from private sector, 2 from an institution of higher education, 3 employee directors. Ownership structure: Public company, where DTU owns all shares.
DBI	Employees: 119 Turnover: 101.5 mill. DKK	Architects, consultative engineers, the construction industry, manufacturers of maritime equipment, manufactures, other businesses, and the fire and security sector.	Total R&D: 10.3 mill. DKK Number of employees with a higher education: 39 R&D pr. employee: 86,555 DKK	Total funds: 6.8 mill. DKK Share of turnover: 7 per cent	Board: 4 from private sector, 2 from the public sector, 2 employee directors Ownership structure: Independent non-profit organization.

64.1 Data only covers six months of activity, as Agrotech was functionally established July 1st, 2007. Hence, level of e.g. result contract funds does not match future funding

64.2 Alexandra was approved as an ATS December 2007. Hence, level of e.g. result contract funds does not match future funding

	Size	Target group and focus area	R&D and competences	Result contract funds	Management and ownership structure
DELTA	Employees: 230 Turnover: 261,1 mill. DKK	Producers of electronics, producers of hearing aids, bio and pharmaceutical industry, medico industry, audio industry, manufactures of machines, optical industry, SW industry, the windmill industry, SME group (innovation service), The Danish Road Directorate, and The Environmental Protection Agency.	Total R&D: 43.2 mill. DKK Number of employees with a higher education: 128 R&D pr. employee: 187,826 DKK	Total funds: 31.4 mill. DKK Share of turnover: 12 per cent	Board: 3 from private sector, 1 from The Danish National Research Foundation, 2 employee directors Ownership structure: Independent organisation
DFM	Employees: 18 Turnover: 16.7 mill. DKK	Businesses that develop and produces measurement and calibrating equipment.	Total R&D: 13.7 mill. DKK Number of employees with a higher education: 13 R&D pr. employee: 761,111 DKK	Total funds: 10.4 mill. DKK Share of turnover: 62 per cent	Board: 2 from private sector, 2 from other GTSs, 1 from an institution of higher education, 2 employee directors Ownership structure: Public company owned by DTU
DHI	Employees: 750 Turnover: 503.9 mill. DKK	Public authorities and institutions, the water sector, and consultative engineers.	Total R&D: 109.3 mill. DKK Number of employees with a higher education: 567 R&D pr. employee: 145,733 DKK	Total funds: 29.7 mill. DKK Share of turnover: 6 per cent	Board: 3 from private sector, 2 from an institution of higher education, 3 employee directors Ownership structure: Independent non-profit organization

	Size	Target group and focus area	R&D and competences	Result contract funds	Management and ownership structure
Force Technology	Employees: 960 Turnover: 827.8 mill. DKK	The transportation sector, the oil and gas industry, the energy sector, and the manufacturing sector.	Total R&D: 163.2 mill. DKK Number of employees with a higher education: 333 R&D pr. employee: 170.000 DKK	Total funds: 49.4 mill. DKK Share of turnover: 6 per cent	Board: 3 from private sector, 1 from an institution of higher education, 2 directors from Force, 3 employee directors Ownership structure: Independent non-profit organization
Teknologisk Institut	Employees: 795 Turnover: 750.5 mill. DKK	Knowledge service, services and supply, manufacturing industry, building and construction, agriculture and fishery, public institutions, R&D institutions.	Total R&D: 203.4 mill. DKK Number of employees with a higher education: 473 R&D pr. employee: 255,849 DKK	Total funds: 88.9 mill. DKK Share of turnover: 12 per cent	Board: 3 from private sector, 1 from an institution of higher education, 2 from associations/ organizations, 2 employee directors Ownership structure: Independent organisation

Source: Data from the GTS Association, structured by DAMVAD

6.3.1 The GTS institutes' management and structure of ownership

Most of the GTS institutes are organised as non-profit private institutions which include that their income and capital only can be used for conventional purposes with importance to the society. The institutes can therefore not commit single-handedly to certain business interests. As something new, there has in Law on Technology and Innovation been opened up for the possibility of the GTS institutes to get organised as non-profit limited companies.

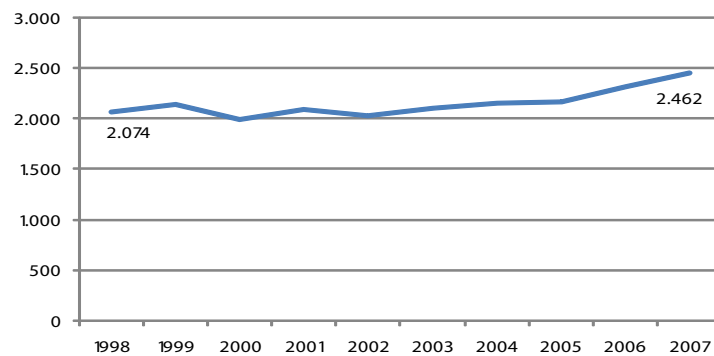
It is typical for the GTS institutes that their boards are representing a broad range of actors from the business enterprise sector, organisations and in numerous instances also from the universities. It underlines the non-profit role the GTS institutes have. Meanwhile, it is also underlining the close connection and formal interactions which a number of GTS institutes have to universities and research institutions.

6.3.2 The GTS nets turnover

The GTS net has a total turnover of almost 2.5 billion DKK, which makes the GTS net a fairly big player in the consultancy market in Denmark. However, the net's total turnover covers large variations within the individual GTS institutes – from the GTS institute (DFM) with 18 employees and a turnover of 17 million DKK to the biggest (Force Technology) with 960 employees and a turnover of 828 million DKK. It is a general tendency that the smaller institutes have a tighter and more trade specific target group while the big institutes, like The

Danish Technological Institute, DHI and Force Technology, provide a more overall technological service. Lately the GTS net has had a stable turnover growth. It can be seen in figure 6.2 that the total turnover for the GTS net in the period 1998-2007 has increased by 19 per cent.

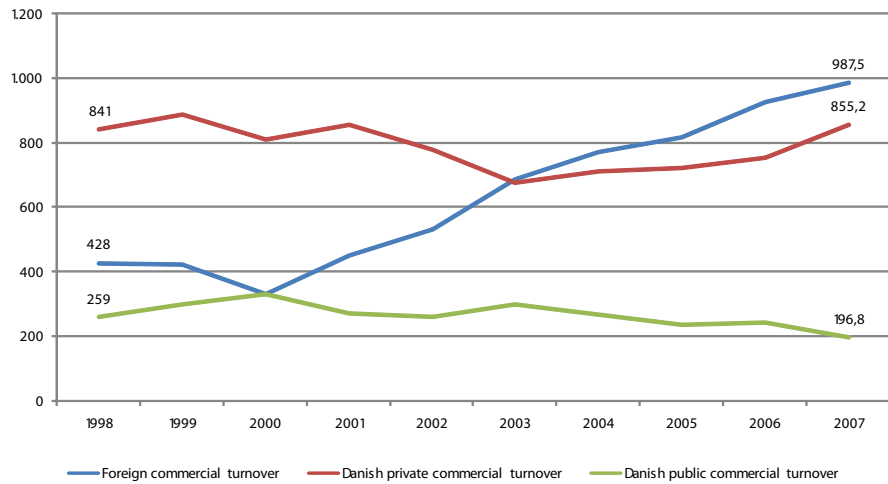
Figure 6.2: Total turnover in the ATS net between 1998 and 2007 (fixed prices, 1.000 DKK)



Source: The ATS Association, 2008

The total turnover covers commercial turnover, i.e. sale of services at market terms, and R & D turnover which covers external funds for R & D. Figure 6.3 demonstrates the development for the commercial turnover for the GTS net in the period 1998-2007. The commercial turnover is interesting as the market based services which the GTS net sells to public and private companies, reflect the companies' need for technological services. It appears that the sale to private Danish companies has increased with only 2 per cent from 841 million DKK in 1998 to 855 million DKK in 2007. It also appears that the GTS net in 2007 has a significant commercial turnover (197 million DKK) to the public sector even though a fall in the turnover by over 20 per cent since 1998 has been registered. On the other hand, it is interesting to see that the commercial international turnover has increased significantly in the period from 1998 -2007 as it more than doubled in the period in question - from 428 million DKK to 988 million DKK.

Figure 6.3: Commercial turnover in the ATS net, 1998-2007 (fixed prices, mill. DKK)

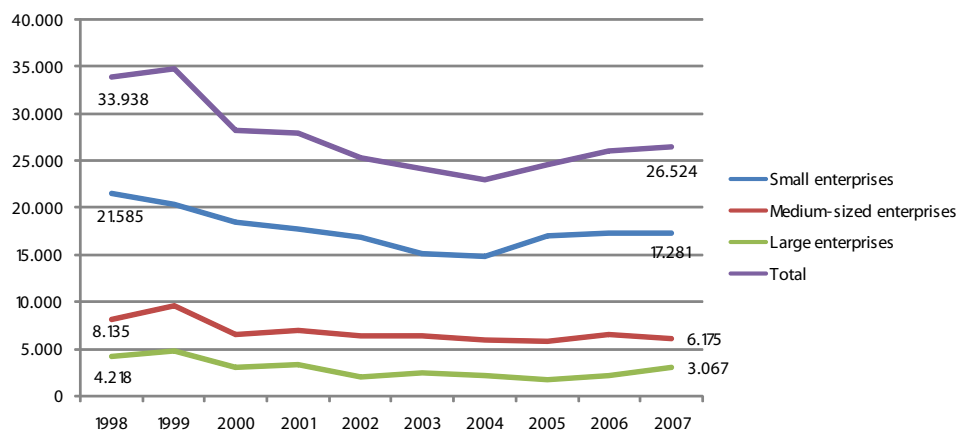


Kilde: The ATS Association, 2008

6.3.3 The client composition of the GTS net

The GTS net’s clientele reflect the contact the GTS net has to the business enterprise sector. Traditionally, the GTS net has compared to other actors in the research and knowledge system a large interface with Danish companies through their consultancy and sale of services. However, many things indicate that the GTS institutes’ interface with the business enterprise sector has become smaller throughout the last years if we look at the number of commercial clients. Figure 6.4 illustrates that the GTS net’s clientele of private Danish customers has fallen from almost 34,000 in 1998 to 26,500 in 2007 which equals a fall of 22 per cent in that period. The fall in the number clients is present within all categories of companies with more than 250 employees and smaller companies with less than 250 employees.

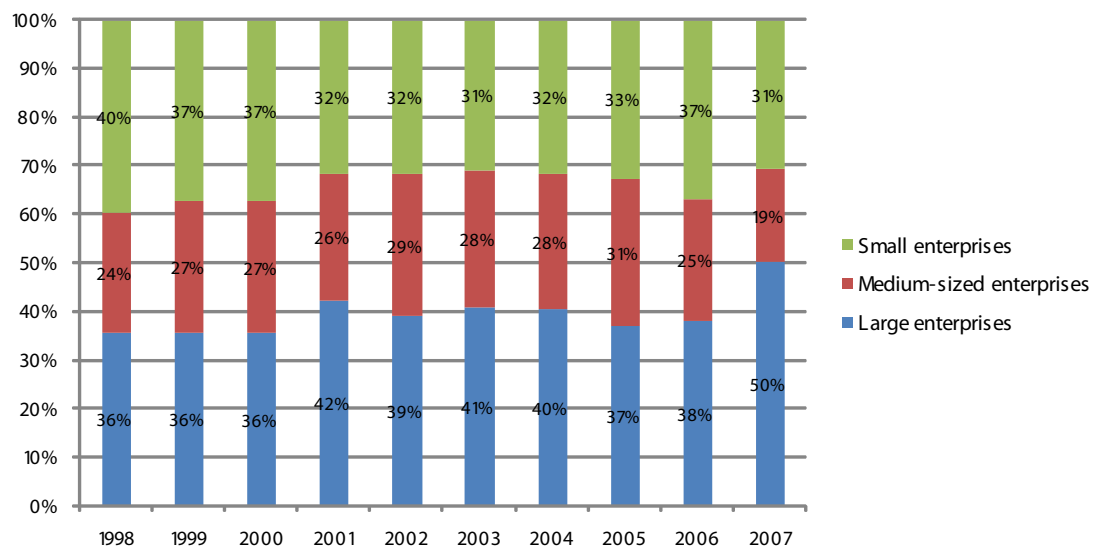
Figure 6.4: ATS clientele distributed on business size between 1998 and 2007 (number of customers)



Source: The ATS Association, 2008. Remark: Small enterprises: Less than 50 employees, medium-sized enterprises: Between 50 and 250 employees, and large enterprises: More than 250 employees

The GTS net has a special commitment to provide service to small and medium-sized companies. It is interesting that there is a tendency here for the GTS net to more and more acquire their turnover from big companies. Figure 6.5 illustrates that the big companies with more than 250 employees account for half of the turnover – against a third 10 years ago.

Figure 6.5: Turnover in the ATS net distributed on business size, 1998-2007

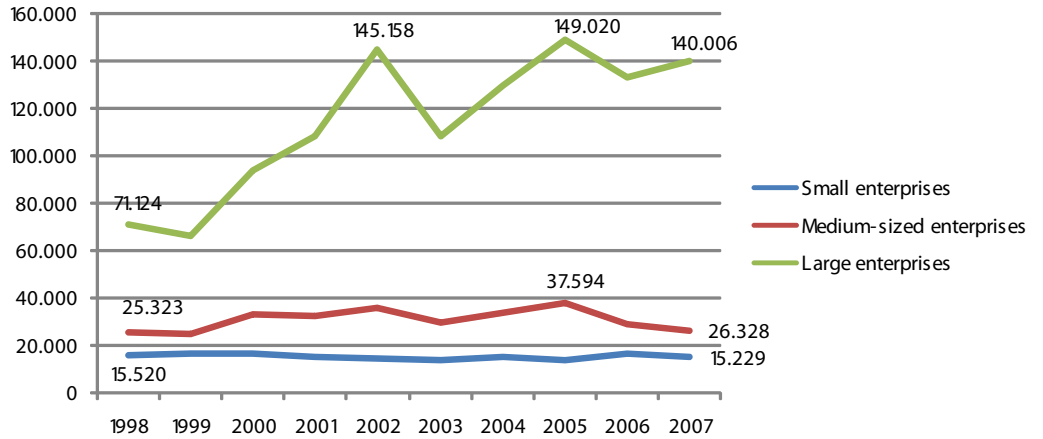


Source: The ATS Association, 2008

Remark: Small enterprises: Less than 50 employees, medium-sized enterprises: Between 50 and 250 employees, and large enterprises: More than 250 employees

It is interesting to look at the GTS net’s turnover per company based on company size as it indicates from where the money is earned in relation to the sales of the individual services. Figure 6.6 shows that it is the larger companies with more than 250 employees that contribute most to the turnover per client, and that this number has been increasing the last years. The turnover per client in the small- and medium sized companies has been relatively stable with approximately 15,000 DKK for small companies and 26,000 DKK for medium-sized companies while the turnover in the big companies has doubled from approximately 71,000 DKK to 140,000 DKK in the period from 1998-2007. The development has resulted in the turnover per client for the large companies today being 9 times as big compared to the small companies.

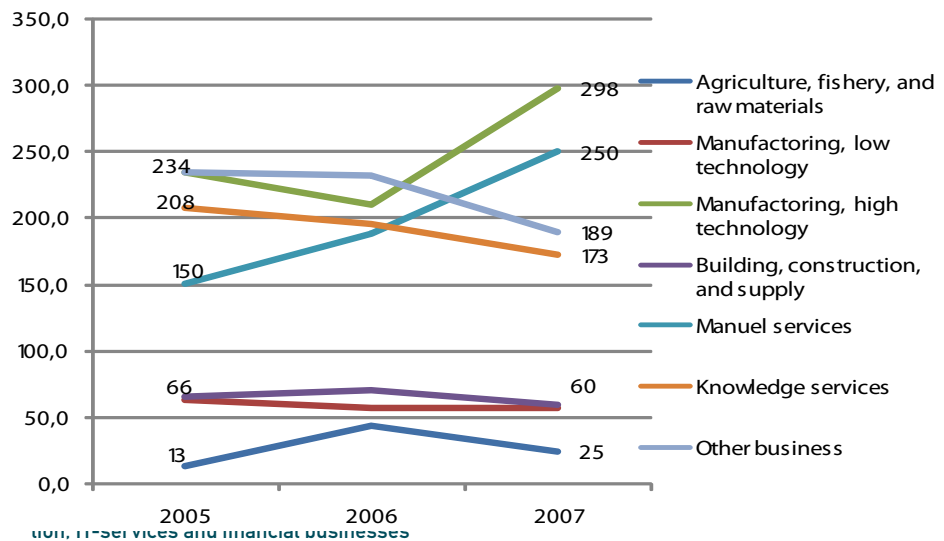
Figure 6.6: Turnover in the ATS net pr. client distributed on size of business, 1998-2007 (fixed prices)



Source: The ATS Association, 2008

When looking at sectors it is also very different which sectors contribute to the GTS net's turnover. Figure 6.7 illustrates that the national turnover in 2007 particularly derives from the high-tech production sectors (approximately 290 million DKK) and the manual service industries (250 million DKK), and that the turnover from these industries have been increasing in the period 2005-2007. Knowledge service⁶⁵ (173 million DKK) and other business enterprises (189 million DKK) is also taking up space in the statistics but the turnover from these industries have experienced a decrease in the period from 1998-2007. The low-tech trades (60 million DKK), building and construction (almost 60 million DKK) and agriculture and fisheries (25 million DKK) are all less prominent in the GTS net's turnover than the other industries..

Figure 6.7: National turnover in the ATS net distributed on sectors of business, 2005-2007 (fixed prices, mill. DKK)



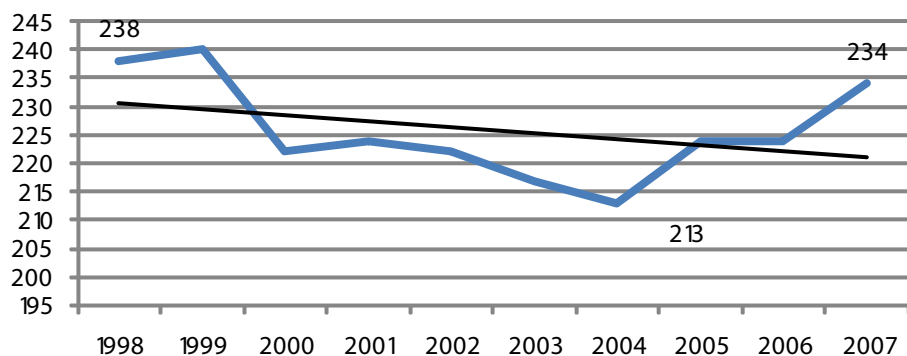
Source: The ATS Association, 2008

6.3.4 GTS nets result contract funds

The size and the development in the state’s contribution to the institutes in form of result contract funding is of decisive importance for the development of the institutes. Historically seen, many of the GTS institutes have been established without financial support from the public sector, cf. section 6.2. From the mid-1940’s and up till today the state has however provided significant contributions to the activities of the institutes. In the beginning of the 1970’s the state’s contribution amounted to between half and two thirds of the institutes’ turnover. From the mid-1970’s this situation was reversed and in the following 20 years the national basic subsidies decreased to about 10 per cent of the turnover as we know it today. There is meanwhile a big variation between the GTS institutes when it comes to the result contract funds’ share of the turnover and the 10 per cent is therefore not applicable for all institutions. Hence, the result contract funds only constitute 6 per cent of the turnover among the big institutes like Force Technology and DHI while they at DFM amount to 62 per cent of the turnover.

In the following we will look at the development in basic funds – in absolute figures as well as relative compared to the total turnover of the GTS net. The figures cover the period from 1998-2007 which is identical to the period in which the GTS organisation has registered data in their performance account for the GTS net. Figure 6.8 shows major fluctuations in the apportionment of contract funds in the actual period. The level in 1998 was at 238 million DKK which is a little higher than in 2007. In between the GTS net experienced a low in 2004 of 213 million DKK and since then the result contract funds have been increasing.

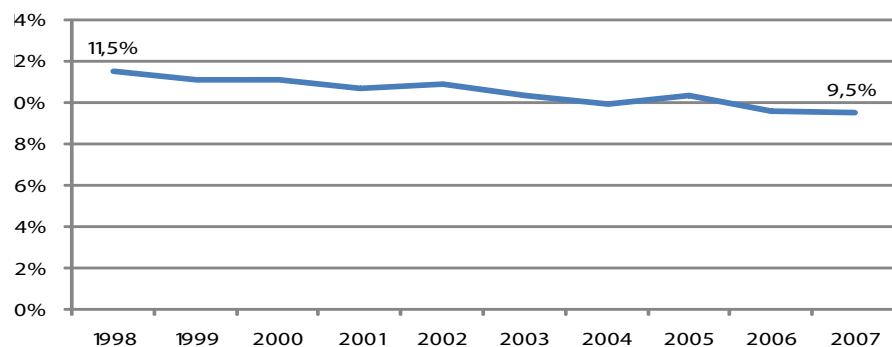
Figure 6.8: Result contract funds in the ATS net between 1998 and 2007 (fixed prices, mill. DKK)



Source: DAMVAD: Analyzed from data from The ATS Association, 2008, and DISKO

Figure 6.9 provides an overview of the development in contract funds as a share of the turnover in the GTS net. The contract fund's share of the turnover has been steadily falling from 11.5 per cent in 1998 to 9.5 per cent in 2007. This implies that the GTS net overall have experienced decreasing support for their basic activities within competence building and knowledge dissemination pari passu with the turnover for the GTS net has increased as such in the period.

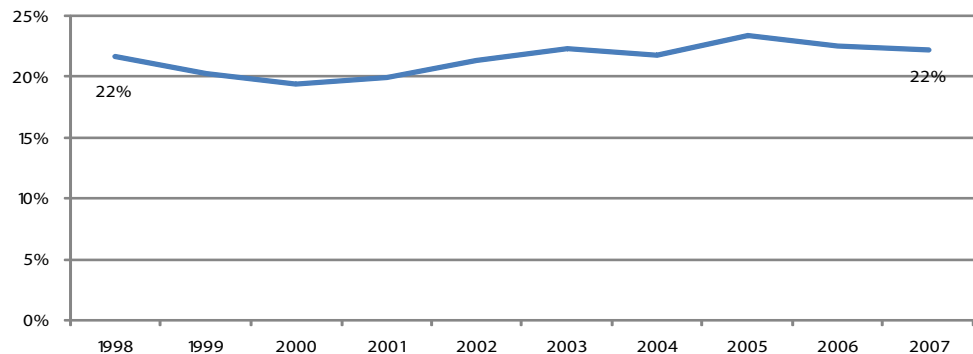
Figure 6.9: Result contract funds as part of total turnover in the ATS net, 1998-2007



Source: DAMVAD: Analyzed from data from The ATS Association, 2008

It can always be discussed how the GTS institutes' contract funds shall be set forth. Another perspective of the contract funds is as regards the funds' share of the national turnover. Here, the picture shows that the contract funds' share of the turnover has been relatively stable in the period from 1998-2007. As outlined in figure 6.10 the level (22 per cent) is exactly the same now as it was 9 years ago.

Figure 6.10: Result contract funds as part of national turnover in the ATS net, 1992-2007



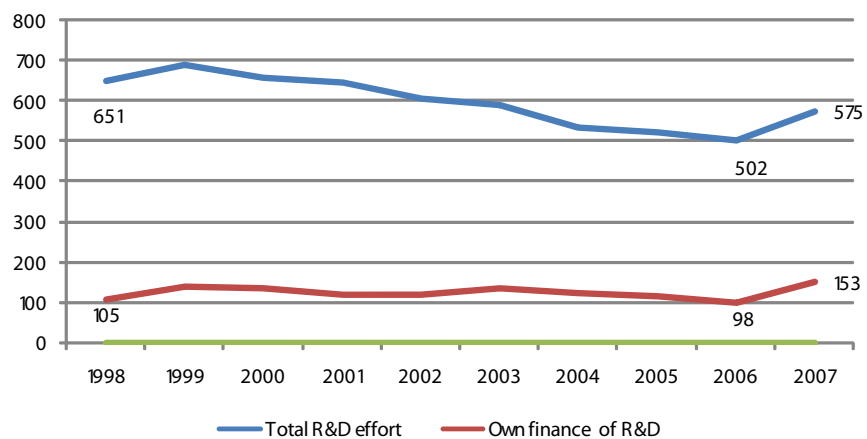
Source: DAMVAD: Analyzed from data from The ATS Association, 2008

The GTS institutes can of course at equal terms and in competition with other actors in the research and knowledge system supplement their result contract funds with national or international program funds. Such program funds can compensate for eventual deductions in the result contract funds but for the institutes these program funds have certain disadvantages: the funds are strongly fluctuating and the same applies for the possibilities to get a share of them. At the same time there are often huge administrative costs connected to participating in programs, e.g. compared to evaluations and follow-ups. Furthermore, it is not certain that the aim and content of the programs necessarily match the strategic perspectives for competence development which lies within the institutes' result contracts with the Danish Council for Technology and Innovation.

6.3.5 The GTS nets research and development activity

Figure 6.11 shows that the total amount allocated to R & D generally has been decreasing in the period in question. However, there has been an increase from 2006-2007 of 15 per cent. The self-funded R & D effort has turned out to be more stable up till 2006 after which it increased by an impressive 56 per cent in only one year and reached a culmination so far in 2007. The general tendency covers big differences in the various GTS institutes' prioritization of R & D. In this way, DBI spends 86,555 DKK per employee on R & D in 2007 while Bioneer spends 780,555 DKK per employee.

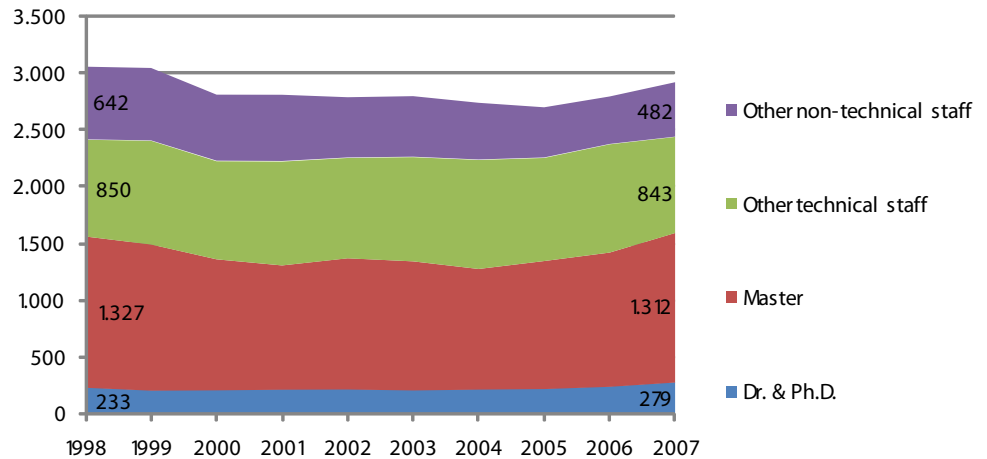
Figure 6.11: The ATS nets R&D effort distribuet on total R&D and own finance of R&D, 1998-2007 (fixed prices, mill. DKK)



Source: DAMVAD: Analyzed from data from The ATS Association, 2008

Figure 6.12 illustrates that a development has taken place towards a more knowledge heavy employee constellation in the GTS net. A general decrease (25 per cent) in the number of 'other non-technical staff' in the GTS net can be observed. Simultaneously, there is an increase of 20 per cent in the number of Dr.'s and PhD's from 233 to 279. The number of 'other technical staff' and employees with a master degree has had a relatively stable level.

Figure 6.12: The ATS nets composition of employees between 1998 and 2007



Source: DAMVAD: Analyzed from data from The ATS Association, 2008

6.4 GTS nets' services to customers

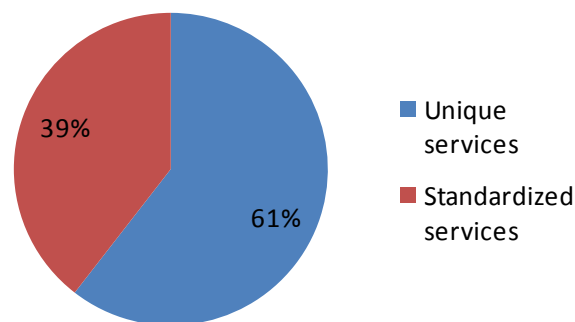
In the following we will evaluate the activity portfolio in the GTS net as a total entity and therefore not evaluate the individual institutes as such. We will try to establish an overview of the institutes' client services as well as the activities that forms the basis of these services, i.e. the activities which are related to the result contract funding from The Danish Agency for Science, Technology and Innovation. The evaluation will be based on statements from the GTS institutes' performance accounts as well as a questionnaire survey among the GTS institutes' consultants conducted as part of this mapping.

As could be seen in section 6.3, the GTS net is heterogeneous with a multitudinous range of activities and services. Some GTS institutes are specialists in narrow fields and others cover technologically broad. Most of them have a wide spectrum of services within technological service while others provide service narrowly in e.g. standardization and testing. There are not only big differences among the activity profile between the different institutes but there is also often significant heterogeneity within the individual institutes. In earlier assessments of the GTS net's activities the following activities are considered the foundational services of the GTS net: education and course activities, consultancy and consultant services, probing, R & D, standardization and participation in cooperation- and interest groups.⁶⁶ Basically, it can be said that the GTS institutes overall deliver two kinds of services to their clients: standardized services and tailor-made/unique services.

⁶⁶ Institutrådet og Erhvervsfremmestyrelsen (1996): "Teknologisk Service: Tendenser og udfordringer – En diskussion af GTS-institutternes værdi for Danmark".

Data from the GTS Association shows the distribution of standardized services and the number of tailor-made/unique services in the GTS net's private commercial turnover, cf. figure 6.13. The numbers show that the majority of the GTS net's commercial turnover is based on unique knowledge heavy services (61 per cent), while a smaller part of the turnover derives from standardized services (39%).

Figure 6.13: ATS nets private commercial turnover distributed on types of services, 2007



Source: DAMVAD: Analyzed from data from The ATS Association, 2008

The difference in the types of services is basically due to how high a degree of knowledge content there is within the services. The standardized services will often concern services of less significance which are less demanding in relation to development of knowledge. It can e.g. concern services offered at commercial terms within testing and probing, inspection and control, certification and calibration. The tailor-made and unique services will on the opposite to a far higher degree demand knowledge work and relations of long duration with the clients with a high knowledge content. This applies e.g. to services offered on commercial basis within consultancy and organisational development, R & D tasks, courses and education, web services and communication and publications.

When the GTS institutes' services and functions previously have been evaluated it has traditionally happened by the means of user investigations focussing on information from the business enterprise sector and from the companies that have used the GTS. It is a relevant procedure if you want illustrate the use of the GTS net's services seen from the companies demand perspectives. But looking at the GTS institutes' services in this way does not necessarily give a complete and correct picture of the GTS net's services, hereunder how much the GTS institutes deal with specific services.

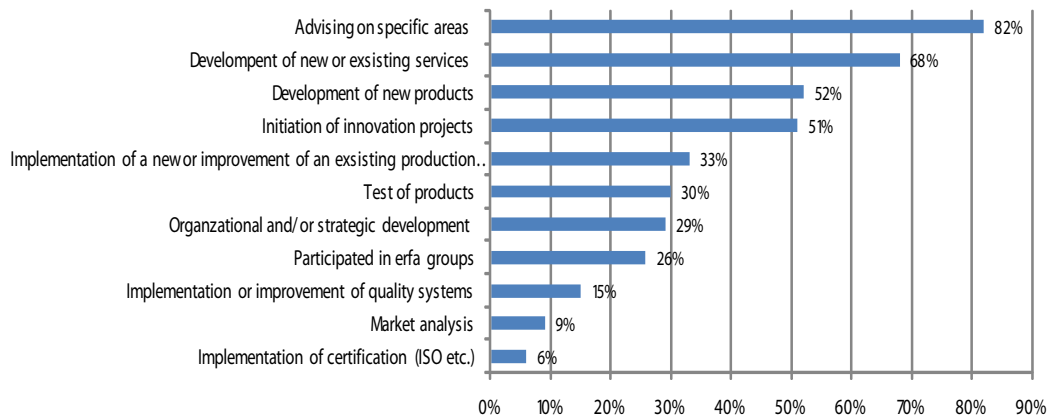
Consequently, we have as part of this mapping conducted a questionnaire survey among the GTS institutes' consultants. The survey is hence focussing on the institutes' services based on a supply perspective. The survey contains replies from over 300 GTS consultants who are selected in cooperation with the GTS institutes so they represent a wide segment of the GTS institutes' nearly 3,000 employees. The survey method is described in detail in section 9.2. Besides questions regarding the GTS consultants' consultancy activities and services

the questionnaire places focus on their interactional relations with the rest of the GTS consultants, the business enterprise sector, the public sector and international actors.

Figure 6.14 illustrates that certain work functions are far more dominating than others among the GTS net’s consultants.⁶⁷ The work functions that most frequently are evaluated as important are first and foremost consultancy regarding specialty areas (82 per cent) and development of new or existing services (68 per cent). Hereafter comes development of products (52%) and implementation of innovation projects (51 per cent).

30 per cent of the questioned GTS consultants said that testing of products has been one of their major work functions while only 6 per cent said that the introduction of certification has been a major work function. It appears thus that work functions, which the GTS consultants carry out, mainly are unique services while the more standardized services are less prominent. That result complies well with the statement from the GTS institutes’ performance accounts shown above.

Figure 6.14: Which substantial work functions have you had withing the last year related to your customers?



Source: DAMVAD, Mapping of the Danish knowledge system, 2008.

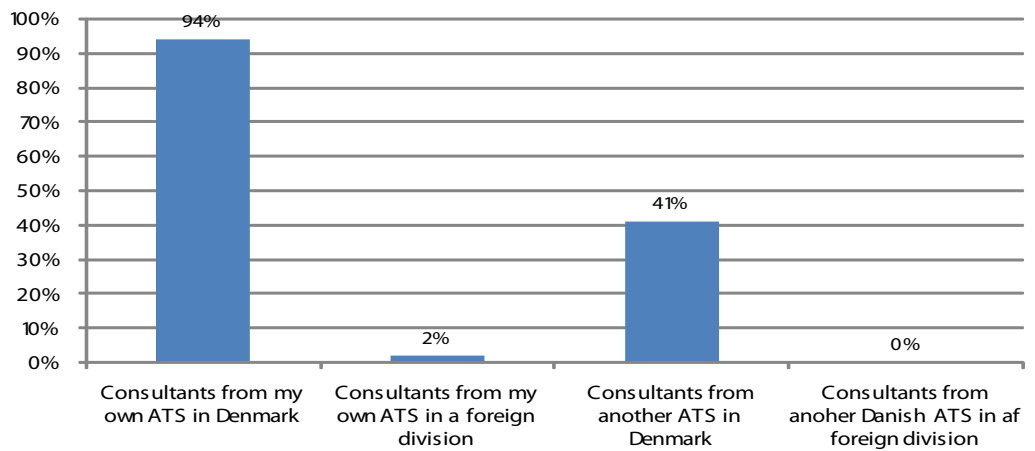
6.4.1 Interaction among the GTS institutes on delivery of services

The questionnaire survey has as one of its objectives to uncover the GTS consultants’ collaboration with other GTS consultants. The consultants were asked whether they had collaborated with other GTS consultants on their last project to which 37 per cent said yes, while 63 percent said no. Of the 37 per cent which had worked with other consultants, 94 per cent had worked together on this project with other GTS consultants from their own GTS institute while

⁶⁷ Work functions are included if the consultant has spend at least 10 per cent of total work hours on this function

41 per cent of the GTS consultants had worked together with GTS consultants from other GTS institutes. It can moreover be seen that only to a limited extent collaboration among GTS institutes across borders takes place in as just 2 per cent of the questioned GTS consultants have collaborated with consultant from their own GTS institute in a foreign division and nobody have collaborated with consultants from another Danish GTS institute in a foreign division.

Figure 6.15: Which ATS consultants have you worked with on your last project?



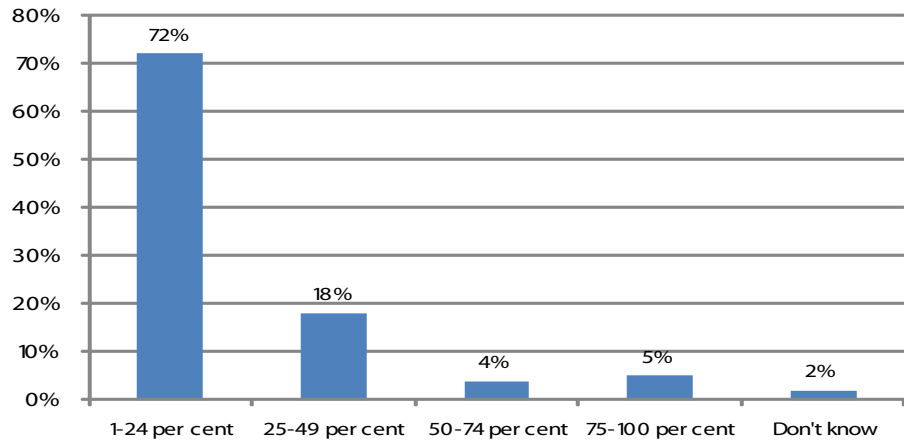
Source: DAMVAD, Mapping of the Danish knowledge system, 2008

6.5 Connection between result contract and commercial services

The DCTI can help develop the GTS net by co-funding effective forms of knowledge building, knowledge dissemination, development of new service supplies and participation in standardization work. The result contract funds can be used for co-funding of competence building projects, e.g. innovation consortiums. Besides the ordinary result contracts the DCTI can moreover co-fund organisational and structural changes as well as amalgamations of GTS institutes, establishment of new GTS institutes and effectiveness- and productivity encouraging initiatives within technological service.

The questionnaire survey among GTS consultants illustrates that the GTS institutes work functions to a high degree individually contains result contract funded basic activities. A total of 82 per cent of the GTS consultants have therefore been involved in activities which were financed by result contract funds within the last year. Of these, 72 per cent of the consultants estimate that 1-24 per cent of their key activities are financed by result contract funds, cf. the below figure 6.16.

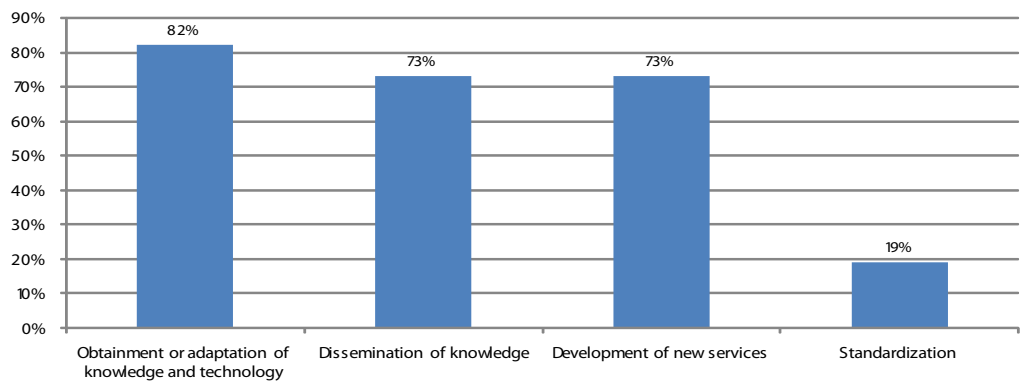
Figure 6.16: How large a share of your total activities has been financed by result contract funds?



Source: DAMVAD, Mapping of the Danish knowledge system, 2008

Figure 6.17 provides an overview of which forms for activities, according to the respondents, are financed by result contract funds. There is an even spread among the various activities financed by contract funds and a high percentage think that activities such as purchasing of knowledge and technology (82 per cent), knowledge dissemination (73 per cent) or development of new service supplies (73 per cent) have been financed by result contract funds. By contrast, only 19 per cent think that they within the last year have been involved in standardization work which has been supported by result contract funds.

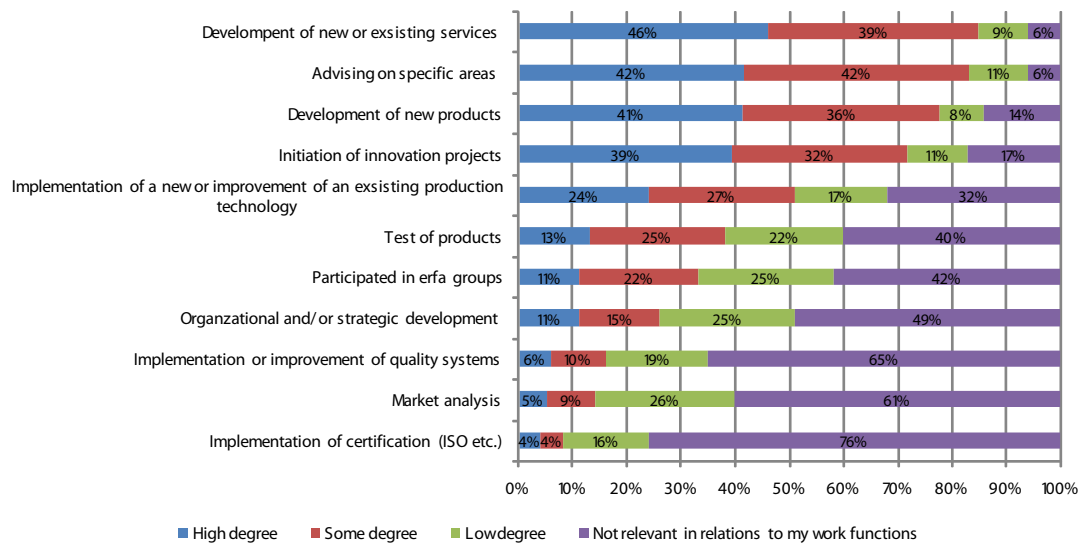
Figure 6.17: Which types of activities that you have been involved in, during the last year, are financed by result contract funds?



Source: DAMVAD, Mapping of the Danish knowledge system, 2008

The GTS consultants have in connection with the questionnaire survey been asked to tell as to what degree their work functions, in relation to the clients, build on knowledge from activities that are financed by result contract funds from the Danish Agency for Science, Technology and Innovation. From figure 6.18 can be seen that the unique services, such as development of new or existing services and consultancy on specialist areas, in half of the instances build on knowledge from activities that are financed by result contracts. Opposite to this, the standardized services, such as implementation of certification, only to a very small extent build on knowledge from activities that are financed by result contracts.

Figure 6.18: To what degree does your work function related to your customers build on knowledge from activities financed by your result contract?

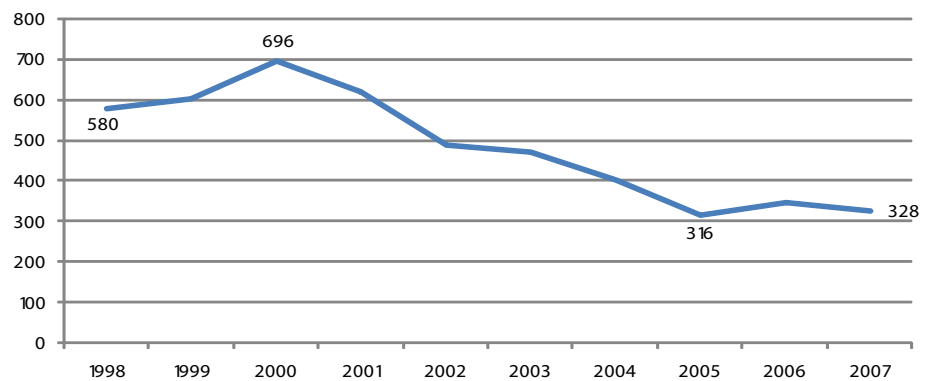


Source: DAMVAD, Mapping of the Danish knowledge system, 2008

6.6 The GTS nets national interaction on research and development

R & D has traditionally been some of the main functions in the GTS net while they have been downgraded the last couple of years. Figure 6.19 shows a bisection in the R & D collaboration projects on a national level, from a maximum of 696 projects in 2000 to a low of 316 in 2005 and to 328 in 2007. It must be underlined that the size of many research and development projects has increased, which might have had an effect on the decline in the GTS institutes participation in the area.

Figure 6.19: The ATS nets national R&D cooperation projects, 1998-2007 (number)



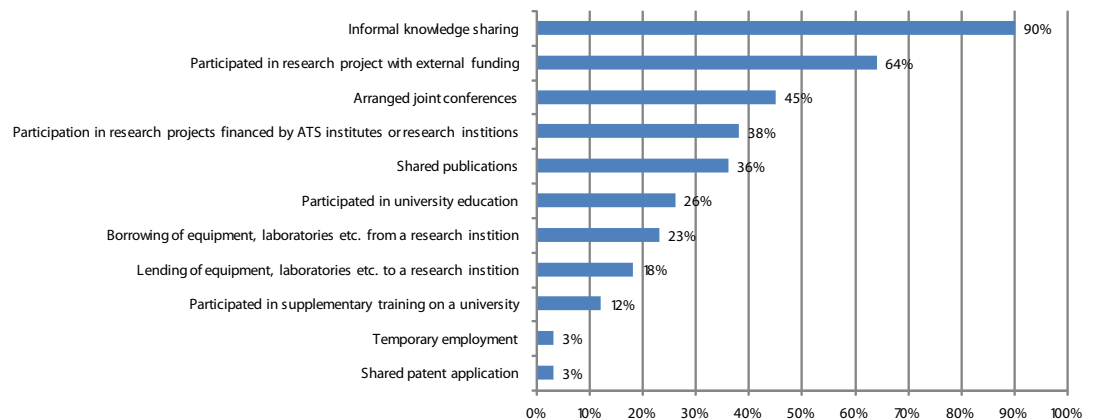
Source: DAMVAD: Analyzed from data from The ATS Association, 2008

If you look at the national innovation programs, the GTS institutes' participation is concentrated on Innovation consortiums while they have a limited participation in other programs (see chapter 5). Especially the participation in research programs, as e.g. strategic research, is restricted. However, this does not indicate that the GTS institutes do not interact with researchers in Danish research institutions in as 79 per cent of the questioned GTS consultants in the questionnaire survey have had interaction with researchers from Danish research institutions (inclusive universities) within the last year in connection with the solution of their work assignments.

Figure 6.20 gives an overview of the forms of interaction we are talking about between the GTS institutes and the researchers at the Danish research institutions. A big proportion of the interaction is characterised by informal knowledge exchange (90 per cent), which can be participation in ERFA-groups, company networks and committees. The interaction also comprises participation in research projects, self-funded (38 per cent) and externally funded (64 per cent), e.g. in innovation consortiums and strategic research. Furthermore, the interaction is e.g. centred around joint conferences (45 per cent) or the publication of joint publications (36 per cent). The interaction can also be said to

have a sort of reciprocity as e.g. the borrowing of equipment etc. goes both ways. However, the GTS consultants are more often offering education to universities (26 per cent) than they receive additional education from the universities (12 per cent), e.g. through an MBA course or similar.

Figure 6.20: Which types of interaction have you had with researchers from Danish research institutions within the last year?



Source: DAMVAD: Analyzed from data from The ATS Association, 2008

6.7 The GTS nets international activities

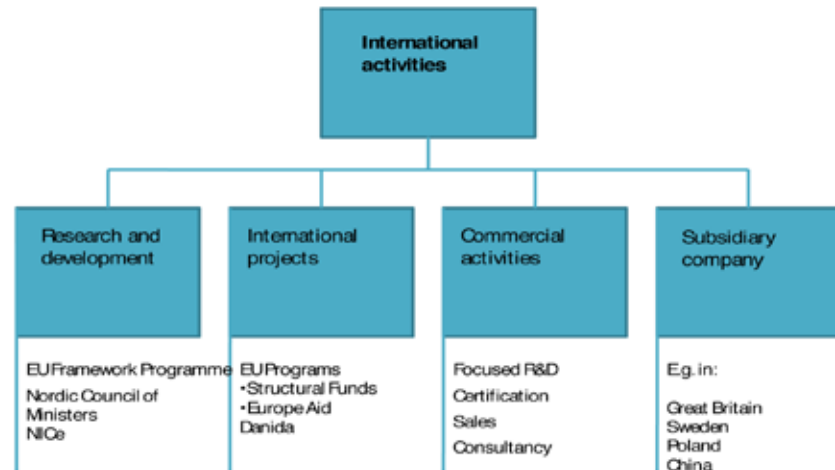
As previously described the GTS net has been through an internationalisation process which has resulted in the international turnover compared to the GTS net as a whole, today exceeds 40 per cent of the total turnover. The internationalisation is however very different across the institutes. Some institutes still do not have any or only a very small international turnover and activity.

Several objectives can be pinpointed when talking about the GTS institutes' internationalisation. First of all the internationalisation will result in purchasing of knowledge, e.g. through R & D projects and interaction with foreign knowledge environments. Besides that the internationalisation will open up for new markets for Danish companies, to quality ensure and develop the GTS services in Denmark and to secure exploitation of economies of scale, e.g. through sales of services to foreign clients. Finally can be said that the internationalisation will result in economical consolidation with the aim of freeing resources for competence building, e.g. via establishment of foreign subsidiary companies.

The internationalisation has truly happened along the implementation of better regulatory requirements for the GTS institutes' possibilities to establish themselves abroad. A noteworthy reason for the internationalisation can, besides the possibilities of increased income knowledge purchasing, also be that the GTS

net throughout the years have experienced a smaller client basis for the GTS institutes, cf. previous sections.⁶⁸

Figure 6.21: The ATS nets international activities

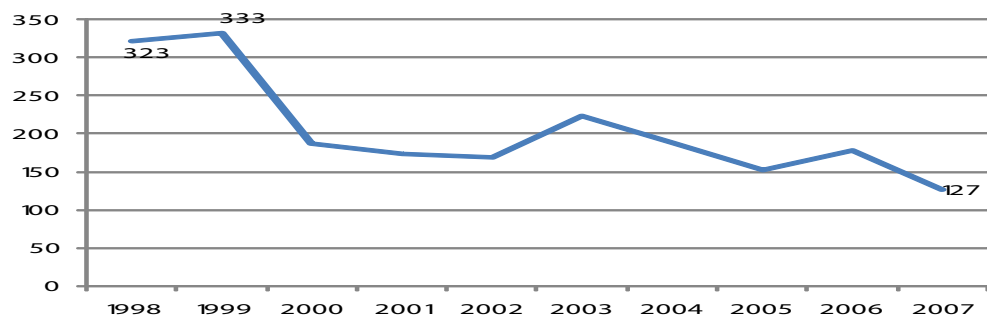


In the following the four different internationalisation activities for the ATS net will be elaborated.

6.7.1 International research and development projects

The GTS institutes join international research collaborations with e.g. universities abroad. The figures show that the international R & D collaboration in the GTS net have been on the down grade for some time. The level today is almost down to a third of the previous level. More precisely the number of projects decreased from 333 in 1999 to 127 in 2007, cf. figure 6.22.

Figure 6.22: The ATS nets international R&D cooperation projects, 1998-2007 (number)

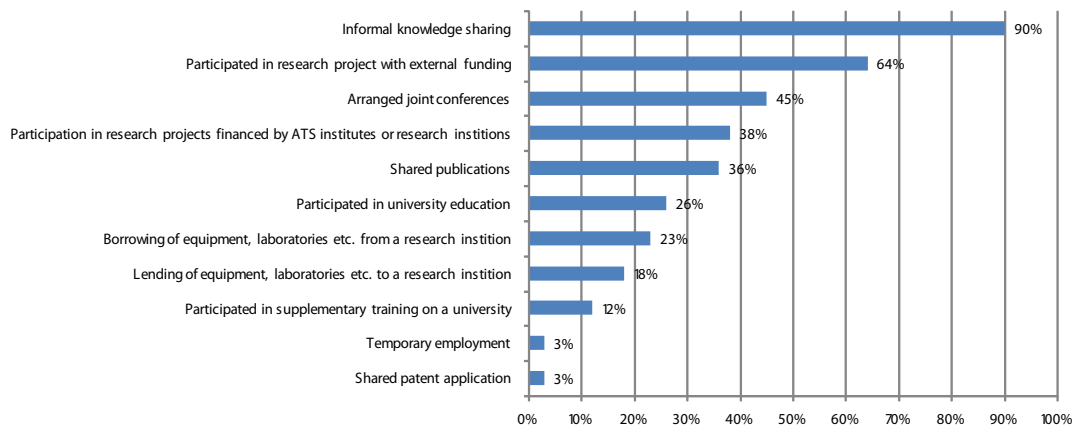


Source: DAMVAD: Analyzed from data from The ATS Association, 2008

⁶⁸ Institutrådet (1996): "Teknologisk Service: Tendenser og udfordringer – En diskussion af GTS-institutternes værdi for Danmark", 1996.

Despite the down graded R & D collaboration in the GTS net, 61 per cent of the GTS consultants state that they within the last year have had interaction with researchers at foreign research institutions (inclusive universities) in connection with the solution of their work assignments. Figure 6.23 shows the types of international interaction in question. It is the informal knowledge exchange, such as ERFA-groups and company networks that drives the far majority of the international interaction (89 per cent). Besides that, there is, like at the national level, a tendency that collaboration in research projects with external funding takes place more often (46 per cent) than in projects with self-funding (17 per cent).

Figure 6.23: Which types of interaction have you had with researchers from foreign research institutions within the last year?



Source: DAMVAD: Analyzed from data from The ATS Association, 2008

6.7.2 International donor-supported projects

The GTS institutes are, besides being involved in foreign projects with private funding, also in some cases involved in projects supported by bilateral and multilateral donors. The projects often concern delivering of technical assistance for projects in e.g. developing countries. Box 6.3 shows examples of projects that have been carried out by various GTS institutes within the last couple of years.

Box 6.3: Examples of GTS institutes' international projects

GTS	Project title	Client	Project description
Danish Technological Institute	Evaluation of EU's regional development programs for business development and innovation.	EU Commission 2008-09	In cooperation with three European partners the Danish Technological Institute, Center for Analysis and Business Development are going to evaluate the results of EU's regional development programs for business development and innovation. Covering 40 economic sectors from cosmetics, medical equipment to furniture and IT the consortium is going to investigate the European competitiveness.
Danish Technological Institute	EU-India Trade and Investment Development Programme (TIDP)	EU Commission 2005-2007	In cooperation with among other Carl Bro A/S the Danish Technological Institute has contributed to the implementation of 'sanitary and phytosanitary arrangements' as part of the TIDP program in India. The Danish assistance has particularly been in establishing verification methods of products for export to EU Countries.
Danish Technological Institute	Egyptian pollution abatement programme (EPAP 2)	The European Investment Bank 2007-2012	COWI A/S is the manager of the consortium also consisting of consultants from the Danish Technological Institute. Together the partners must deliver technical support to the Egyptian industry, helping them to respect the current environmental regulation and limit pollution. Furthermore the consortium must support the Egyptian Environmental Office for the effective administration of the EPAP 2 project.
Force Technology	Evaluation of air pollution and noise from a power-plant on the Maldivé island of Malé.	Danida, 2007-	Force Technology are going to carry out an evaluation with the purpose of describing the environmental consequences of a planned expansion of the current diesel-run power plant. Malé has approximately 100.000 inhabitants and since the island is only 1 km x 2 km it's very densely built-on.
DHI	REACH Implementation	EU Commission 2006-2007	DHI was manager of a consortia consisting of Center of Toxicology and three European partners. The consortium delivered technical assistance in the form of lines of direction to producers and importer for implementing REACH. DHI coordinated the project during the course of the project.
DFM	Development of a plan of strategy to the Metrological Institute of Bolivia	Danida 2003	DFM delivered technical assistance in the form of strategic development to The Metrological Institute of Bolivia.

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

6.7.3 International commercial activities and subsidiary companies

The GTS institutes' commercial activities abroad are important in order to try out new knowledge and technology in international competition and to sustain the necessary income. The sales of services to clients abroad can at the same time contribute to exploit the economies of scale in the equipment the GTS institutes possess, e.g. expensive testing equipment. This makes the international business development central to many of the GTS institutes work. The development in the export the last couple of years indicates that the growth is stabilised at around 5-6 per cent.⁶⁹

Table 6.2: GTS institutes subsidiary companies and sales offices abroad

GTS Institute	Subsidiary companies and sales offices abroad
Agrotech	-
Alexandra Instituttet	-
Bioneer	-
DBI	-
Delta	Sweden: DELTA Development Technology AB Britain: DELTA Microelectronics Ltd.
DFM	-
DHI	All members of DHI Group: Australia, Bangladesh, Brazil, Bulgaria, France, India, Italy, Japan, China, Malaysia, New Zealand, Norway, Singapore, Slovakia, Spain, Sweden, Czech Republics, Germany, and USA.
Force Technology	Norway, Sweden, and USA.
Teknologisk institut	Sweden and Poland.

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

However, it is very different how internationalised the individual GTS institutes are when it comes to establishing subsidiary companies abroad. As can be seen from table 6.2, 5 institutes have subsidiary companies today and on aggregate they have sales offices in 28 countries in most of the world as well as activities in about 100 different countries.⁷⁰ A major part of the GTS net's growth from abroad can be ascribed to growth in the number of subsidiary companies.

6.8 Participation in academic councils and committees

The GTS institutes shall, besides their role as consultants, also enter into networks or cooperate in councils and committees that are targeted against specific industries. This activity shall secure that also small and medium-sized

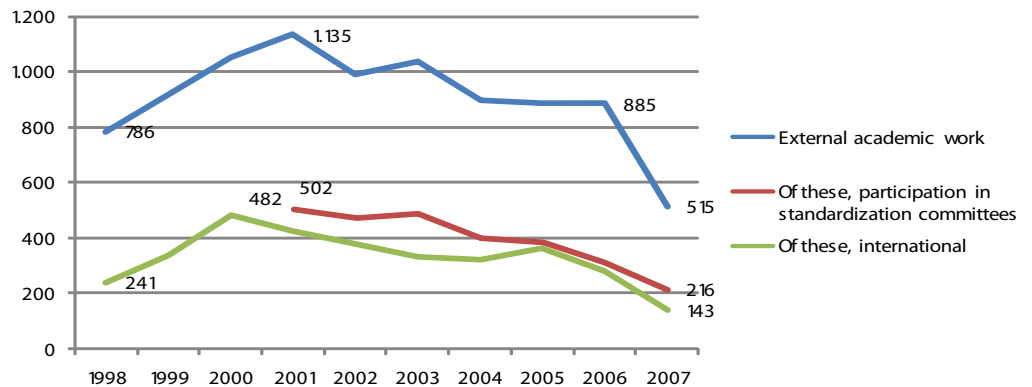
⁶⁹ GTS-sammenslutning (2008): "International evaluering af GTS-systemet"

⁷⁰ GTS-sammenslutning (2008): "International evaluering af GTS-systemet"

companies in a feasible way can get access to research results via a general collective dissemination of technology.⁷¹ This function mainly originates from the fact that parts of the GTS net historically seen have roots in the business enterprise organisations, cf. Section 6.2.

Figure 6.24 illustrates the development in the GTS institutes' participation in formal committees and networks - in which competence development is involved. Overall the development has been downward going since 2001 where the number peaked with 1,135 participations within standardization work, councils, boards, committees and other external commissions. Today the number is 515 participations. Approximately 40 per cent of the total interaction in commissions and networks is concerning participation in standardization commissions, while the number of participations in these commissions has decreased from 502 participants in 2001 to 216 in 2007.

Figure 6.24: ATS institutes' participation in academic committees, 1998-2007 (number of participants)



Source: The ATS Association, 2008

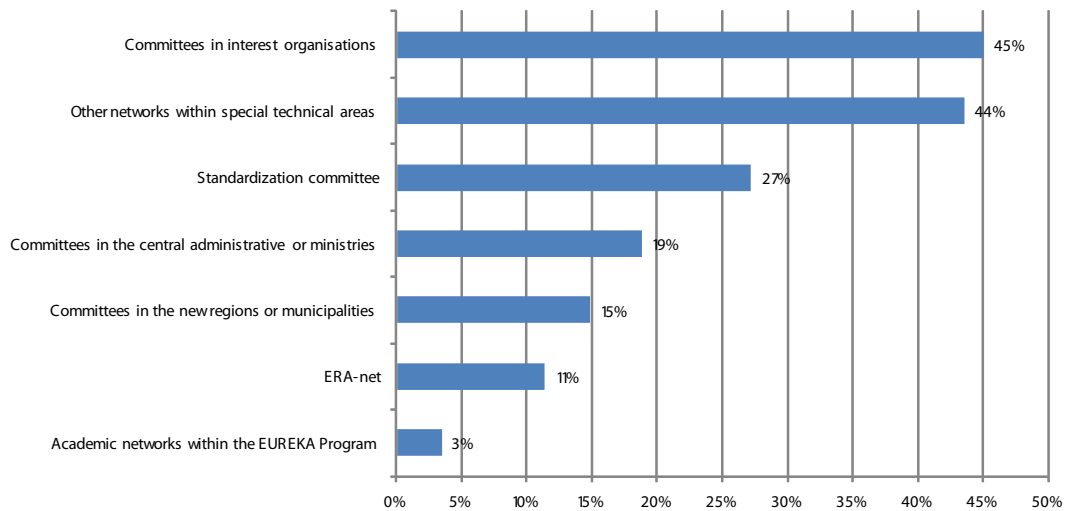
The participation in external networks and commissions is further mapped via the questionnaire survey among app. 300 GTS consultants. In the questionnaire we asked what kind of commissions the consultants have participated in. The results reveal that 67 per cent of the questioned GTS consultants actively have participated in external commissions and networks within the last year. Figure 6.25 illustrates which commissions and networks are in question. It appears that 45 per cent of the GTS consultants, which have participated in external networks and commissions, have entered into collaboration with commissions under trade organisations who support the GTS institutes' role as technology intermediaries in specific industries. 44 per cent have entered into other networks within special technical areas which mainly cover national and international ERFA-groups within technical specialist areas, ATV networks, Nordic cooperation and high-tech network.⁷² Moreover, almost a third of the respondents say they have participated in standardization commissions, as well as a number of them also have participated in commissions in national institutions (18%) and in regions

71 Erhvervsministeriet (2000): Effekten af teknologisk service i Danmark

72 Based upon written responses to the category "Others, which?"

or municipalities (16%). A comparatively small part of the participating GTS consultants (11 per cent) have been involved in more informal network such as ERA networks.

Figure 6.25: The ATS consultants' participation in academic committees within the last year



Source: The ATS Association, 2008

6.9 The GTS net's courses and dissemination activities

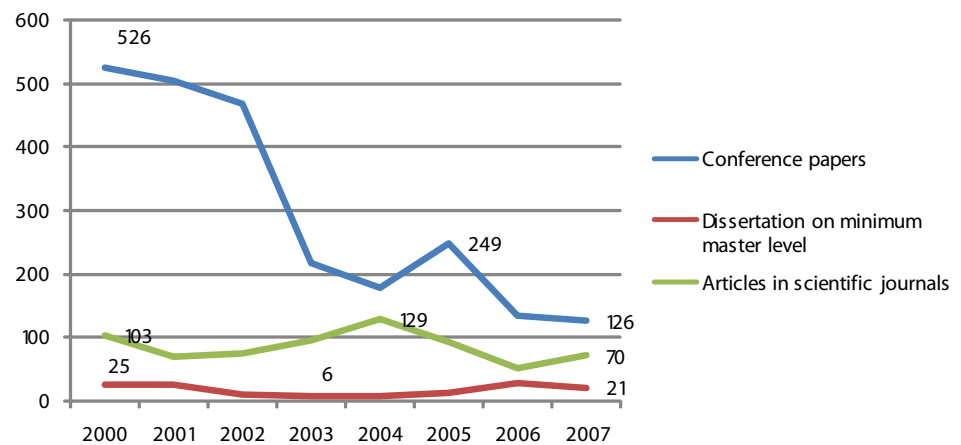
In the actual guidelines for Authorised Technological Service institutes, one of the central demands is that the GTS institutes maintain a high professional level, an ability to disseminate knowledge and in fact be able to *"...realise and disseminate knowledge to a large and broad sphere of users within the business enterprise sector and the public sector, especially through commercial services"*⁷³. It can be useful to differentiate between common non-research mediation such as course activities, and more specifically research mediation in the form of e.g. articles in scientific publications. Common non-research mediation entails the following: trade- or product specific homepages, non-scientific publications, courses, 'closing time' meetings, open house arrangements and professional/ technical commissions affiliated to the institutes.⁷⁴

⁷³ Videnskabsministeriet (2005): "Retningslinier for Godkendt Teknologisk Service i Danmark". side 7

⁷⁴ International evaluering af GTS-systemet – Baggrundsmateriale (2008): "Notat nr. 3: GTS-systemets formidlingsaktiviteter"

As concerns the specific research mediation in the form of articles in scientific publications, this activity has been ever increasing since 2000. Figure 6.26 shows that particularly the publication of conference papers have experienced a huge fall of 76 per cent, while the publication of reports at thesis level at the least, have fallen by 16 per cent and the publication of articles in scientific journals has fallen with 32 per cent. The huge difference in the number of the publications in the GTS net and at the universities is due to the fact that the GTS institutes do not have the publication of research articles as a significant goal, in that the individual GTS consultants – opposite the university researchers – typically not are being measured on the background of their publications.

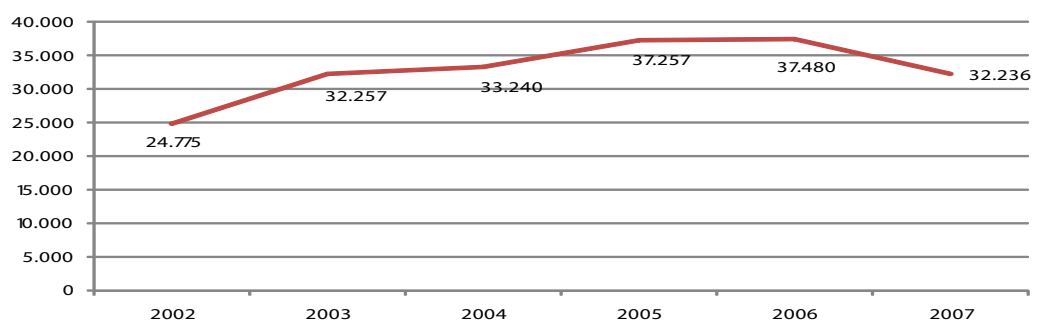
Figure 6.26: Number of academic theses and articles in the ATS net, 2000-2007



Source: The ATS Association, 2008

The GTS institutes had in 2007, as a part of their ordinary common mediation, course activities of app. 32,000 employees from companies and institutions in Denmark. Figure 6.27 below provides an overview of the GTS institutes' course activity in Denmark throughout the years. An increase of 30 per cent in the number of participants can be observed from 1998 to 2007 – and this in spite of a decrease of approximately 5,000 course participants from 2006 to 2007. However, the number of course participants is today at the same level as in 2004.

Figure 6.27: Number of participants in courses in Denmark, 2002-2007



Source: The ATS Association, 2008

7 Division of labor between central actors in the knowledge system

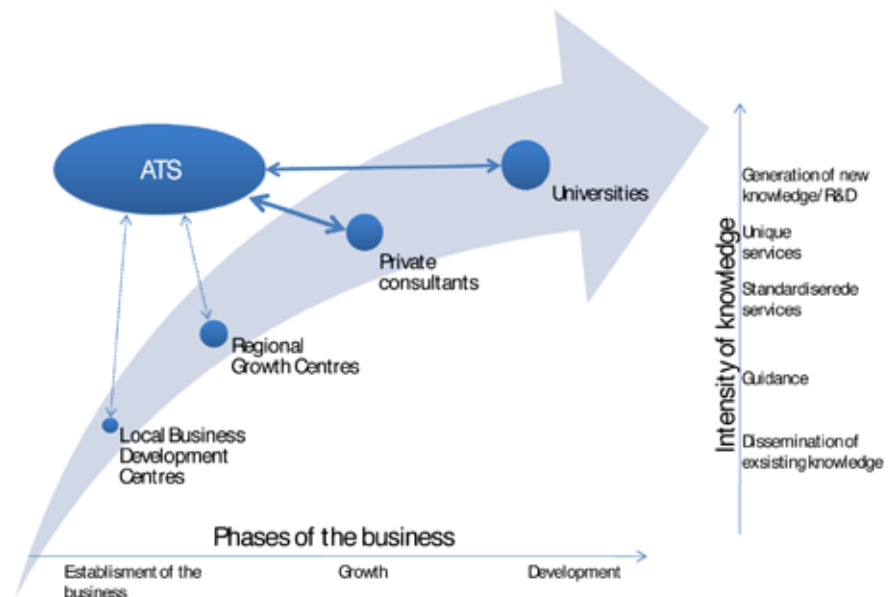


7.1 Introduction

The previous chapters have established the central actors in the research and knowledge system as well as uncovered the overall interaction within the knowledge and research system and the role and tasks of the GTS institutes. This chapter will build on these parts in an in-depth analysis of the labour sharing between the GTS institutes and certain central actors in the research and knowledge system. Moreover, the chapter is based on the questionnaires and the in-depth interviews conducted with a number of key persons in the Danish research and knowledge system.

The chapter will focus on the GTS institutes' interaction and roles in relation to the universities, the private consultants, the regional business policy actors and the multidisciplinary university colleges and the university colleges of engineering. These actors are all significant within the research and knowledge system but have at the same time very different assignments and roles. The difference is manifested in the actors' role in relation to the companies within the business enterprise sector. The below figure illustrates at a general level the actors' placing and role in relation to the business enterprise sector.

Figure 7.1: The companies' path through the knowledge system



Source: DAMVAD, Mapping of the Danish knowledge system, 2008

The regional business policy actors are especially relevant for entrepreneurs and new-start growth companies. The local industry centres and regional hothouses shall first and foremost disseminate existing knowledge to the companies and if necessary, assist in guiding the companies towards more knowledge intensive actors – the private consultants and the universities. The role of the private consultants is generally more focussed at delivering more or less knowledge intensive services to well founded companies. Finally, the role of the universities in relation to the companies is first and foremost based on very knowledge intensive services, hereunder R & D.

The question is how the GTS institutes fit within this set-up? The GTS institutes can potentially play a role in relation to all the actors and thereby simultaneously play a role for companies in various phases. On one hand, this requires that the GTS institutes have a very close relationship with the actors of the research and knowledge system in order for them to have an effective collaboration. On the other hand, there is a risk that the tasks of the GTS institutes are so in line with the tasks of the actors hence an inexpedient competition can arise. How the central actors in the research and knowledge system judge the role and assignments of the GTS institutes is evidently key to cooperation possibilities. Thus, the chapter starts in section 7.2 with a general actor assessment of the GTS institutes. This actor assessment is based on the results from DAMVAD's questionnaire among approximately 300 central persons in the Danish research and knowledge system.

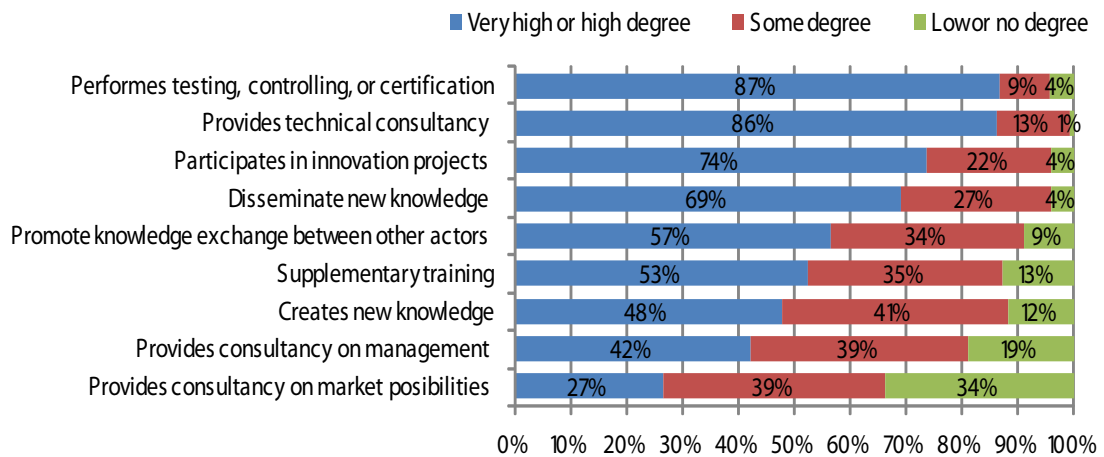
In the following sections the cooperation between the GTS institutes and chosen actors is illustrated. The sections will be based on the previous chapters, the questionnaires and the in-depth interviews with selected persons.

Section 7.3 analyses the overlap between the universities and the GTS institutes. The analysis shows on a general level that the GTS institutes have many cooperational overlaps with the universities, however there is a potential for a strengthened collaboration. Section 7.4 analyses the overlap between the GTS institutes and the private consultants. The overall result of the analysis is that the two actors have a very close cooperation but the relation is in some instances characterised by competition between the two actors. Section 7.5 analyses the overlap between the GTS institutes and the regional business promotion actors. The overall result is that the GTS institutes currently have a moderate informalised cooperation with the regional actors. Section 7.6 analyses the overlap between the GTS institutes and the multidisciplinary university colleges. The analysis shows that the two actors generally have very limited interaction, however there is potential for a future cooperation.

7.2 Overall actor evaluations of GTS

In questionnaires among approximately 300 central actors in the Danish research and knowledge system, DAMVAD asked the respondents to answer whether they know at least one GTS institute. 95% of the respondents answered yes to that question. Among these respondents 72% had had direct contact or cooperated with one or more of the GTS institutes. The respondents who already knew the GTS institutes were asked to evaluate to what extent the GTS institutes and their own organisation attend to certain general types of assignments. The below figure 7.2 sums up the respondents overall evaluation of the GTS institutes.

Figure 7.2: Which roles and tasks are taken care of by the ATS institutes today?



Source: DAMVAD. Mapping of the Danish knowledge system, 2008

As can be seen from the figure, the far majority of the respondents think that the GTS institutes to a very high or high degree perform probing, testing and control. Likewise, the respondents think to a very high degree that the GTS institutes provide technical consultancy. Opposite, the respondents have e.g. a general perception that the GTS institutes only to some degree, to a low degree or not at all provide management- and market consultancy.

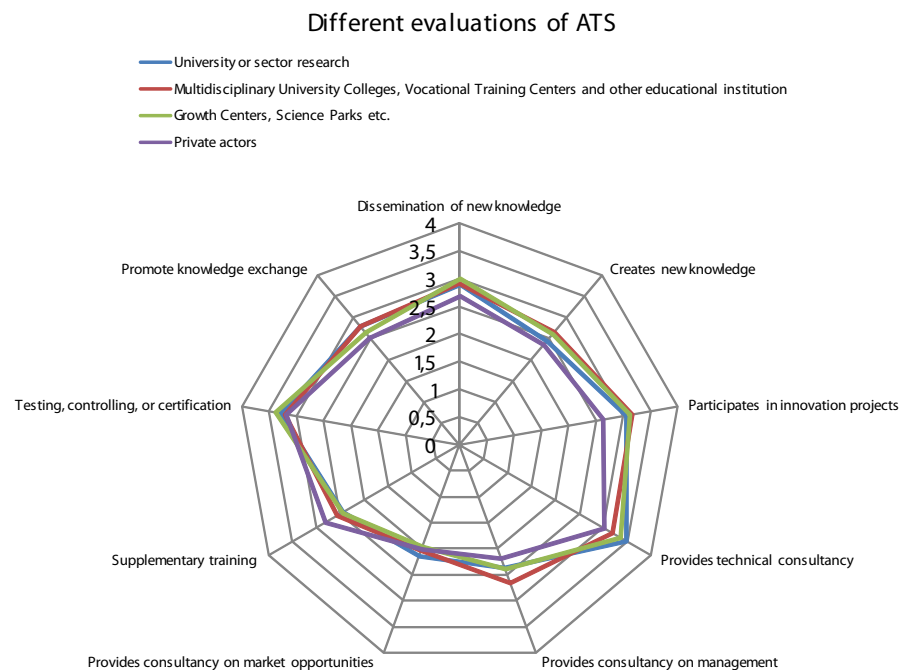
It is also important to stress that we are talking about a mapping of the respondents perception of which tasks the GTS institutes fulfil today. The responses themselves do not reveal to what extent the respondents think the GTS institutes are good or bad at performing these tasks or whether the GTS institutes ought to focus more or less on specific tasks.

The figures are first and foremost interesting when compared to the respondent's perception of their own organisation. By comparing the respondent's evaluation of the GTS institutes and their own organisation, you get an overall indication of the possible labour sharing and specialisation among the actors. The selected

actors' evaluation of the GTS institutes and their own organisation will be examined in sections 7.3-7.6.

In order to make a plain comparison, a so-called 'actor evaluation index' is established. The actor evaluation index for a specific group of actors is defined by looking at the average replies of the group's evaluation of the work tasks (the answer *To a very high degree* is given the value of 4, *To a high degree* is given the value of 3, *To some extent* is given the value of 2, *To a small extent* is given the value of 1 and *Not at all* is given the value of 0). These results can be graphically outlined in a 'spider web'. The below spider web shows how the four general groups of actors perceive the role and tasks of the GTS institutes.

Figure 7.3: All actors' evaluation of the GTS institutes roles and tasks

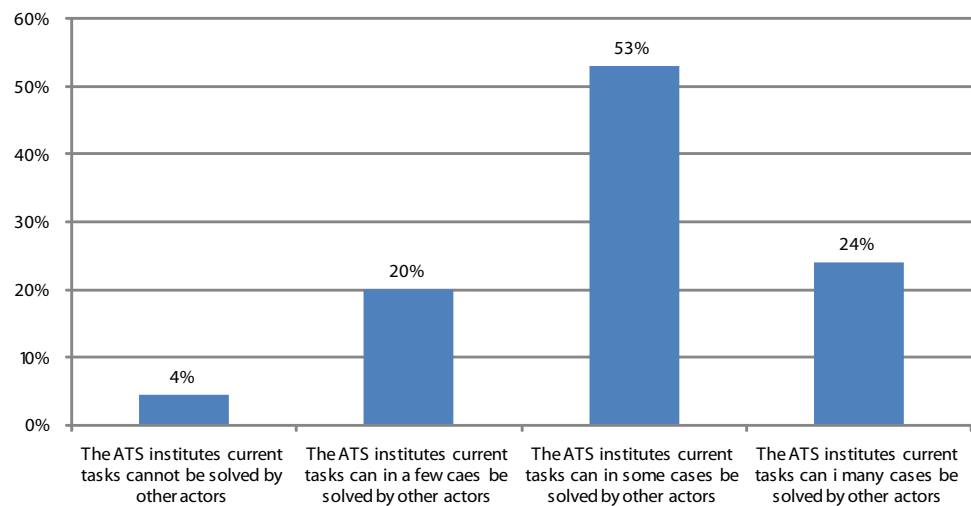


Source: DAMVAD. Mapping of the Danish knowledge system. 2008

different actors have very different interfaces with the GTS institutes (which will appear from the following sections), they have apparently a very homogenous perception of the GTS institutions. Another interesting perspective of the problem solving of the GTS institutes is the question of whether the tasks could be handled by other actors in the research and knowledge system. The respondent's evaluation of this question can be seen in figure 7.4 below.

As can be seen from the figure only four per cent thinks that the tasks of the GTS institutes cannot be handled by other actors. Another 20 per cent think that the tasks of the GTS institutes only in a few cases can be handled by other actors. It is thus more than 75 per cent of all respondents who think that the tasks of the GTS institutes in some or in many cases can be handled by other actors.

Figure 7.4: Which statement suits the situation of the ATS institutes best?



Source: DAMVAD, Mapping of the Danish knowledge system, 2008

It is important not to over-interpret this distribution of replies as a proof of the GTS institutions generally being considered obsolete actors (however, we can obviously not disregard that some of the respondents are of this opinion). It is therefore easily imaginable that respondents who think the tasks of the GTS institutes in many instances can be handled by other actors *at the same time* think the GTS institutes have particular strengths or qualifications in handling their tasks.

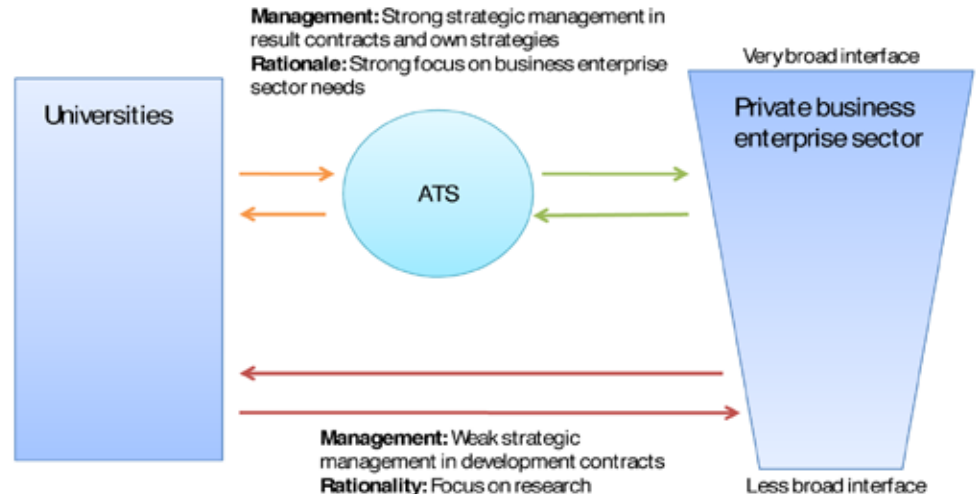
However, the replies clearly show that the other actors do not consider the tasks of the GTS institutes as tasks which necessarily have to be handled within the GTS net. In other words, they do not have a natural monopoly. The replies thus indicate that the GTS institutes' position in the research and knowledge system is dependent on them continuously showing the world that they are attractive collaborators. Not because they are the only ones to handle their tasks but because they are the best to handle their tasks. It is, however, important to remember that the GTS institutes are responsible for a number of official tasks, eg. in regards to standardisation and testing. A transfer of these tasks would be difficult within a short timeframe and the legal framework regarding technological service.

7.3 Overlap between GTS and universities related to the business enterprise sector

Both universities and the GTS institutes are involved in R & D, education and various sorts of cooperation with the business enterprise sector. As it will appear in this section there are, however, major differences between the two actors. This section will illustrate the similarities and differences between the universities and the GTS institutes. In continuation of this illustration the background for the differences will be analysed. Finally, the consequences of these differences for the actor's cooperation and possibilities in relation to the business enterprise sector will be illustrated.

As it appeared in chapter 3, the key assignments of the universities (research and education) are assignments that also to a certain extent are handled by the GTS institutes. Besides that, universities as well as GTS institutes are involved in a number of different forms for collaboration with the business enterprise sector. The overlaps between the universities, the GTS institutes and the private business enterprise sector can be illustrated by the below figure 7.5.

Figure 7.5: The ATS net and the universities in the knowledge system



Source: DAMVAD. Mapping of the Danish knowledge system, 2008

The universities' collaboration with the private business enterprise sector (illustrated as red arrows) comprises beside income covered business, among other things also education of PhD students (hereunder Industrial PhD), private consultant services and research collaboration. The universities have through out the last couple of years generally become more collaboration oriented towards the business enterprise sector. The increased focus on the business enterprise sector is for one thing due to the result of the merger between the sector research institutions and universities as well as the new university law from 2003 which among other things introduced boards with external majority at the universities.

However, the universities do not have the same broad interface with the companies as the GTS institutes have. Firstly, the universities see themselves as having a more limited role compared to the business enterprise sector while the GTS institutes are appointed a role as providers of a long range of consultancy services etc. Secondly, the universities and the GTS institutions have very divergent perceptions of the premises for collaboration with the business enterprise sector. The rationale for collaboration with the business enterprise sector for the universities is to a high degree that this collaboration provides a range of research possibilities. Simultaneously, there is a strict belief that the collaboration with the business enterprise sector may not take place on the expense of the universities' autonomy and freedom of research. In other words, the collaboration is to a high degree taking place on the premises of the research.

Contrary to this the GTS institutes are fundamentally focussing on the needs of the business enterprise sector. This is to a far extent due to the GTS net's historically close relation to the business enterprise sector, as many of the GTS institutes are 'conveyed' within the organisations of the business enterprise sector, cf. chapter 7. At the same time, the rationale behind the GTS institutes collaboration with the business enterprise sector (illustrated as green arrows) is that the GTS net must create commercial value for the companies through commercial market based services.

Thus, there are fundamental differences between the collaboration of the universities and the GTS institutes with business enterprise sector and the access they each individually have to the business enterprise sector.

Contrary to this the collaboration of the GTS institutes with business enterprise sector is controlled via more binding result contracts with the Ministry of Science (The Danish Agency for Science, Technology and Innovation). The strong strategic control in relation to the business enterprise sector concurrently comes from the GTS institutes themselves as they to a far higher degree than the universities are dependant on the commercial income they receive directly from the business enterprise sector.

The fundamental differences between the universities and the GTS institutes provide a range of possibilities and challenges for the internal cooperation of the actors as well as for the common collaboration with the business enterprise sector. As of today there are already a number of interfaces between the universities and the GTS institutes (illustrated as yellow arrows). The universities have for one thing established GTS institutes, are on boards, are physically located to each other, join R & D collaboration and participate in formal and informal network with the GTS institutes. The investigation has at the same time shown that there is potential for a strengthening of the collaboration between universities and GTS institutes if a number of present barriers for collaboration can be eliminated. Presently the collaboration is limited by among other things lack of competences among the GTS institutes and the lack of economical recourses for collaboration.

7.3.1 Overlap between universities and GTS institutes

On an overall level the universities and the GTS institutes provide much of the same type of services to the business enterprise sector. However, there are also major differences in the size and character of these kinds of services among the two actors. The table below compares universities and GTS institutes on a number of areas. The comparison is based on different sources for GTS institutes and universities respectively. It must therefore be with the proviso that there can be different definitions in the surveys. Nevertheless the comparison is interesting as it illustrates a number of similarities and differences.

Table 7.1: Chosen numbers of activities for GTS institutes and universities

	GTS	Universities
R&D	<ul style="list-style-type: none"> – 575 mill. DKK in R&D expenses – 455 R&D cooperation project 	<ul style="list-style-type: none"> – 7.3 bill. DKK in R&D expenses – 14,342 contribution financed research projects
Traditional research dissemination	<ul style="list-style-type: none"> – 70 academic article – 461 conference contributions – 21 academic theses 	<ul style="list-style-type: none"> – 15,573 academic article – 4,488 conference contributions – 1,238 academic books
Educational activities	<ul style="list-style-type: none"> – 32,200 participant in courses – 31 ph.d.-students – 164 academic employees with connection to education institutions 	<ul style="list-style-type: none"> – 22,420 tuition paying students/ participants in courses either full or part time – 119,983 bachelor and master students – 5,790 PhD-students – 4,745 university teachers (full time equivalent)
Commercial sales	<ul style="list-style-type: none"> – 34,939 clients of which 30,589 are Danish – 2,040 mill. DKK in commercial turnover of which the 1,052 mill. DKK in commercial turnover. 	<ul style="list-style-type: none"> – Uncertain number of customers/cooperation partners 501 mill. DKK in commercial turnover

Source: GTS: Performance Account, Universities: Rektorkollegiet and CFA

Universities as well as GTS institutes have a significant R & D activity. As can be seen from the table the universities' expenses for R & D are 13 times as much as the GTS institutes' expenses. At the same time the universities have far more many R & D projects than the GTS institutes (however, there can be major differences in the magnitude of such collaboration projects and one should therefore be careful to draw conclusions on the basis of these figures).

The quantitative differences in relation to the dissemination of knowledge is to a high degree a reflection of the universities and the GTS institutes performing very different forms of research. As could be read in section 3.4, over half of the universities' R & D activities are characterised as basic research while the GTS institutes to a far higher degree are engaged in applied research and developmental work. This means e.g. that the production of scientific articles not can be seen as creditable for the individual GTS consultant whereas scientific articles are an absolutely central activity for university researchers. This difference has been underlined in the qualitative interviews conducted.

Both universities and GTS institutes are engaged in education - however, this primarily constitutes a key activity for universities which have almost 150,000 students divided into bachelor-, master-, PhD- and open and part time educations. Looking isolated at tuition fee paying students the GTS institutes seem to have more students annually than the universities but this should be seen in the light of the fact that the tuition fee paying students at the universities often are master students within multi-annual studies. Out of the universities' almost 6,000 PhD students enrolled, only 31 are affiliated with the GTS institutes.

Both actors have also to a major extent collaboration with the business enterprise sector. However, the GTS institutes' commercial collaboration is more wide-ranging than the universities'. The GTS institutes served more than 30,589 Danish customers in 2007 of which 17,281 were small companies. The cooperation with the business enterprise sector resulted in a total commercial turnover of 2,040 million DKK for the GTS institutes. This can be compared to the total commercial turnover for the universities which was 501 million DKK.

As it also appears from the following section, the universities' cooperation with the business enterprise sector is far from restricted to income covered business. DAMVAD has as a part of this investigation contacted universities in order to map the overall cooperation of the universities with the business enterprise sector. As a reaction on our approach the individual universities have provided extensive lists regarding the cooperation (lists of cooperation with the IT-university, Roskilde University and Aarhus University can be found in the appendix).

The feedback from the majority of the universities has though been that it was not possible to send such information as they were not registered (many universities have partial registrations but were unwilling to hand these out as they do not provide a sufficient picture). Part of the explanation of the missing registrations and lists at the universities can be that we are talking about a complex field: more universities pointed out that the cooperation comprises

many different forms, and often they are registered at a decentralized level (faculty or institute).

The inadequate registering of the business enterprise collaboration can also nonetheless be seen as an expression for the universities (lacking) prioritisation of the field. The conducted in-depth interviews have shown that not all the university actors think there is a huge need for a better overview regarding their collaboration with the business enterprise sector – they first and foremost work towards developing the registrations because the Ministry of Science in the universities’ result contracts requires documentation for the collaboration with the business enterprise sector. The universities’ attitude in this area will be further examined in the following section which takes a closer look at the universities’ and the GTS institutes’ collaboration with the business enterprise sector.

7.3.2 The universities and the GTS nets business sector oriented roles

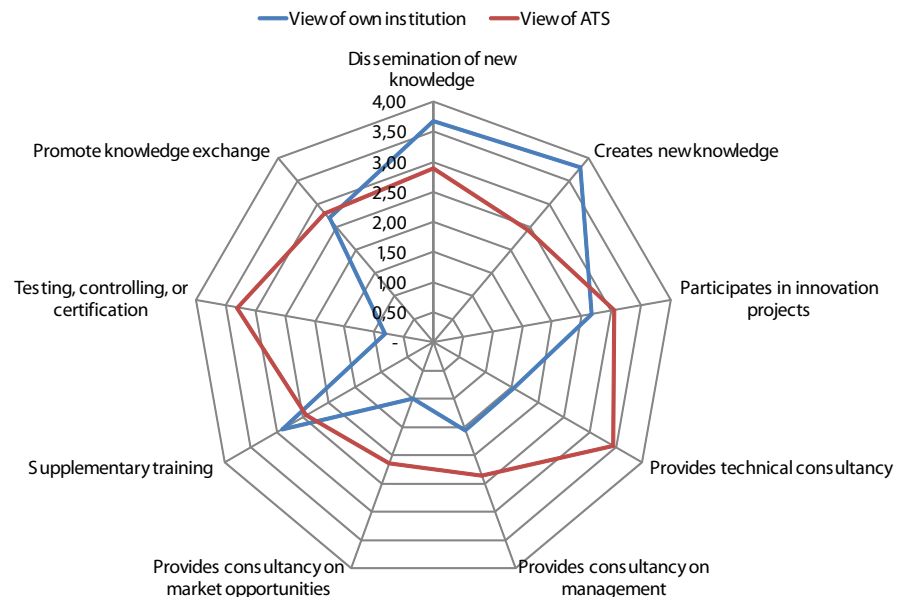
Though the documentation regarding the universities’ cooperation with the business enterprise sector is insufficient, it is clear that the universities have a broad collaboration with the business enterprise sector and that the universities generally have approached the business enterprise sector through out the last couple of years. The universities’ commercial income covered business is hence in just one single year increased from 194 million DKK in 2006 to 501 million DKK in 2007⁷⁵. At the same time the universities’ interaction with the business enterprise sector is far from limited to formal agreements about commercial income covered business. The collaboration also takes place in form of education of PhD students (hereunder Industrial PhD), the researcher’s private consultancy business, sale of patents and licenses, research cooperation, establishment of new companies etc.

Two explanations of this approach to the business enterprise sector have been stressed in the conducted in-depth interviews. The first factor is the introduction of the new university law which was passed by the Danish parliament in 2003. With the new university law boards with external majority at the universities were established. The large amount of business enterprise persons in the boards of the universities has lead to an increased focus of the business enterprise sector and the requests of the political system. The other factor is the mergers between the universities and the sector research institutions that took place in 2007. Many of the sector research institutions and the smaller universities (among those The Faculty of Life Sciences and The Faculty of Pharmaceutical Sciences) have always had a knock-on effect on the big universities which previously had a more limited contact with the business enterprise sector.

⁷⁵ http://www.rektorkollegiet.dk/politik_debat/statistik/testside/universiteternes_statistiske_beredskab

Nonetheless, the universities do still not have the same broad interface to the business enterprise sector as the GTS institutes. In this case it is interesting to look at which role the universities ascribes themselves to in relation to the interaction with the business enterprise sector compared to which role the universities ascribe to the GTS net. It is evident from the questionnaires that the universities still ascribe themselves to a more limited cooperational interface regarding the business enterprise sector. The universities' and the sector research institutions' evaluation of own their tasks and the tasks of the GTS institutes is illustrated in the below actor evaluation figure.

Figure 7.6: Role evaluation index – the role evaluation of the universities



Source: DAMVAD, Mapping of the Danish knowledge system, 2008

It appears from the figure that the universities first and foremost see themselves as disseminators and creators of new knowledge. The universities also ascribe themselves a certain role in relation to exchange of knowledge as well as further education. On the other hand, the universities do not generally perceive consultancy as an important task for them. Probing, testing and certification are to a very limited extent perceived as a relevant task for the universities.

The universities perceived thereby their own roll in relation to the business enterprise sector as particularly different compared to the role they ascribe to the GTS institutes. The universities generally perceive, like the other questioned actors, the GTS institutes as actors who to some or to a high extent provide technical consultancy, participates in innovation projects and perform probing, testing and certification – which all are services that to a high degree are business oriented.

The conducted in-depth interviews have in chorus documented that the universities, still, are influenced by a completely dissimilar culture than the

GTS institutes when it comes to cooperation with the business enterprise sector, although there can be seen large differences among the university actors. Overall, two different views on the universities' cooperation with the business enterprise sector can be traced in the conducted in-depth interviews. The different viewpoints can be summarized in two ideal-typical descriptions. The interviewees cannot necessarily all be characterised single-handedly as clear representatives for the advocates of one of the two ideal-types but the ideal-types illustrate the width in perceptions among the university actors:

Ideal-type 1: universities as lighthouses

A number of the interviewees saw to a high extent the cooperation between the university and business enterprise sector as a process in which the universities create knowledge through their own research and thereafter convey it to (passive) receivers in the business enterprise sector. This was expressed by the collaboration with the business enterprise sector being seen as interesting for the universities and the researchers if they received economic compensation in order to disseminate their research results. This perception of the role of the universities in relation to the business enterprise sector corresponds very much to what Reichert (2006) refers to as "*the purist view*" which is characterised by a one-way transfer of knowledge from the universities to their surroundings.⁷⁶

Ideal-type 2: Knowledge sharing between the university and the business enterprise sector

Other respondents from the university field were to a higher degree expressing that the cooperation between the university and the business enterprise sector could provide valuable input to the research. Here the focus was more that a knowledge synergy between public and private research could be achieved by, for one thing, the private research and the private business enterprise bring practise, problem orientation and business relevance into the public research. The perception correlates somehow to "*the sober view*" or "*the creative view*" by Reichert (2006), where the universities are seen as actors who enter into knowledge exchange or reciprocal stimulus and support with other actors respectively. We are close to a modus 2 approach to knowledge production in this case.⁷⁷

⁷⁶ Reichert, Sybille (2006): *The Rise of knowledge Regions: Emerging Opportunities and Challenges for universities*

⁷⁷ Gibbons et.al (1994): *The New Production of knowledge*

Box 7.1: Statements from people interviewed (DAMVAD's translation)

"I don't think that the business enterprise sector should be able to determine our research areas. We determine our research areas ourselves. But we are willing to engage in dialogue with other actors on potential areas of research."
Jens-Peter Lynov, Vice-director, University of Copenhagen

"The universities are currently in a dilemma between on the one side, to become more business oriented and on the other side to emphasize the importance of general research. It's a big challenge to maintain the right balance between these two considerations." Egon Toft, Pro-Dean, University of Aalborg

"The orientation towards knowledge sharing with other actors is not inconsistent with maintaining a strong focus on research. The initiative on focusing on knowledge sharing with the business enterprise sector on the contrary provides new resources." Jens Oddershede, Rector, University of Southern Denmark

"The universities have often cooperated with the GTS institutes. It is often the GTS institutes that are the initiator in relations to the establishment of a project group. The university's experiences with the GTS institutes in these cooperation projects are mixed. The experiences are that the people involved from the GTS institutes often lack project management experience, which some times results in the projects not being followed through. There is a clear competition between the GTS institutes and the universities in some areas. It is a possibility that some of the GTS's tasks will be taken over by the universities." Egon Toft, Pro-Dean, University of Aalborg

"We do a lot to establish dialogues with the businesses, but universities should not function as consultants for businesses. In those cases where we provide direct counseling to the business enterprise sector it must be knowledge and research based – e.g. directing a formulation of a research based problems to a target group of SMEs, who often are not able to formulate a research based problem on the basis of the needs they have on for example how to solve a technical task. But it must also be a matter of the businesses providing some kind of feedback to the university research. Our consultancy must have a very clear connection to research and the knowledge found in the universities." Søren Elkjær Frandsen, Pro-rector for Knowledge Transfer, University of Aarhus

"At the same time the GTS institutes should not engage in research the same way as the universities. To the extent the GTS institutes do engage in research it must be with basis in concrete, technological, problems and uses of technologies in the business enterprise sector and not with basis in general research. General research should be conducted by universities not GTS institutes." Søren Elkjær Frandsen, Pro-rector for Knowledge Transfer, University of Aarhus

"A lot of GTS institutes are very commercial, but there are areas, where we see obvious possibilities for cooperation with the GTS institutes. We would, however, like incentives, which would make it more interesting for the GTS institutes and the universities to cooperate. It's important not to monopolise the cooperation between the universities and GTS. When the universities wish to interact with someone it's because they are amongst the best in that field not because you should interact with a certain institute." Søren Elkjær Frandsen, Pro-rector for Knowledge Transfer, University of Aarhus

"The university and the GTS institutes are partly players in the same field, but there is plenty of room for both of them. The universities deliver in the form of knowledge whilst the GTS institutes have the client base. For this division of labor to work the GTS institutes must be careful not to try to deliver based only on their own knowledge. The universities on the other hand must be careful not to engage in direct client contact. At University of Southern Denmark we have a good dialogue with the GTS institutes on this division of labour – primarily Force and Teknologisk Institute." Jens Oddershede, Rector, University of Southern Denmark

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

Despite the differences in attitude there is however a fundamental agreement among the university actors that the research of the universities is not supposed to only be research for and to the business enterprise sector. The autonomous and free basic research is vital in the universities' self-knowledge, and the universities have generally no ambitions of becoming vendors of consultancy services to the same extent as the GTS institutes are.

There is therefore a fundamental difference between the criteria for success among the universities and the GTS institutes regarding research and research collaboration with the business enterprise sector. The difference was summarized by one of the investigation's actors as the difference between Stockholm and Wall Street: The researchers at the universities have ambitions in scoring high on the Stockholm index (i.e. research which can lead to Nobel prizes) while the GTS consultants research ambitions are targeted towards the Wall Street index (i.e. research and innovation with a large business potential).

7.3.3 Different financing of universities and GTS institutes

The essential differences in the universities' and the GTS institutes' market orientation are supported by the way the universities and the GTS institutes are funded by the public sector. As documented in chapter 3 and chapter 6 the commercial incomes constitute a far greater share for the GTS institutes than for the universities. Even if you only focus on the two actors research costs there are significant differences.

Universities as well as GTS institutes both receive "basic funding" for research from the Ministry of Science, and simultaneously they enter into contracts with the ministry regarding what they have to deliver because of the funding. The universities receive basic funds and enter into development contracts while the GTS institutes receive GTS result contract funding.

Figure 7.7: The public finance of GTS and universities research and development

	Funding of independent research	Funding of strategic research
General funding	General funding for universities	ATSResult Contract Funds
Funds in competition	The Danish Councils for Independent Research Danish National Research Foundation	Consortia of Innovation Danish National Advanced Technology Foundation The Danish Council for Strategic Research EU Framework Programmes

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

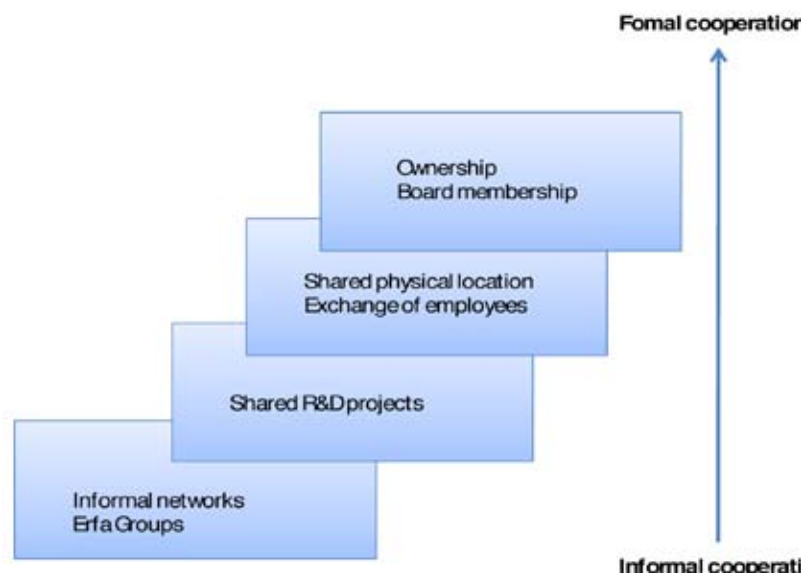
As earlier mentioned, the basic funding for the GTS institutes is founded on a much stronger strategic control than the basic funding to the universities is. In this way the GTS institutes' basic funding can be seen as a strategic grant. This means that the result contract funding of the GTS institutes often are carried out as part of specific business enterprise oriented activities, competence building or support. On the opposite, the basic funds of the universities are free means which are prioritised internally at the universities primarily on research based criteria.

The activity based control with the basic funding at the GTS institutes involves that it can be more difficult for the GTS institutes than for the universities to receive so-called competition funds from among others the research- and innovative financed system. It applies to means from the EU's framework programs, The Danish Council for Strategic Research and The Danish National Advanced Technology. The challenge for the GTS institutes is to be able to free sufficient resources from the basic funding towards the co-funding that often is demanded in order to be able to receive these competition exposed means.

7.3.4 Cooperation between universities and GTS institutes

The basic differences in universities and GTS institutes establish a number of challenges as well as possibilities for the actors' internal collaboration and joint collaboration with the business enterprise sector. As illustrated in the below figure 7.8 there are presently a long range of contact- and cooperational overlaps between the universities and the GTS institutes

Figure 7.8: Channels of cooperation between ATS and universities



Source: DAMVAD, Mapping of the Danish knowledge system, 2008

The strongest formal ties between universities and GTS institutes are the instances where the universities directly own GTS institutes: as could be seen in chapter 6, the two Danish GTS institutes, Danish Fundamental Metrology and Bioneer, owned by The Technical University of Denmark. It appeared from the conducted in-depth interviews that The University of Southern Denmark likewise have had considerations as to establish one or more GTS institutes. However, the University did conclude they were not quite ready yet. As also appeared in chapter 6, the universities are represented on the boards of several GTS institutes.

The formal interfaces between universities and GTS institutes consist moreover also of employee exchange and physical co-placement. One of the latest GTS institutes, the Alexandra institute, has placed its Copenhagen branch in the IT-hothouse which is located at the top of the IT University. Besides that the universities and the GTS institutes enter into different forms of R & D cooperation. The University of Southern Denmark and The Danish Technological Institute are e.g. involved in Robocluster which is a competence network concerning robots, automation and intelligent mechanical systems⁷⁸. Finally, the contact area between the universities and GTS institutes are characterised by a number of informal networks.

The conducted interviews among the university actors have indicated that there, according to the universities, is basis for a strengthened cooperation between the universities and the GTS institutes. As far as the universities are concerned there is a certain consent to letting the GTS institutes work as links between universities and the business enterprise sector. More concretely, the GTS institutes could contribute to securing a more effective (commercial) use of the research infrastructure at the universities by acting as intermediaries between the business enterprise sector and the universities.

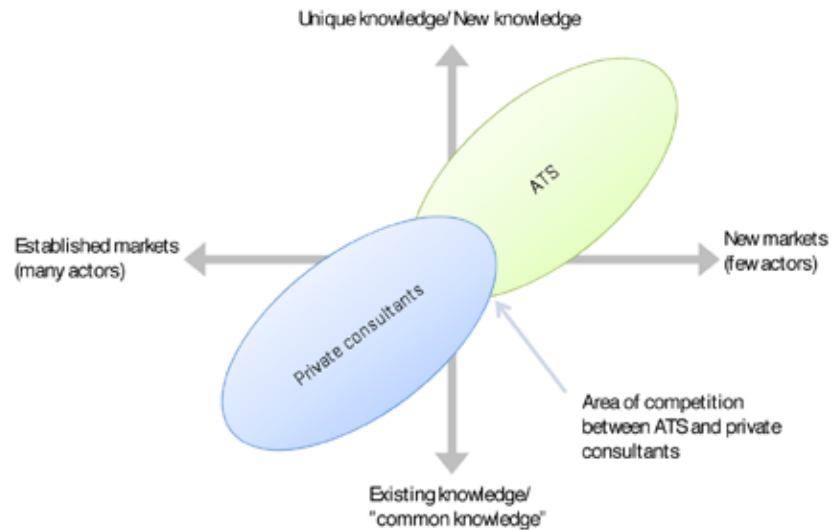
7.4 Overlap between GTS and private consultants

The supply of commercial based activities from the GTS institutes means that they to a high degree are placed in the same part of the knowledge and research system as a number of private actors in the knowledge market. Therefore, there is a large overlap between the GTS institutes and the private advisors. The most important question in relation to this overlap is whether it is characterised by cooperation or competition.

This section shows how the two actors differ in relation to their role within R & D. In continuation of this, we firstly illustrate the collaboration overlaps between the GTS institutes and the private actors, and secondly the competition situations between those two actors are illustrated. In summing up, the relation between the GTS institutes and the private consultants can be described via figure 7.1 below.

⁷⁸ <http://www.robocluster.dk>

Figure 7.9: Division of labour between ATS and private consultants



Source: DAMVAD, Mapping of the Danish knowledge system, 2008

There are large differences between the GTS institutes and the private knowledge consultants. This is reflected partly in the two actor's R & D activities where the GTS institutes generally are more research intensive than the private consultants. At the same time, the GTS institutes have various forms for affiliation to the Danish universities (cf. section 7.4) as well as a number of foreign knowledge institutions. These differences mean that the GTS institutes have a number of strengths which make them relevant collaboration partners for the private consultants. As several GTS institutes historically seen at the same time are 'conceived' by a number of the business enterprise sections organisations themselves, there are a range of obvious cooperation overlaps in which the GTS institutes can pass on new knowledge and specialised knowledge to the private consultants. All together, the GTS institutes can be part of creating and cultivating new markets that in the beginning are too unsure for the private consultants.

The cooperation between the GTS institutes and the private consultants is thus helping in adding specialised competences to the private consultant's solution to their assignments. However, there are areas which the GTS institutes, according to some of the private consultants, have neglected. It concerns the 'soft' humanistic and society relevant areas for one thing – areas which become more important for the private consultants but meanwhile areas where the GTS institutes are less and less active.

Despite the differences between the two actors there are however also such a huge overlap in competences that the GTS institutes and the private knowledge consultants sometimes are in direct competition with each other. These competitive situations arise because of the constant development which takes

place in the market. The GTS institutes' unique services today are standard services tomorrow, and among some private actors the opinion can be found that the GTS institutes sometimes focus too much on established markets where they compete against a range of private consultants with the same competences (based on the above figure it can be stated that services in time will move from the top right corner to the bottom left corner).

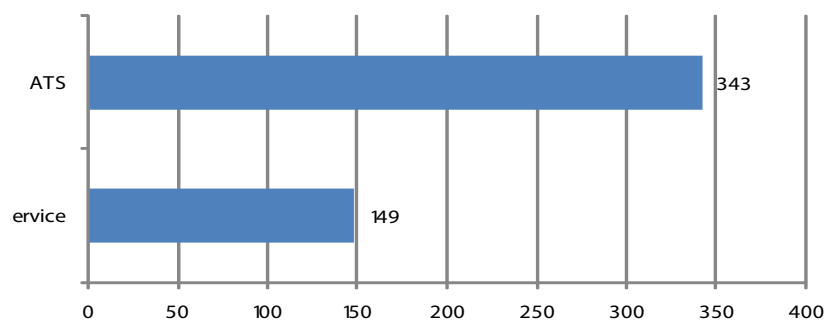
This competitive situation is often seen as unfair and problematic by the private consultants. This challenge is not getting smaller as the private consultants gradually are focussing more on R & D, and thereby faster than before acquire the new and specialised knowledge of which the GTS institutes' services are based.

7.4.1 Differences in research and development

The activities of the two actors in R & D can essentially explain the cooperation as well as the conflicts between the GTS institutes and the private consultants. On one side, the R & D activities of the GTS institutes make them major collaboration partners for the private consultants. On the other hand, the public economic support to the GTS institutes can result in a competitive situation which can be viewed as uneven and problematic by the private consultants. Thus it is worth focussing on the R & D activities among the two actors.

The GTS institutes as well as the private consultants within knowledge service are involved in R & D. If you only look at volume the private knowledge service has a far higher turnover within R & D than the GTS institutes. A special report from The Danish Centre for Studies in Research and Research Policy shows that the private knowledge service in 2005 altogether invested 6.9 billion DKK in R & D activities, while the GTS institutes had R & D activities for 676 million DKK⁷⁹. However, the GTS institutes have generally a remarkably higher R & D intensity compared to the private actors. The special report shows as such that the GTS institutes in 2005 on average performed R & D activities for 343,000 DKK per employee, while the private actors within knowledge service had an average R & D activity of 149,000 DKK per employee. The difference is illustrated in the below figure 7.10:

Figure 7.10: R&D intensity (1,000 DKK pr. Employee, 2005)



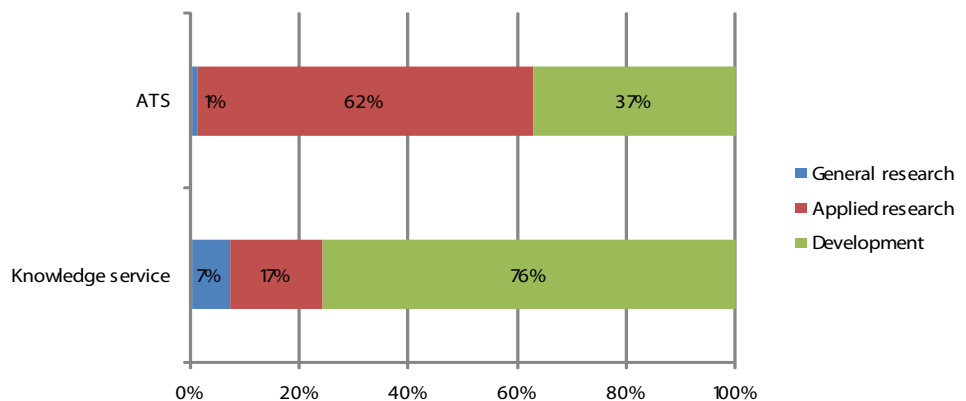
Source: Customized data, CFA, Forskningsstatistikken, 2008.

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Source: The Danish Centre for Studies in Research and Research Policy (CIS 2006), 2008.

Meanwhile, there are noteworthy differences in the character of the R & D activities from the GTS institutes as well as the private consultants. As can be seen from the below figure 7.11, 62% of the GTS institutes' research is classified as applied research which implies research that consist of original investigations with the aim to achieve new knowledge primarily targeted for defined practical purposes. For the private actors the applied research only accounts for 17% of the total R & D activity. However, 76 per cent of the R & D activity performed by the knowledge service actors is classified as developmental work, i.e. systematic work based on the use of knowledge achieved through research and/or hands on experience with the aim to create new or significant improved materials, products, processes, systems or services. Both the GTS institutes and the private knowledge consultants are only to a limited extent involved in basic research.

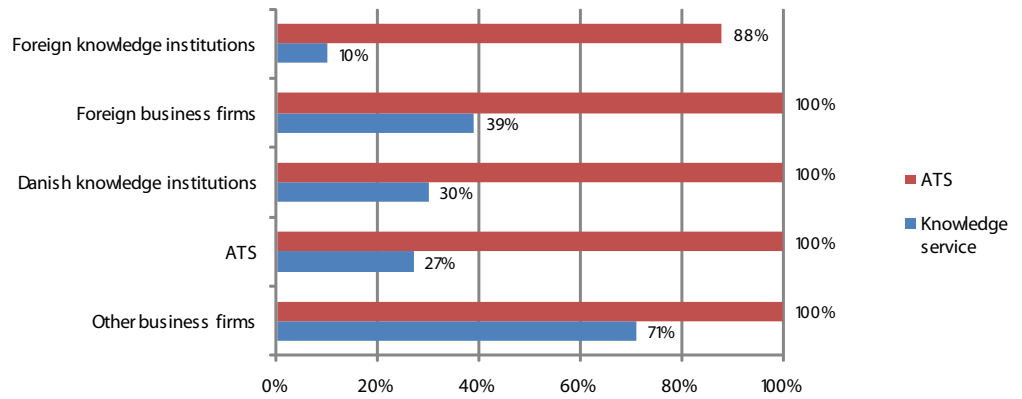
Figure 7.11: Types of research, 2005



Source: Customized data, CFA, Forskningsstatistikken, 2008.

It is also particularly noteworthy that the GTS institutes generally have a broader interaction in their R & D activities than the private knowledge service actors. Figure 7.12 below shows that nearly all GTS institutes cooperate with foreign knowledge institutions regarding R & D. All GTS institutes had collaboration with foreign companies, Danish knowledge institutions, other GTS institutes and companies. The private knowledge service actor had to a far less degree R & D collaboration with those actors. It is worth mentioning that only 10 per cent of the private knowledge service actors had R & D collaboration with foreign knowledge institutions.

Figure 7.12: Interaction on R&D, 2005



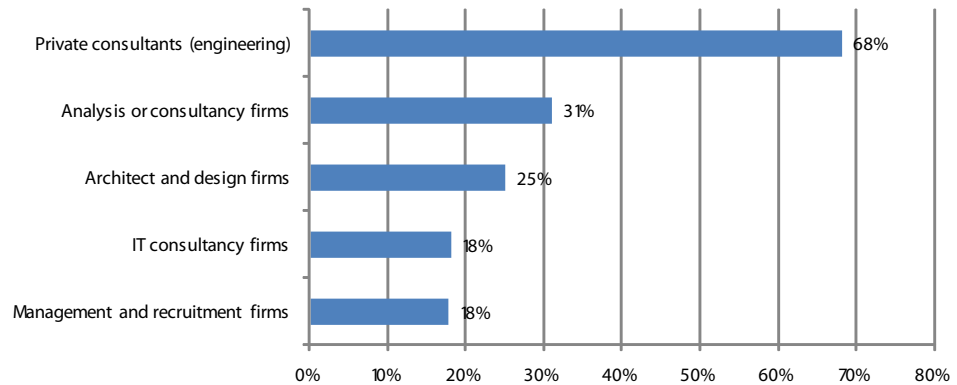
Source: Customized data, CFA, Forskningsstatistikken, 2008.

The GTS institutes’ research intensity, research type and research interaction separate itself significantly from the private consultants in this way. On behalf of these differences it is fair to assume that the two actors build different forms for expertise which can add to form basis for collaboration between the two actors. As it also appeared from chapter 6, several GTS institutes are created by the business enterprise sector itself on the basis of an expectation that the institutes could provide service to the private actors. This concerns among others The Danish Technological Institute which was established in 1906 in connection to the foundation of The Confederation of Danish Employers and The Confederation of Danish Industry (formerly known as Industrirådet). This trade affiliation is obviously helping to increase the expectations of the GTS institutes’ ability to cooperate with and service the private consultants.

7.4.2 Division of roles between GTS and private consultants

DAMVAD’s questionnaire confirms irrevocably that there is cooperation between the GTS institutes and the private consultants. 70 per cent of the respondent GTS consultants have had collaboration with one or more private suppliers of knowledge services in connection to the solving of their assignments. The GTS consultants who replied they have worked together with private suppliers of knowledge services have in continuation to this answered what type of private suppliers they have collaborated with. The replies of the GTS consultants are summed up in the below figure 7.13.

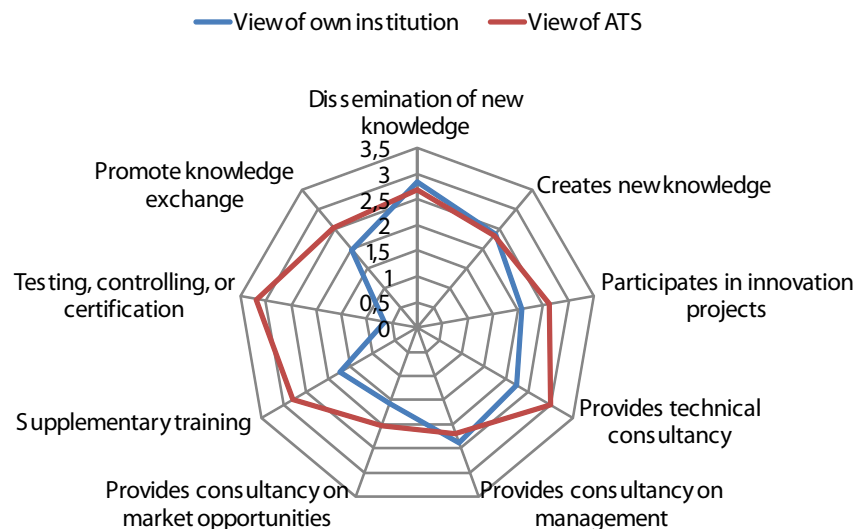
Figure 7.13: Which types of suppliers of private consultancy have you cooperated with within the last year?



Source: DAMVAD, Mapping of the Danish knowledge system, 2008

As appears from the figure, the GTS consultants collaborate specifically with private consultants. A total of 68 per cent of the GTS consultants, who have collaborated with private suppliers of knowledge services, have thus collaborated with private consultants. The questionnaires results imply however that the collaboration overlap between the GTS institutes as well as the private consultants not necessarily is defined by clear labour sharing. The private consultants are certainly of the opinion that the GTS institutes deliver the same overall types of services as the private consultants themselves. The private consultants' evaluation of own tasks and the tasks of the GTS institutes is lined out in the below figure.

Figure 7.14: Actor evaluation – private consultants



Source: DAMVAD, Mapping of the Danish knowledge system, 2008

As it appears from the actor evaluation, the GTS institutes, in the opinion of the private consultants, are highly involved in the same types of tasks as the private consultants themselves. The clearest sharing of labour is found regarding probing, testing and certification, which the private consultants basically do not deal with. Also regarding further education there is a relatively clear labour sharing but on the remaining areas both GTS institutes and private consultants are in some or to a high degree suppliers of the same main types of services. On the background of these results it is of course important to look at whether the overlap between the GTS institutes and the private consultants is dominated by positive cooperation relations, or if the private consultants just as much look upon the GTS institutes as competitors.

7.4.3 Cooperation areas

There is, as the results from the questionnaire have shown, a significant collaboration between GTS institutes and private consultants. There has within the qualitative interviews likewise been pointed out a number of concrete collaboration projects and interviews have confirmed that the knowledge consultants see a number of positive contributions from the GTS institutes.

In the concrete projects the GTS institutes will often contribute with special analyses and special knowledge to e.g. private consultants who in return have expertise in relation to the planning of building projects and the use of technology. The GTS institutes and the private actors e.g. make offers for projects within the structural funds of the EU and Danida. Finally, the GTS institutes can often act as intermediaries in relation to the private consultants. The Alexandra Institute has e.g., besides cooperating with private consultants, often procured contact between companies and private consultants. The GTS institutes are in this case often trustworthy intermediaries because they are seen as neutral consultants.

The conducted interviews have shown that there are at least two reasons for the GTS institutes being much coveted collaboration partners for the private consultants.

Firstly, it is emphasized that the GTS institutes have a position of strength in relation to research. This is due to the GTS institutions being more R & D intensive than the private consultants (cf. the above section), but it is also specifically emphasized that the GTS institutes have a special position in relation to the cooperation with foreign knowledge institutions. As could be seen in the previous section the GTS institutes have a broad collaboration with foreign knowledge institutions. The strength of the GTS institutes compared to these foreign knowledge institutions is based on, according to the private actors, the prestige which derives from being official acknowledged and so to speak are “officially approved”. Moreover, the GTS institutes have sister organisations in other countries with similar GTS arrangements.

Secondly, the GTS institutes are according to the interviewees strong compared to the more risk accentuated knowledge purchasing from abroad. In many cases it will stay unclear which possibilities there are to incorporate new

foreign knowledge into a commercial framework in the Danish market. Such investments will thus be very risk accentuated and will therefore be able to hold private consultants, and other strictly private actors, from investing in such a purchase. The GTS institutes have contrary to this the possibility and willingness to such more risky projects.

These two conditions provide in many instances a sensible labour sharing between the GTS institutes and the private actors. The GTS institutes are entirely in front when it comes to R & D which is disseminated (via cooperation) to the private actors. If and when there are private actors who also are capable (in other words, when a private market has been established) the GTS institutes move on to other assignments and new markets. This labour sharing is secured for one thing through formalised dialogue between the GTS institutes and representatives from the private consultants. The Danish Technological Institute thus meets twice per year with both The Danish Association of Consulting Engineers and The Knowledge Consultants. The GTS institutes themselves stress at the same time that they are very alert that they do not create practises that distort competition by entering into areas which can be handled by private consultants.

The conducted interviews have also revealed that there might be potentials for more collaboration areas. Among the private consultants therefore are actors who regret that the GTS institutes almost entirely have focus upon the technical and scientific fields and not pay attention to humanistic and social sciences which are relevant for the organisational and managerial problems in the companies. Interviews with GTS actors confirm the perception that the GTS institutes in fact focus to a lesser degree on these areas. This applies for e.g. The Danish Technological Institute which more and more removes itself from these 'soft' knowledge fields such as management and organisation which are handed over to the management consultants. The lacking focus of the GTS institutes on these areas is perceived as a problem by the private consultants because the universities generally do not focus either on the dissemination of knowledge within these areas. Hence, there is an unfulfilled need for research procurement within these areas.

Box 7.2: Statements from people interviewed (DAMVAD's translation)

"I am happy that the GTS institutes' roles in the knowledge system is being mapped, because we lack concrete knowledge about how the GTS institutes can become better at adding value to both service businesses in general and consultancy businesses in specific." Christian Tanggaard Ingemann, Market Director, Danish Business

"I don't perceive the GTS institutes of being in a position of competition with the private consultancy sector. And they ought not to be. It must be ensured that the GTSs are active in areas, where there is no private business coverage." Christian Tanggaard Ingemann, Market Director, Danish Business

"We perceive ourselves as neutral in our consultancy. With private consultants there is a risk, that they are influenced by their own products and therefore highlight these products when giving advice. The advice from Alexandra Institute is more deeply rooted, because it is based on national and international IT-research. In this way, we try to view things from a R & D point of view." Jan Bisbjerg, Head of knowledge dissemination, Alexandra Institute

"We often cooperate with private consultants – e.g. the larger players within IT development. On the other hand we also mediate contacts between companies and private consultants – this is possible based on the neutrality of our own consultancy." Jan Bisbjerg, Head of knowledge dissemination, Alexandra Institute

"We have a certain 'hate/love' relationship regarding the GTS. Sometimes they function as partners other times as competitors. Today the GTS institutes are too unfocused on the things they are good at. There is also a need for greater transparency about which kind of activities and equipment the GTS can receive public funding for. This is very difficult to determine today." Poul Skadhede, CEO, DI Knowledge Advisors

"The tools of the GTS institutes are primarily located within the technical and natural science areas. If you look at how society develops, it is a challenge for the GTS system to develop knowledge services directed towards the more 'soft' knowledge areas. The GTSs have, looking historically, had their justification related to the traditional industrial society. The GTS should also focus on areas of R & D where it is presently not known whether the areas can translate into business." Poul Skadhede, CEO, DI Knowledge Advisors

"GTS has a niche when it comes to bringing home the 'risky' knowledge from abroad, where it is unclear what happens when you put this in a commercial frame in Denmark." Henrik Garver, Director, The Danish Association of Consulting Engineers (FRI)

"The private consultants in the engineering area also have a direct link from the universities to the customers and we also bid on EU framework programmes. The private consultants in the engineering field have a lower research and development intensity than the GTS institutes, but this is not so prominent if you subtract the public general funds the GTS institutes receive." Henrik Garver, Director, The Danish Association of Consulting Engineers (FRI)

"Teknologisk Institutes field of work does not overlap substantially with the private consultants – the ones we overlap the most with are the private consultants in the field of engineering. We often cooperate in EU projects, where we deliver special analysis and knowledge. We are both very specialized. The private consultants in the engineering field today are so professional in their tasks that the GTS institutes have no role to play on their area. We would for example never dream of being project managers on a construction project, where the private consultants are immensely skillful. In by far the most cases the services supplied by GTS and private consultants are complimentary." Søren Stjernqvist, CEO, Danish Technological Institute

Source: DAMVAD. Mapping of the Danish knowledge system, 2008

7.4.4 Competition situation

Even though the overlap between the GTS institutes and the private consultants often are characterised by cooperation, it is meanwhile evident that the overlap in certain situations can be competitive marked and full of conflicts. Desk research has uncovered examples of the GTS institutes being reported to The Danish Competition Authority by private actors. The two examples are described in the below box.

Box 7.3: The Danish Competition Authority's decision regarding GTS institutes

Two decisions illustrate how the GTS institutes' overlaps with private knowledge service actors can be seen as conflictual.

The RM Group's complaint about Dansk Brand- og sikringsteknisk institut

The Danish Competition Authority heard in 2004 a complaint from the RM Group (RMG) about the fact that Dansk Brand- og sikringsteknisk institut (DBI) miscredited RMG to its customers, refused to engage in exchange of experience on interpretation of directions, and refused to publish RMG's advertisement in DBI's journal. Furthermore RMG complained that DBI was dumping the prices, had too long terms of notice, demanded too high fees, and misused its public function to demand information from the other businesses in the field, which could identify RMG's customers and marketshare. The Danish Competition Authority dismissed the points of complaint after an investigation of the matter.

Complaint about Teknologisk Institut

In 2005 The Danish Competition Authority chose not to make further investigations related to a complaint about Teknologisk Institut, Tribologiscetret. The complainant claimed that Tribologiscetret had a too dominating position on the market for certain tribology services, that Tribologiscetret was providing discriminatory discounts and that Tribologiscetret possibly violated the Danish law on competition chapter 3a on competition distorting financial support. The Danish Competition Authorities made a preliminary investigation of the market, but chose not to proceed with the investigations related to the complaint.

The two incidents of The Danish Competition Authority illustrate that the overlap between the GTS institutes and private consultants can result in conflicts. Two incidents in 2004 and 2005 respectively is however not an indication that the overlap in question is full of conflicts (The Danish Competition Authority did in the years up till then handle almost 300 complaints annually).⁸⁰

The conducted interviews have though confirmed that the private consultants to a certain extent have had a love/hate relationship with the GTS institutes. The most significant problem is, from the point of view of many consultants, when the GTS institutes stay in a market with too many private actors even though the

80 <http://www.ks.dk/om-os/maal-og-styring/aarsrapport/virksomhedsregnskab-2002/vr2001pdf/>

GTS institutes no longer are the leading experts in this market. Such competition from the GTS institutes is not *necessarily* considered a problem if there is a perception that it is offered at equal market terms. But the competition can be considered problematic if it is not exactly clear for the other actors whether the GTS institutes are able to offer their services cheaper due to public subsidies.

From the perspective of the private consultants there can thus be a wish for the GTS institutes being better to pull out of markets with large competition. It is at the same time though an acknowledgement of the fact that we are talking about a very difficult balance which all the time is moved because the GTS institutes, private actors and the markets are constantly developing. In other words it not possible to make a permanent line of demarcation between the markets at which the GTS institutes shall be present and the markets they should leave to private consultants.

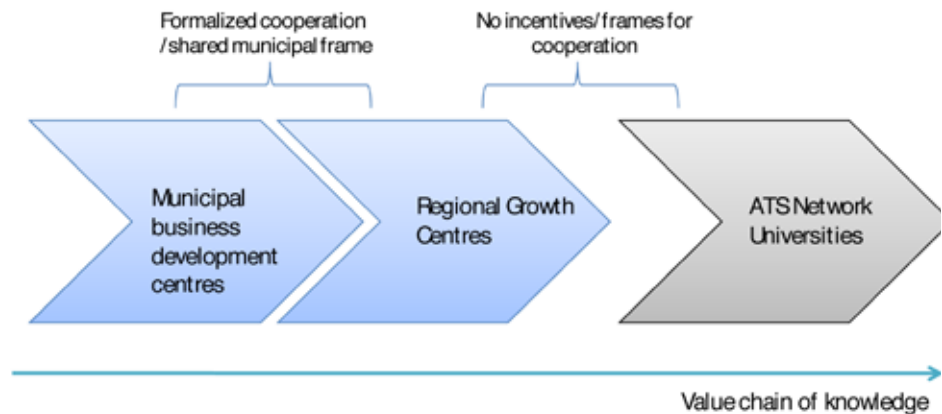
The major challenge for the GTS institutes in relation to the private consultants is therefore that the institutes must develop and disseminate themselves in the areas and markets the private consultants find appropriate, but at the same time move on when the knowledge and matching competences have been firmly established among the private consultants. In other words the GTS institutes must constantly work at being at the forefront with the services of the private consultants.

7.5 Overlap between GTS and regional business development actors

The regional business promotion system is currently characterised by new actors – the hothouses – and the hereof following new role allocation between the enterprise centres and the hothouses. The hothouses and the local enterprise centres have already by now entered into a number of collaboration agreements, and the relations between the two actors are expected to be further formalised in the future.

The equivalent formal collaboration model does not exist when it comes to the relation between regional business promotion actors and the GTS institutes. The GTS institutes operate at a higher level of the knowledge value chain than the regional actors and it is therefore worth considering whether the potential for collaboration between the GTS, the hothouses and the local enterprise councils can be realised through formalised collaboration agreements. As it is illustrated in the below figure, the lacking collaboration relations can mean that the companies are not being brought forward in the research and knowledge system which again means they not are brought forward in the knowledge value chain.

Figure 7.15: Missing connection between regional actors and ATS institutes



Source: DAMVAD. Mapping of the Danish knowledge system, 2008

In the following sub section an example is given of the regional business promotion actor's activities and cooperation. In continuation of this the cooperational overlap between the regional business promotion actors and the GTS institutes is illustrated.

7.5.1 The regional business development actors

The local enterprise councils work in close interaction with the regional hothouses, and often they will point companies which have a need for specialised guidance towards the hothouse. The hothouses' most important task is, as it was mentioned in chapter 4, to guide and point towards relevant private consultants as well as encourage cooperation between public and private actors.

A relevant example of a regional initiative is VÆKSTmidt, which aim it is to support companies in the Central Denmark Region. The program focuses on companies that are situated in rural areas and lies within the region's "mega staking areas" (provision, health as well as environment and energy). Moreover, the program is mainly targeted at small and medium-sized companies. These companies constitute partly the core in the employment basis in the region and partly act as sub-suppliers for the regions big international group of companies. VÆKSTmidt is described further in the box below.

Box 7.4: VÆKSTmidt

The tools within the VÆKSTmidt program covers:

1. Strategy and management

The overall objective for the tool within strategy and management is to improve innovation and competitiveness for SMEs. This happens with the help of four tools:

- "The Development Kompass": Financial support to an external consultant with the purpose of solving a concrete development problem with relevance for the business' innovation or competitiveness..
- "Manager for rent": Financial support for the inclusion of an external advisor. The advisor must function as a 'whip' and sparring partner for the management and the employees.
- Growth sparring: An experienced business man or woman is attached to the business as a sparring partner.
- Plato: Managers from 10 small or medium sized businesses meet in a group, which has two executives from larger enterprises attached as mentors.

2. Export and Globalisation

The tools of "Globalization" provide support particularly in the areas focused on the utilization of globalization (import, eksport and sourcing).

- Global guide: The business is given financial support to attach an external consultant e.g. with the purpose establishing an international network or creating a globalisation strategy.
- Globus Growth Group: 8-10 businesses are offered a course of competences development within culture, international administration, strategy for sourcing etc.

3. Teknologi og Innovation

The tools are especially directed towards SMEs, who doesn't seek external technological knowledge themselves for further developing already existing project programs. The financial support is directed towards projects, where you through technological development develop and improve innovation and competitiveness with the business' products.

- "Check theTechnology": Businesses are given a consultant from the Regional Growth Centre for uncovering the needs of the business. After this, financial support is given for an external consultant, who must give guidance on for example test of materials, patent application, and similar issues.
- IT for growth: Financial support is given for the attachment of an external consultant and for participation in seminars on the use of ITC.

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

VÆKSTmidt is a good example of companies having more entry roads to participation in such enterprise programs. The companies can either get in direct contact with the Midtjylland hothouse or get visited through the local business centres in the individual municipalities. The local and regional business promotion actors have in multiple instances entered into more general formal

agreements concerning cooperation and references.⁸¹ In relation to this it is worth mentioning that the hothouses, though being regional actors, actually are founded by the municipalities. Reference from a business centre to a hothouse is thus to be seen as a reference between two local authority actors and it must be expected that this relation is contributing to strengthen the interlink between the actors. It is therefore generally a very close interlink between the local business centres and the regional hothouses. As it will appear from the following section, this is to a somewhat lesser extent the case for the interlink between the regional business promotion actors.

Box 7.5: Statements from people interviewed (DAMVAD's translation)

Does the University of Aalborg have a role to play as regional growth engine? Yes, definitely – it is a role that the universities take very seriously. The region and other actors in the area often contact the university to acquire knowledge or in order to let the university take part in regional development projects. Egon Toft, Pro Dean, University of Aalborg.

"We should resist any tendencies among regional growth centres to keep the contact the businesses to themselves. We need to assist e.g. the work of the Hothouses in directing the business further in the knowledge systems value chain and we should make sure that there are incentives to lift the level of competences in the business. So the businesses evolve. This can be done e.g. by securing a better interaction with the GTS net or the universities. We must avoid suboptimization and secure synergy amongst the actors in the knowledge system." Jan Bisbjerg, Head of knowledge dissemination, Alexandra Institute

"We would like to see an increased cooperation with the new regional growth centres, which could function as a food chain on the businesses road to the GTS network. Søren Stjernqvist, CEO, Danish Technological Institute

"The GTS institutes are also partly caught in the dilemma between academic synergy and presence. They are located around Copenhagen and that means something in how they are perceived. Physical presence is a precondition for good customer contact – this problem is particularly felt in the north of Jutland. But being present is not a problem and task for the GTS institutes alone. It is also a task of the universities to include the GTS institutes, which would increase their regional presence. It is a mutual obligation. Jens Oddershede, Rector, University of Southern Denmark

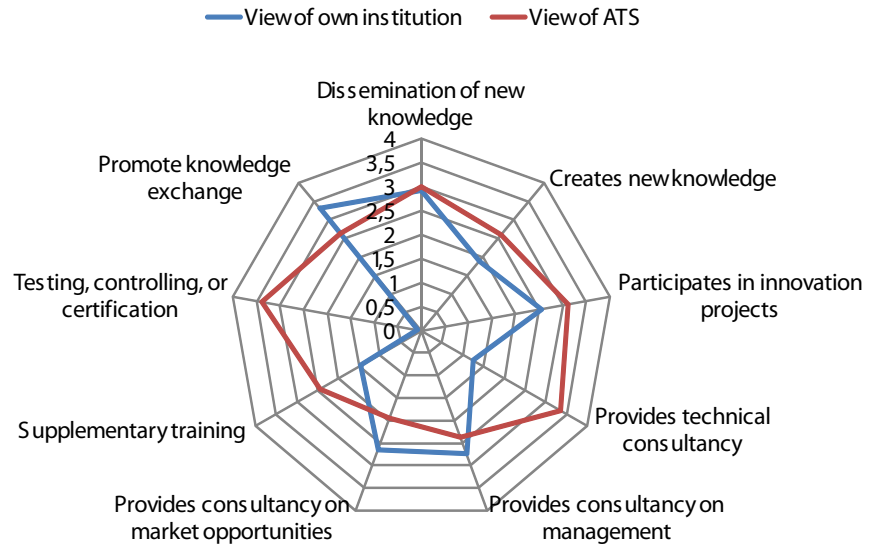
Source: DAMVAD, Mapping of the Danish knowledge system, 2008

7.5.2 Actor evaluation from the regional business development actors

The conducted questionnaire has documented that the regional business promotion actors place a significantly different role upon themselves compared to the role they place upon the GTS institutes. The regional business promotion actors' evaluation of their own and of the GTS institutes tasks respectively is illustrated in the below figure 7.16.

⁸¹ See e.g. agreement between VIBORGEgnens Erhvervsråd, VIBORG KOMMUNE OG VÆKSTHUS MIDT-JYLLAND ([www.viborg.dk/db/dagsord.nsf/4aad8661c8259a2fc12572540051db8d/3989031eea8fd3a5c125745100517b7b/\\$FILE/EUU-220508-10-1.pdf](http://www.viborg.dk/db/dagsord.nsf/4aad8661c8259a2fc12572540051db8d/3989031eea8fd3a5c125745100517b7b/$FILE/EUU-220508-10-1.pdf))

Figure 7.16: Actor evaluation – Regional business development actors



Source: DAMVAD, Mapping of the Danish knowledge system, 2008

As it appears from the figure, the regional business promotion actors first and foremost see themselves as an actor who shall encourage dissemination of knowledge. Besides that the actors do to a certain extent provide consultancy about management and market opportunities (the local business promotion actors do often distinguish between their *guidance activities* and proper *consultancy* which is handled by private actors. Viewed from the perspective of the local business promotion actors it is hence more correct to talk about guidance compared to the market opportunities and management).

The local business promotion actors have at the same time the perception that the GTS institutes to a high or to some extent maintain a range of tasks, hereunder probing, testing and certification as well as technical consultancy. It is there not unfair to assume that the local business promotion actors are alert to the fact that companies in need within these areas can be pointed towards the GTS institutes. The possibilities for reference are strengthened by the GTS institutes often being represented at a regional level.⁸²

The conducted interviews have also shown that there is in fact a rather close contact between the regional actors and the GTS institutes. Djursland business council has e.g. worked closely together with the Alexandra Institute, The Danish Technological Institute and Agrotech concerning various projects.

82 International evaluering af GTS-systemet – Baggrundsmateriale, september 2008: Notat nr. 5: GTS-systemet i regionalt perspektiv

Midtjylland hothouse have likewise worked together with these GTS institutes while the business council in the Viborg area especially have worked together the Alexandra Institute and The Danish Technological Institute.

However, based on the conducted interviews it is also evident that the cooperation between the regional business promotion actors and the GTS institutes is comparatively informalised and to a high degree driven by personal contacts. It is in this occasion important that the GTS institutes, as opposite to the universities, not are represented in the regional growth forums. As it appeared in chapter 5, the GTS institutes' participation in regional funded innovation projects is likewise limited.

The GTS institutes can themselves help to strengthen the interaction between the regional actors. A concrete proposal from the conducted interviews was a road show in which the GTS institutes, maybe in cooperation with the hothouses, present new concrete ideas for collaboration between the local, the regional and the national level within the business service area.

7.6 Overlap between GTS and University Colleges

7.6.1 Introduction

The multidisciplinary university colleges are, as it was laid out in chapter four, new actors in the Danish research and knowledge system which was established in January 2008 by merging the former CVU's. The multidisciplinary university college's primary contribution to the research and knowledge system is education of multidisciplinary bachelors. The multidisciplinary university colleges educate to a high extent for the public labour market (nurses, educationists, teachers etc) but do also offer a number of educations that are targeted towards the private business enterprise sector (bio analysts, business oriented educations, building technicians etc). To this the engineering educations at the two academies of engineering have to be added.

The multidisciplinary university colleges have also via their knowledge centres a number of activities that are targeted more directly towards the public and private sector. The multidisciplinary university colleges are therefore interesting in relation to the GTS institutes since they to a high degree are placed as an interlink between real life and the world of research. It is hence natural to consider whether a close interaction between the multidisciplinary university colleges and the GTS institutes could be appropriate as regarding a strengthening of the knowledge dissemination in the research and knowledge system. The analysis has though shown that there currently is a relatively restricted interaction between the multidisciplinary university colleges. There exist informal contacts between the two actors but the interaction has no real strategic importance.

In the following section the multidisciplinary university colleges' activities concerning knowledge dissemination is mapped out. Following that, the overlap between the multidisciplinary university colleges and the GTS institutes is examined.

7.6.2 The University Colleges knowledge dissemination activities

It is stated in the law on multidisciplinary university colleges for higher educations that the multidisciplinary university colleges have to ensure their knowledge basis through cooperation with relevant research institutions. It appears explicitly from the law that this also includes that the multidisciplinary university colleges shall cooperate strategically and concrete with the universities.⁸³

Box 7.6: Examples of reseacher affiliation

Researcher affiliation can happen for example by:

- That the teacher at the Multidisciplinary University Colleges completes a master or a researcher education, or participate in supplementary training, seminars, conferences etc. at the university.
- That universities and other institutions of research are included in the Multidisciplinary University Colleges' development projects or that the colleges participate in releveant research and development projects at the universities.
- That acces to the research liberaries databases etc. or other online information on the newest research and newest forms of materials and knowledge teaching is ensured etc.

The concrete utilization of the obligation of researcher affiliation – meaning decision on the concrete researcher affiliation initiative, prioritizing of funds for researcher affiliation and the choice of concrete parternes on the specific initiatives is made locally on the Multidisciplinary University College.

Source: DAMVAD, on the basis of "Bilag om Dokumentation, udvikling og deling af viden (forskningstil-knytning)". Globaliseringsrådet, 2006.

As it appeared in chapter four the multidisciplinary university colleges in Copenhagen have e.g. entered into a cooperational agreement with the University of Copenhagen which includes cooperation regarding education as well as cooperation regarding R & D.

The law likewise constitutes that the multidisciplinary university colleges shall attend to knowledge centre functions. The multidisciplinary university colleges shall among other things through national and international cooperation as well as knowledge and competence development furthermore contribute to regional and national development and growth of trades and professions, hereunder in edge areas. These demands to the multidisciplinary university colleges therefore suggest that the multidisciplinary university colleges are placed as an interlink between research and practise. This role is also reflected in the multidisciplinary university colleges' result contracts with the Danish Ministry of Education.⁸⁴

83 Lov om professionshøjskoler for videregående uddannelser (LOV nr 562 af 06/06/2007)

84 Undervisningsministeriet, "Udviklingskontrakter 2008-2009", 2008.

The multidisciplinary university colleges are as mentioned new institutions. However, they build upon the CVU's who also handled knowledge centre functions. The development of these knowledge centres took among other things place by project funds from the Ministry of Education.⁸⁵ The below box includes an overview of the knowledge centres that received knowledge centre funds from the Danish Ministry of Education:

Box 7.7: Overview of centres of knowledge, which has recieved knowledge center funds
Integreret Energidesign (IED)
Nationalt Videncenter for Matematikdidaktik
Videncenter for Sundhed, Kost og Motion for børn og unge
Videncentre for Realkompetencevurderinger
Nationalt videncenter for læremidler
The Animation Workshop - Videncenter for Animation (TAW)
National videncenter for Inklusion og Eksklusion
Videncenter for Turisme og Oplevelsesindustri
Videncenter Dellabs
Videncenter for International Innovation
Videncenter for Teknologisk Innovation
Videncenter for rehabilitering og fysisk aktivitet for borgere med kroniske lidelser
Videncenter for powerline teknologi
Videncenter om sammenhængende patientforløb og rehabilitering
Videncenter for Ledelse
Videncenter for evaluering i praksis
Videncenter for Innovative Processer
Center for Anvendt Naturfagsdidaktik
Videncenter i ledelse og læring
Nationalt Videncenter for Læsning
Videncenter for e-læring (eVidenCenter)
Sundhedsteknologier i hjemmet (SIH)
Trådløse teknologier og økonomi
Videncenter for bedre undervisning af toprogede elever i uddannelsessystemet
Videncenter for Uddannelses- og Erhvervsvejledning
Videncenter for Fødevarer og Sundhed
Videncenter for Industrielt Byggeri (VIB)

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

⁸⁵ <http://www.uvm.dk/admin/institutionsstruktur/videncenter.htm?menuid=2535>

However, it is important to add that a long range of knowledge centres did not receive knowledge centre funds from the Danish Ministry of Education. An evaluation of the knowledge centres has shown that the knowledge centres particularly are aimed at public educational institutions and other public institutions. Almost two thirds (64%) of the centres had to a high extent or to some extent delivered consultancy services targeted at the educational institutions. In a fewer instances (60 per cent) the centres had offered consultancy to public companies. Only a fourth (25 per cent) replied that they to high extent or to some extent had offered consultancy to private companies. More than 60 per cent replied that they had not offered consultancy to private companies at all.⁸⁶

The multidisciplinary university colleges' knowledge functions are not yet been illustrated to the same extent but their knowledge centre functions are as mentioned to a high degree based on the CVU's knowledge centre functions. The conducted interviews confirm that the multidisciplinary university colleges to a high extent look upon themselves as "cement mixers". The multidisciplinary university colleges seek heavy research (and participates to a limited extent) at the universities and contributes at the same time with extensive practical knowledge to the universities. Meanwhile, their gained knowledge is canalised out via the knowledge centres. The multidisciplinary university colleges have thereby a function which in many ways is parallel to the function of the GTS institutes.

7.6.3 Interaction between University Colleges and GTS institutes

The questionnaire among the central actors in the Danish research and knowledge system resulted in 15 replies from headmasters and other leaders from multidisciplinary university colleges, engineering institutions and business academies. From these 15 respondents, 7 persons indicated they have had direct contact or cooperated with one or more GTS institutes. However, there was not found examples of cooperation between these actors and the GTS institutes which have any significant strategic meaning. The conducted interviews did not either give examples of any formalised interaction between the actors. The multidisciplinary university college in Copenhagen has e.g. contact to the Danish Technological Institute but this contact has been based on personal relations and have not yet resulted in a real formalised collaboration.

There have not been identified significant obstacles for collaboration between the multidisciplinary university colleges and the GTS institutes in the investigation. The lacking collaboration can therefore be the result of the two actors not seeing each other as important collaboration partners. It is however worth to consider whether the two actors, who to such a high degree are involved in dissemination of knowledge, would be able to gain positively from an extended collaboration. It is evident that the multidisciplinary university colleges' close contact to the private business enterprise sector could involve a potential for an extended collaboration between the two actors.

⁸⁶ Pluss Leadership (2006): "Analyse af videncentre- Statusrapport om resultater og erfaringer"

Box 7.8: Statements from people interviewed (DAMVAD's translation)

"The Multidisciplinary University Colleges can function as 'cement mixers', which gains advanced research – and to some degree participates in it – from the universities. At the same time the Multidisciplinary University Colleges can provide practical experience to the universities." Laust Joen Jakobsen, Rector, University College, Copenhagen

"The Multidisciplinary University Colleges are maybe not closely tied to the knowledge system yet, but the current legislation provides the possibilities, and the universities have a real interest in the cooperation. The division of the educational institutions in the Ministry of Education and the Ministry of Science is foolish, however. If the institutions were located in the same ministry the discussions on whether the Multidisciplinary University Colleges could offer a master degree would be far more open. The cooperation with the universities would furthermore be easier." Laust Joen Jakobsen, Rector, University College, Copenhagen

"The Multidisciplinary University Colleges has no formal cooperation with the GTS institutes today. I have talked to The Technological Institute about the possibility of some of our leading employees visiting the institute. The work regarding the establishment of the Multidisciplinary University Colleges has, however, meant a postponement of the plans." Laust Joen Jakobsen, Rector, University College, Copenhagen

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

8.1 Challenges for the knowledge system

The former chapters in this mapping have shown that there is a comprehensive interaction between the actors in the knowledge system. In some parts of the knowledge system this interaction is closer than in others. At the same time it is different amongst the actors in the knowledge system how close the contact to the business sector is, and which types of services that are delivered to the businesses related to their innovation needs. But at the same time the analysis show that in some areas can be created more and stronger incentives for cooperation between the actors in the knowledge system. In this chapter, we focus on the challenges in the research and knowledge system with basis in the results presented in the previous chapter.

The challenges focused on in the following should contribute to reflections on how the knowledge system and its functionality can be improved and optimized. This including how the interaction between the knowledge system and the GTS can become more efficient and coherent, with the purpose of creating a strengthened framework for innovation in the Danish business enterprise sector. On the basis of the mapping three overall challenges can be pointed out:

- To ensure increased coherence and visibility amongst the actors in the knowledge system to give the companies an easier access to the offers of the knowledge system
- To create the best frameworks for an increased development effort broadly among other things to direct the effort towards smaller companies and the knowledge service businesses
- To create a better framework for the internationalisation of the knowledge system and the business enterprise sector to strengthen the purchasing of knowledge from abroad.

The pinpointing of the challenges is based upon the results in the previous chapters and the survey among the actors in the research and knowledge system. There is focus on the challenges for the research and knowledge system in general as well as on specific challenges for the GTS net. The table below provides an overview of the challenges for the research and knowledge system and for the GTS net.

Table 8.1: Challenges for the research and knowledge system and the ATS net

Knowledge system	ATS net
Coherence and visibility	
<ul style="list-style-type: none"> – More incentives and funds for cooperation across actors and larger coherent endeavours – national and regional. – Increased coordination between actors in the knowledge system related to the contact to the businesses. 	<ul style="list-style-type: none"> – More coherence in the ATS Institutes effort. The institutes must strategically work as a joint network. – The ATS net should be more active in the regional innovation and business development policy. Must contribute to regional growth. – Continuing to secure dynamics in the ATS net and increase dialogue between ATS and private consultants to avoid distortion of competitiveness and secure the build-up of business relevant competences.
Better framework for increasing knowledge in larger parts of the sector	
<ul style="list-style-type: none"> – Securing frames to ensure that the knowledge systems activities are supporting private research and development. – Preparing research and innovation grants and projects to make it attractive for more businesses to participate. 	<ul style="list-style-type: none"> – Ensuring increased focus on SMEs and on business firms within knowledge service. – Ensuring increased participation for the ATS net in more business oriented research and innovation projects. – Ensuring the development of more models of cooperation between ATS and universities. E.g. on research infrastructure to make sure a wide section of the Danish business enterprise sector is reached.
Strengthened internationalization	
<ul style="list-style-type: none"> – More incentive for the actors in the knowledge system to participate in international innovation cooperations. – Utilize the possibilities in the existing regulation to attract environments of knowledge from abroad to Danish cooperative projects. 	<ul style="list-style-type: none"> – Increased ATS participation in EU Framework programmes. Both regular participation and with coordinating function. – Support the ATS institutes strategy for internationalisation – especially related to international cooperation on research and bringing home knowledge. – Secure national research of the ATS nets internationalisation to benefit most Danish companies.

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

8.2 Increased coherence in the knowledge system

8.2.1 Coherence in the knowledge system

The mapping illustrates that it is important not only to look at the question of coherence in the knowledge system as a question of mediation and communication. It is to a high degree a question of coordinating the effort and establishing more incentives for interaction in order to create a coherent system that supports the companies' varying needs for knowledge and innovation.

Though there seems to be a major collaboration among the actors in the research and knowledge system, especially regarding R & D collaboration, there is a challenge in strengthening the interaction further if the companies' need for knowledge is to be supported optimally. The analysis shows that the actors in the research and knowledge system demand more collaboration and see potential for such collaborations. This applies, for one thing, to interaction between GTS institutes and multidisciplinary and engineering university colleges as well as interaction between GTS, universities, and the regional business policy actors. In this connection, it is worth noting that only 3 per cent of the units at the university hospitals, which are responsible for 11 per cent of the public research, collaborate with the GTS institutes (cf. chapter 4 and 5). At the same time, the actors demand more incentives for collaboration between the actors, especially currently as there have been reforms in many areas of the research and knowledge system, and where there have been established new actors, e.g. the Regional Hothouses.

It is the impression from the interviews that there can be a need for the research and knowledge system's actors themselves to contribute to an increased coordination and coherence in the effort. This applies for example in relation to the regional effort towards the companies where new actors on the regional scene are trying to find their place. In the same way the universities have a regional role in light of the visions concerning the universities being regional growth engines. It is here crucial to avoid a situation in which all actors contact the same companies; hence the need for increased coordination concerning the contacting of the companies is evident.

8.2.2 Coherence in the GTS nets effort

Although the individual GTS institutes are under a common regulatory foundation and form part of a 'net' (the GTS net), the institutes are mutually very heterogeneous. It is a challenge to administer a group of organisations so different and also to secure the "net" works as a unit and not just as individual institutes. The challenge is to strengthen the net's collaboration in order for the resources, when relevant, to be included in the overall efforts and activities instead of the institutes acting individually. At the same time, it will secure critical mass and weight so the net overall can attend to larger areas of action. Moreover, it will be able to provide a visibility and common identity towards the users.

Another challenge is to create coherence in the GTS net's national and regional effort. As earlier mentioned we see currently that the universities to an increasing extent are being perceived as regional growth engines. The question is whether the GTS shall have a similar role, and what the labour sharing shall be between the universities and the GTS institutes.

Finally, it is important with coherence towards the remaining private consultancy market. A basic challenge in the GTS net is that they have to balance between a market oriented and a non-profit role. This means that the GTS institutes inadvertently can get too close to the private market for consultancy and technological knowledge, and thereby risk twisting the market with public grants. The potential for such conflicts can not really be eliminated but they can be handled within reason. A way could be to create more institutionalized frameworks for dialogue between the GTS net and the business enterprise sector's organisations.

Box 8.1: Statements from people interviewed (DAMVAD's translation)

"We must create a motivational overview that makes it simple and allows entry into the knowledge system for businesses. There is a risk of 'drowning' the businesses in good intentions. The challenge is to simplify the system and help the businesses on their way. In our experience, the businesses are very interested in dialogue and cooperation when we contact the one-on-one." Jan Bisbjerg, Head of knowledge dissemination, Alexandra Institute

"It takes a long time before research from the universities is made accessible to the technical schools. I see a potential for knowledge from both universities and GTS institutes to contribute to a greater extent in lifting the competencies of basic education. This would ensure coherence amongst elite and basic actors across the knowledge system." Mogens Nielsen, Director, Copenhagen Technical Academy and Copenhagen Polytechnic

"It is generally important to increase cooperation across the knowledge system. We must make sure not to build a structure that forms barriers for cooperation, rather we must create positive incentives for cooperation. The actors should collaborate on a voluntary basis and mutually be able to see the professional advantages of cooperation." Søren Elkjær Frandsen, Pro-rector for Knowledge Transfer, University of Aarhus

"The challenge is to create sufficient volume in the funds for research and innovation, so we get strong clusters of competence and achieve significant results that really make a difference. When research funds are distributed, there is a tendency to spread them in a way so everybody receives a something." Henrik Garver, Director, Danish Association of Consulting Engineers (FRI)

"The biggest problem with the GTS institutes is that they are not known. As a "brand" GTS is not good and the Technological Institute is better known than GTS. The GTS institutes have the additional problem that they themselves have trouble agreeing on a precise profile and are therefore not in a position to report what an GTS is." Jens Oddershede, Rector, University of Southern Denmark

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

8.3 Increasing knowledge in larger parts of the private sector

8.3.1 Businesses more involved in innovation projects

Even though the private investments in R & D overall seen have increased the last couple of years, the investment in R & D in relation to the gross domestic product (GDP) has gradually decreased. As a share of the GDP the private investment in R & D has fallen from 1.78 to 1.65 per cent. An often heard explanation for this is that many companies gradually place more research abroad. This is a development that creates grave concern among politicians as Denmark in this way risks facing challenges in surviving in the international competition of knowledge and competences.⁸⁷

There is a political desideratum that the investments of the business enterprise sector in R & D develop positively which shall be secured through wide frameworks for highly educated manpower, relevant public research of high quality and good frameworks for collaboration between public and private research.

The research and knowledge system has thereby an important role in stimulating increased R & D in the private sector, e.g. through increased R & D collaboration. As the analysis illustrates, there is a positive coherence between the companies' collaboration with the knowledge institutions and their R & D effort. The analysis simultaneously points out that several surveys also underline that public research to a high extent can support and stimulate to further private R & D.

A challenge is to coordinate the grants from the research and innovation grants, so it becomes attractive to both companies and knowledge institutions to collaborate intensively. The analysis shows there is a huge difference in the participation among companies across the research and innovation programs. In the regional programs there is a relatively smaller part of the participating companies (23 per cent) compared with e.g. Innovation consortiums (64 per cent) and the projects under The Danish National Advanced Technology.

8.3.2 Focus on smaller enterprises and services in the GTS net

The analysis shows that while the public sector generally has experienced increasing R & D activities, the GTS net has on the contrary experienced a decrease in the R & D activities. Likewise, the GTS net has experienced a decrease in relation to a range of the net's other activities within competence building and the dissemination of knowledge. This can mean that the GTS net has more difficult conditions compared to the other actors in the research and knowledge system – e.g. universities – as regards contributing to further R & D in private companies.

⁸⁷ http://vtu.dk/filer/publikationer/2008/erhvervslivets-investeringer-i-forskning-og-udvikling/html/entire_publication.htm

Firstly, it is a significant condition in order to be able to use the research institutions research results in the companies, that the GTS institutes themselves research at a highly qualified level. Secondly, it is an important condition to strengthen the GTS institutes' collaboration with Danish and foreign research institutions that the GTS institutes are attractive and highly qualified collaboration partners.

There lies a challenge in being able to support more companies' R & D activity. There lies a special challenge in being able to lift the GTS net's effort towards the smaller companies in Denmark. Especially in light of the fact that the turnover for this group of companies has decreased even though the GTS net has a special obligation towards the small and medium sized companies in Denmark. There lies furthermore a challenge in strengthening the relation to the knowledge service field and the low-tech occupational fields. In an analysis DAMVAD has conducted on behalf of The Danish Agency for Science, Technology, and Innovation the figures show that only 14 per cent of the service companies use the GTS institutes as a source for knowledge transfer⁸⁸.

At the same time there lies a challenge in strengthening the GTS net's participation in the most research oriented research and innovation programs in Denmark - among this participation in strategic research. The survey shows that the GTS institutes only participate in 9 per cent of the strategic research projects while the universities participate in 76 per cent and the companies in 61 per cent. An analysis from The Strategic Research council points specifically at the GTS institutes not being very visible in the projects and the parties primarily prioritising universities and companies in the projects. Often participation in strategic research requires a significant R & D capacity, and it can be absolutely decisive that the GTS institutes also are able to sustain that role.⁸⁹

The analysis points at a general need for more collaboration models between the GTS net and the universities – and a need for both systems to facilitate one another a higher degree than it is the case today. The analysis points out that both universities and the GTS institutions see huge advantages in exploiting each others competences in order to better support the innovation of the business enterprise sector. But at the same it is pointed out that the frameworks for collaboration between the parties should be enhanced and new models for collaboration should be developed, e.g. through more incentives and increased resources for collaboration.

An area identified by several of the interviews is the possibility of a more specific and systematic use of the GTS net's role as a kind of technology screeners. It is thereby pointed out that one could to a greater extent exploit the GTS net's knowledge about the business sector to inspire business relevant R & D in the universities. It has here been stressed that in connection with

⁸⁸ Forsknings- og Innovationsstyrelsen (2007): "Inside Service Innovation - Challenging Policy"

⁸⁹ DAMVAD (2008): "Analyse af den potentielle effekt af strategisk forskning". Det Strategiske Forskningsråd

investments in research and technological infrastructure there could to a higher extend be incorporated interaction between universities and the GTS net. This will secure access to the expensive research equipment to a larger group of companies and thereby secure a more effective use of the equipment. It will also be obvious to incorporate the hospitals in the interaction.

Box 8.2: Statements from people interviewed (DAMVAD's translation)

"There is a need for the GTS net to open up so that it becomes easier for others to apply for GTS funding. Also, GTS systems ought to have a broader professional perspective, so there is not exclusive focus on the technical and scientific areas." Poul Skadhede, CEO, DI Knowledge Advisors

"The tools of the GTS institutes are primarily located within the technical and natural science areas. If you look at how society develops, it is a challenge for the GTS system to develop knowledge services directed towards the more 'soft' knowledge areas. The GTSs has, looking historically, had their justification related to the traditional industrial society. The GTS should also focus on areas of R & D where it is presently not known whether the areas can translate into business." Poul Skadhede, CEO, DI Knowledge Advisors

"It is important to institutionalize the interaction between GTS and universities. Today there is much interplay with relation to individual researchers from universities and consultants at GTS institutes. This means that much of the interplay is not registered centrally by the universities and therefore, for example, is not credited in follow up on development contracts. There is a need to professionalize and lift the collaboration up to the institution level, so that it is institutions and not individual researchers that collaborate." Søren Elkjær Frandsen, Pro-rector for Knowledge Transfer, University of Aarhus

"The university sees good prospects for the interplay between GTS institutes, but the interplay should not be forced, for example with development contracts or rules. There should be established positive incentives for the interplay so that both players gain something positive from voluntarily working together. Incentives are not so much about working it into universities' development contracts. It is rather a matter of finding professional reasons and visions to cooperate and perhaps supplementation of resources to promote the collaboration." Søren Elkjær Frandsen, Pro-rector for Knowledge Transfer, University of Aarhus

"The Technological Institute has a long historical tradition of being close to our customers. We are still close to our customers, but not in the same way as previously. We were previously very branch oriented but are today far more technology oriented, with a focus on high quality and high end market." Søren Stjernqvist, CEO, Danish Technological Institute

"The technological institute removes itself more and more from the traditional leadership consultancy, which is management consultants' area. We have almost none of that type left." Søren Stjernqvist, CEO, Danish Technological Institute

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

8.4 Increased internationalisation of knowledge

8.4 More incentives for actors

The research in Denmark only constitutes app. 1 per cent of total research in the world. Therefore, Danish companies and knowledge environments must be integrated in a still more globalised knowledge market and purchase the new knowledge that is created in the rest of the world. This can be secured through Danish companies' and researchers' collaboration with the best knowledge environments in other countries. The need for internationalisation of Danish research and innovation is certainly on the agenda politically in connection with the government's globalisation strategy. An important key area in the government's visions is exactly that the Danish participation in EU's framework programs shall be strengthened, and that the research councils and The Danish Council for Technology and Innovation have a particularly significant role in this respect.

This mapping of the Danish research and knowledge system has shown that the actors in the Danish research and knowledge system most certainly are integrated in the international research and knowledge system; however there is decreasing participation in the EU's framework programs. This can endanger the knowledge purchase and the access to important research and technology we cannot produce ourselves in Denmark. A major challenge for the entire research and knowledge system in Denmark is to establish incentives for participation in international research projects. This can for example be by endorsing international interaction projects in EU's framework programs via special pools for internationalisation.

Likewise, there could be established increased possibilities to attract foreign partners to Danish research and innovation projects. In going through the national and regional research and innovation projects it was the impression that there were relatively few participating companies from abroad. There can be potentials to exploit the new possibilities in law on technology and innovation to distribute up to 20 per cent of the council's funds to international forums.

Increased internationalisation of the Danish research and knowledge system could furthermore support the EU commission's thoughts on establishing an inner market for knowledge. The goal is partly to secure international solutions to the major social challenges such as climate changes, environment disasters, and chronic illnesses. The EU's thought is hence to create an inner market for knowledge with common research programs and with further degrees of freedom for the researchers. The challenge is to secure that the actors in the Danish research and knowledge system are prepared to join the inner market of knowledge in the EU.

8.4.2 Increased participation in The EU for the GTS net

An important task for the GTS net is to participate in international R & D. As the analysis shows, the GTS net has gone through a development in the last couple of years with increasing internationalisation of their activities. This

is a development that is highly supported by the GTS institutes now having possibilities to establish themselves abroad through subsidiary companies, which more of the GTS institutes have made use of. Likewise the survey shows that the GTS consultants to a high extent have informal and formal collaboration relations with foreign actors within research and technology, e.g. through participation in ERA-net, standardization committees, and committees within special technological areas.

Despite the positive development in the GTS net's internationalisation, the analysis shows at the same time that the international R & D collaboration in the GTS net have been decreasing. There has been a decrease in the number of participants in international R & D projects from 333 in 1999 to 127 in 2007. At the same time there has been a decrease in the participation in international professional committees and networks. The decreasing international R & D effort makes it difficult to purchase knowledge from abroad for Danish companies and knowledge environments.

One of the areas in which there is a challenge for the GTS net's internationalisation is in connection to the EU's framework programs which partly can constitute a major source in the funding of the GTS net's research and purchasing of knowledge and technology from abroad, and partly provide possibilities to gain influence on the research prioritisations at EU level. Today the GTS net has limited EU participation with regards to other Danish knowledge institutions. The universities and many companies have a far more dominant role in the EU's framework programs in comparison to the GTS net. Especially concerning the coordinator role - which will be an obvious role for the GTS institutes - the GTS institutes can play a more significant role. Only one per cent of the total Danish project coordinators are an GTS institute.

The survey points out that more GTS institutes have downgraded EU participation due to problems in co-funding. However, much indicates that increased EU participation now is part of more of the GTS institutes' strategies. It can be decisive to support these strategies by creating frameworks and incentives for increased internationalisation of R & D in the GTS net. A strengthened internationalisation of the GTS net could also make the GTS institutes more interesting as collaboration partners for Danish universities.

It is of course a balancing act for the GTS net in relation to on one side support Danish companies with knowledge and on the other side secure an anchoring on the international markets. A risk in the increased internationalisation of the GTS net is that the GTS institutes will function as consultants on international markets and help foreign companies with knowledge so they can compete with Danish companies. There is indeed a real risk for the GTS net to be disconnected from the national innovation system which will have a negative impact on many Danish companies. The attitude from more of the interviewees in the survey is however that the GTS net must be active abroad because its activities abroad is a condition for the companies in Denmark and also to be able to fulfill the role as knowledge purchaser.

Box 8.3: Statements from people interviewed (DAMVAD's translation)

"Ten years ago, Technological Institute had many projects within EU's framework programme. To be able to compete with the best, we have set focus on it again. We have set aside five million kroner per year to develop good project applications with the goal of increasing participation in the EU's framework programmes. Compared to corresponding GTS institutes in other countries, the Technological Institute is about average when it comes to participation in EU's framework programmes."

Søren Stjernqvist, CEO, Danish Technological Institute

"The Technological Institute has—like other GTS institutes—a clear strategy in the international arena. International activities should contribute to ensuring earnings and building of competences but also contribute to increased knowledge. At the same time, internationalization shows the quality for our performance. It requires a great deal of resources to participate in EU's framework programmes—and we must ensure that there is a commercial part to finance R & D—because EU participation is often poorly financed."

Søren Stjernqvist, CEO, Danish Technological Institute

"We have previously been involved in many EU projects and we would like to strengthen EU participation. We participate e.g. in the REGIS Project, which showcase Katrinebjerg as a rolemodel in other parts of Europe. We also have a project with Central Denmark Region—IT as innovation's driving force - where an important element is support of the businesses' purchase of IT and contact to foreign knowledge environments in the IT area." Jan Bisbjerg, Head of knowledge dissemination, Alexandra Institute

Source: DAMVAD, Mapping of the Danish knowledge system, 2008

9.1 Introduction

This section describes the different methods applied in this project. The project applies three different methodological approaches; survey questionnaire, qualitative interviews and manual count of research- and innovation projects in the business industry.⁹⁰

9.2 Survey analysis and role valuation index

The research done by DAMVAD included two surveys:

- A survey amongst 330 consultants from the GTS-system, with the aim of shedding light on the services and terms of cooperation in the GTS-system.
- A survey covering approximately 500 central actors within research, education, regional business development and private counselling, with the aim of showing the general interaction and roles in the research and knowledge system, and also investigating the actors' attitude towards the role and function of the GTS-system.

The two surveys have been carried out as internet based surveys, using the survey- and analysis tool Analyzer, which implies sending the survey as e-mail. The survey was carried out in the period September-October 2008.

9.2.1 Survey among consultants in the GTS system

The questionnaire survey is aimed at uncovering the GTS institutes' own perception, of their interaction with other actors in the research and knowledge system. Furthermore, the aim of the survey is to give a better overview of the concrete roles and assignments carried out in the GTS system. The survey will contribute to delivering new knowledge about the GTS institutes' joint pallet of roles and services in relation to the business sector. The survey will among other things reveal the work functions of the consultants, the connection between work functions and contract funding and other external partners as well as the cooperation with other consultants in the GTS system.

The questionnaire is developed in cooperation with the GTS central body. DAMVAD cooperated with the GTS central body in testing the questionnaire on a number of consultants in the GTS system to ensure a high quality of the questionnaire. The questionnaire was then adjusted on the basis of comments from the consultants.

⁹⁰ The analysis is also based on general desk research

Survey sampling in questionnaire to GTS institutes

The survey sample has been chosen among a population consisting of all employees in the Danish GTS institutes. To ensure, that the sample reflected the relative size of the institutes every GTS institute was asked to contribute with 10 pct. of their employees. Together, all the GTS institutes have contributed with 330 respondents.⁹¹ The sample makes up 11 pct. of the total number of employees in Danish GTS institutes.

Response rate and non-response

The quality of a survey is very dependent on the response rate. It is only possible to say whether the survey is representative, if a certain number of respondents actually answer the survey. DAMVAD has sought to maximize the response rate by constructing a short and thoroughly tested questionnaire and by sending several reminders to the respondents.

The response rates for GTS consultants are depicted in table 9.1 below.

Table 9.1: Questionnaire response rate

Actor	Number of questionnaires sent out	Number of answers in total	Number of complete answers	Number of incomplete answers	Response rate
GTS institutes	330	315	308	7	93 pct.

The questionnaire was sent out to 330 respondents, out of them, 315 answered. 308 of the answers were complete, while 7 answers were incomplete. DAMVAD has thus attained a response rate of 93 pct. for the completed answers. This can be considered a very high response rate and the questionnaire survey can hence be considered as being of very high quality.

9.2.2 Survey to public institutions and business

The questionnaire for public institutions and business covers the interaction between private companies, public institutions and research institutions on one side, and GTS institutes on the other side. The questionnaire was sent out to key actors in the research and knowledge system, however not to the GTS institutes. The actors are asked about their cooperation with GTS institutes and their knowledge about and attitude regarding the roles and tasks delivered by the GTS institutes. The aim of this survey is to uncover the different roles and functions of actors in the research- and knowledge system, especially in relation to how they contribute with knowledge and competences to the business sector and the public sector.

⁹¹ The GTS Institutes provided DAMVAD with email addresses for 332 respondents, two of which turned out to be invalid

The survey should ideally uncover the role of the different organizations in delivering knowledge to the business sector, how the organization interacts with others to develop, produce and supply knowledge and the survey should furthermore help evaluate the role of GTS in relation to the business sector.

Survey population for the questionnaire directed at public institutions and business

The survey population for the questionnaire directed at public institutions and business consists of two main groups of actors; private actors and public actors.

The survey population covers the following public sector actors: Universities, sector specific research institutions, higher education institutions, vocational training centres, other educational institutions, regional growth centres, communal business development centres, research- and science parks. Within the private sector, the research population covers technical advisors, as well as management consultants. The research population has been chosen in cooperation with a number of business organizations and interest groups.

For the purposed of this survey, the many different types of actors have been divided into four general actor groups.

- Universities and sector specific research (including long-cycle higher education)
- Other educational institutions (vocational training centres, other educational institutions)
- Regional business development actors (growth centres, communal business development centres, research- and science parks)
- Private knowledge consultants

Response rate and non-response for the questionnaire directed at public institutions and business

The research population for the survey to public and private actors consists of 481 respondents.⁹² Table 9.2 below shows the number of respondents within the four main groups and the response rates for these groups.

⁹² The questionnaire was originally sent to 500 respondents. 19 respondents never received the questionnaire because of an invalid email address. These 19 are not considered part of the survey population

Table 9.2: Questionnaire response rate

Actor	Number of questionnaires sent out	Number of answers in total	Number of completed answers	Number of incomplete answers	Response rate
Universities and sector specific research	127	89	87	2	70 %
Other educational institutions	67	48	46	2	72 %
Regional business development actors	88	68	66	2	77 %
Private knowledge consultants	199	98	90	8	49 %
Total	481	303	289	14	63 %

303 respondents answered the survey and 289 of these answers were complete, while 14 were incomplete. The total response rate was 63 pct. for the complete answers. If we divide the answers into the categories presented above all except one category has a response rate between 70 and 77 pct. The response rate is relatively high for the category consisting of universities and sector specific research (70 pct.), and also for other educational institutions (72 pct.) and regional business development actors (77 pct.) The response rate is considerably lower for the category private knowledge consultants, here only 49 pct answered. However in general the total response rate (63 pct.) can be considered satisfying for a broad survey like this.

9.2.3 Role valuation index

On the basis of the answers from the survey sent to public institutions and business actors, a so called role valuation index has been created to perform an actor valuation of roles, services and functions in the research- and knowledge system. Concretely the index will contribute with:

1. A mapping of the roles and tasks of the various organizations
2. A mapping of the roles and tasks of the GTS institutes, by asking the other actors in the research- and knowledge system how they perceive the role of the GTS institutes.

The index consists of ten statements, all of which the respondent has to consider and rate on a 5-point likert scale. The actor, for example has to deal with the question “*My organization contributes with new knowledge*”.

Example of question for actor evaluation

State to which degree the following statement matches the roles and tasks performed by your organization in the cooperation with private companies and public institutions.					
	To a very high degree	To a high degree	To some degree	To a small degree	Slet ikke
My organization contributes with new knowledge					

The actor valuation index for a given group of actors is calculated by taken the mean of the groups' valuations. (The answer *to a very high degree* is given the value 4, *to a high degree* is given the value 3, *to some degree* is given the value 2, *to a small degree* is given the value 1 and *not at all* the value 0).

9.3 Qualitative interviews

As an addition to the survey, DAMVAD has carried out 15 qualitative in-depth interviews in weeks 40-34, 2008. The interviews act as a supplement to the survey results by going a step deeper in relation to attitudes, interest and considerations about visions and challenges.

9.3.1 Purpose and procedure

The 15 qualitative interviews shed light on the roles and functions of actors in connection with their contribution of knowledge and competence to the business- and public sector. Specifically the interviews are meant to uncover the following areas:

- The actors' (the interviewee's organization or the actors that the interviewees organization represents) role in developing and conveying knowledge to the business sector.
- The actors' (the interviewee's organization or the actors that the interviewees organization represents) interaction with other actors about development and conveying knowledge and competences to business.
- The interviewee's opinion about the role of the GTS institutes and their role in connection with the business sector.

The interviews have been carried out on the basis of a semi-structured framework, centred around the roles of the actors in the research and knowledge system. This semi-structured interview framework has been chosen to ensure that the overall relevant themes are described in all of the interviews, however still with the possibility of adapting the interview to a certain extent based on the respondent's answers. Compared with the structured interview, the semi-structured interview creates flexibility and opens up the possibility of discussing new subjects, which might be brought forward because the respondent deems it relevant. Fourteen of the interviews are carried out as personal interviews and one interview has been carried out over the phone. The interviews have all lasted between 30 and 60 minutes.

9.3.2 Selection of interviewees

The interviewees have all been pointed out by the Danish Agency for Science, Research and Innovation. The selection criteria of the interviewees are that it is key persons in relation to the Danish research and knowledge system, which mean that they have a leading role within the private consultancy, research- and educational institutions, Authorized Technological Service Institutes or other companies in Denmark. Table 9.3 delivers an overview of the persons who have been interviewed.

Table 9.3: People interviewed

Position	Institution	Name
GTS		
Head of knowledge dissemination	Alexandra Institute	Jan Bisbjerg
CEO	Danish Technological Institute	Søren Stjernqvist
Universities		
Pro-Dean	University of Aalborg	Egon Toft
Pro-rector for Knowledge Transfer	University of Aarhus	Søren Elkjær Frandsen
Vice-rector	Technical University of Denmark	Knut Conradsen
Vice-director	University of Copenhagen	Jens-Peter Lynov
Rector	University of Southern Denmark	Jens Oddershede
Private businesses		
Market director	Danish Business	Christian Tanggaard Ingemann
Director	The Danish Association of Consulting Engineers (FRI)	Henrik Garver
CEO	DI knowledge advisers	Poul Skadhede
Regional Actors		
Formand	Business Development Denmark	Knud Erik Larsen
Business Director	Djursland Business Council	Finn Petersen
Director	Growth house – central Jutland	Erik Krarup
Other institutions of education		
Director	Copenhagen Technical Academy and Copenhagen Polytechnic	Mogens Nielsen
Rector	University College, Copenhagen	Laust Joen Jakobsen

9.4 Count of innovation projects and network analysis

9.4.1 Purpose

The aim of counting all innovation projects is to get an overview of the Danish research and knowledge system, insofar as it especially focuses on the interaction between the different actors and their roles and tasks. The focus is on national, regional and international programs.

More specifically, the Danish actors involved in various innovation projects are identified. The identification of different actors is done on a relatively general level, for example all faculties and institutes within the University of Copenhagen are categorized as University of Copenhagen. The count is based on the institutional structure at the start of the project, hence even though The Royal Veterinary and Agriculture University today (KVL) is a part of the University of Copenhagen, it will still be treated as KVL.

9.4.2 Scope and period

The count of innovation projects is based on an analysis of the individual project grants that has been given to a number of the relevant institutions, who administrates the programs, funds and pools aimed at supporting innovation projects. The institutions and the different programs, funds and pools are listed in table 9.4. In total it covers more than 1400 granted projects, whereof the largest part is from EU's sixth framework program.

Table 9.4: Innovation pools

Financing institution	Program/pool/fund	Number of project	Financing year	Total amount financed (mill. DKK)
EU	EU sixth framework programme (FP6)	1141	2002-2006	143.347,5 (19.113 mio. EUR) – Projects with Danish participation only make up a small part.
Danish Enterprise and Construction Agency (EBST)	User Driven Innovation	30	2007	92
Danish Enterprise and Construction Agency (EBST)	User Driven Innovation	8	2008	17,6
Danish National Advanced Technology Foundation		60	2005-08	807
Danish Council for Strategic Research	Research funds	67	2006	428,7
Innovation Consortia		55	2003-08	130,6 (2007)
Regional Growth forums	EU structural funds	96	2007-2008	390,9

The count of innovation projects is based on numbers delivered by the institutions, who grant the different pools and funds. There can be large differences in the way institutions register projects, especially regarding the period of the project, why it has been difficult to identify the duration of all included projects. Most projects have not been finished, because many projects are long term research projects. Common for all projects is that they have received funding and therefore the projects are differentiated according to when the grant has been given and the size of the grant. As table 9.4 shows, the reporting includes projects that have received a grant in the period from 2002 until today.

Special circumstances are present when counting projects under the individual project programs. These special circumstances will be commented in the following section, where we will first look at the national and regional innovation projects and hereafter the projects under the EU's sixth framework programme.

9.4.3 National and regional innovation projects

The national innovation projects cover a count of all projects within the four national programs and pools: The program "User driven innovation" managed by the Danish Enterprise and Construction authority, the innovation pools managed by the Danish National Advanced Technology Foundation, Innovation Consortia and research funds from the Danish Council for Strategic Research. There also exists other national innovation pools, but DAMVAD has chosen to focus on these four, as they are the biggest pools and moreover the most general in character, directed at all sectors.

The innovation programs have thus been selected according to their broad sector focus and their considerable size. This means that a number of innovation programs have not been included in the project. Specifically these programs are: "Reserve for entrepreneur- and innovation activities" and "Innovation and productivity in construction", managed by The Ministry of Economic and Business Affairs. The program "Contribution to energy research" managed by The Ministry of Transport and Energy, and the program "Contribution arrangements for the furthering of environmentally effective technology" managed by the Ministry of Environment are both left out of our analysis. Finally not included in the project are three following programs managed by the Ministry of Food, Agriculture and Fisheries: "Innovation and development in primary agriculture", "Innovation and development in the processing sector" and "Innovation and research in the farming and fisheries sector".

The count is in most circumstances made on the basis of information available on the websites of the relevant institutions and organizations, except the numbers from the innovation consortia, which have been received from The Danish Agency for Science, Technology and Innovation. It varies which period the counted projects cover, all depending on which innovation programs that we are speaking of. Hence the count of projects in the innovation consortia includes project which were granted money in 2003, while the project under the program for User driven innovation have only been counted from 2007 and onwards,

simply because it did not exist prior to this. Regarding the Danish National Advanced Technology Foundation, it has not been possible to identify when each project was initiated by accessing the website, and hence the count builds on all of the fund's distributions since December 2005.

In total there are 220 national innovation projects, with a total grant of X mio. kr. For each of the 220 projects, all participants are Danish actors, all registered and categorized according to the prescriptions described above. The count has resulted in the identification of 1568 actors.

The count of regional innovation projects is based on numbers from each of the six Danish regions, who have received structural funds in the program period 2007-2013, as of 12th of August 2008. The numbers the count builds on, has been collected from each of the Danish regions, because there does not exist any official statistics, which contains all the relevant information. There is in total 96 projects, but here is significant difference between the number of projects from each region. In the region of central Jutland, there are 34 projects, which have all received structural funds in the covered period. In contrast to this, Region Sealand and The capital region only had eight projects, and in the Bornholm region only 7 projects. The count of 96 projects resulted in the identification of 388 actors.

9.4.4 Projects supported through the EU's sixth framework program

The counting of projects supported by the EU sixth framework programme for Research and Technological Development is based on numbers for the individual projects, localized through EU's database for the sixth framework programme on the homepage www.cordis.europa.eu/fp6/dc/index.cfm.

When using the search term "Denmark" in the EU database, there appear 1.151 projects. In most of these projects, Denmark is an actor in the project, but in ten cases Denmark is only mentioned in the project description without being a project participant. These ten projects are not taken as a part of the innovation projects, why we end up with 1141 projects supported by EU's sixth framework programme. When counting the Danish actors in these projects, we found 1.642 actors in total.

The database is very much like the database that The Danish Agency for Science, Technology and Innovation use in their publication "Numbers about Danish Participation in the EU's Sixth framework programme", but there are some minor differences. In this database there are listed 1141 projects with Danish participation and 212 projects with a Danish coordinator, while the overview made by the Danish Agency for Science, Technology and innovation only contain 1123 projects with Danish participation and 210 projects with a Danish coordinator. The differences can probably be attributed to the fact that new projects have been added since the last count.

10.1 Institutions in the research statistics for the public sector

The list below contains an overview of the relevant institutions related the statistic *Forskning og udviklingsarbejde i den offentlige sektor*. The list is adjusted for the use of this mapping of the Danish knowledge system.

The list of institutions contains an overview of all the institutions, which has provided information for the research statistics 2006. Some of these institutions have informed that they didn't carry out research or development work in 2006. The fact that an institution is part of this list is in other words not the same as that institution is active in research. Numbers in parentheses indicates the number of informed unites larger than one.

Universities and institutions of higher education
Danmarks Farmaceutiske Universitet (3)
Danmarks Pædagogiske Universitet
Danmarks Tekniske Universitet (16)
Den Kgl. Veterinær- og Landbohøjskole (12)
Handels- og Ingeniørhøjskolen i Herning
Handelshøjskolen i Århus (6)
Handelshøjskolen i København (20)
IT-Universitetet i København
Københavns Universitet (42)
Roskilde Universitetscenter (12)
Syddansk Universitet (36)
Aalborg Universitet (24)
Aarhus Universitet (41)
Danmarks JordbrugsForskning (8)
Danmarks Miljøundersøgelser (11)
Forskningscenter Risø (7)
Danmarks Fødevarer- og Veterinærforskning (8)
Danmarks Rumcenter
Danmarks Fiskeriundersøgelser
Danmarks Transportforskning
Statens Institut for Folkesundhed
Statens Byggeforskningsinstitut
Øvrige LVU-institutioner
Arkitektskolen i Aarhus
Danmarks Designskole
Det Fynske Musikkonservatorium
Det Jyske Musikkonservatorium

Det Kgl. Danske Kunstakademi (3)
Det Kgl. Danske Musikkonservatorium
Nordjysk Musikkonservatorium
Rytmask Musikkonservatorium
Vestjysk Musikkonservatorium
Sector research institutions (according to sektorforskningsloven 2004)
Arbejdsmiljøinstituttet (2)
Danmarks og Grønlands Geologiske Undersøgelse
Forsvarets Forskningstjeneste
John F. Kennedy Institutet - Statens Øjenklinik
Socialforskningsinstituttet
Statens Serum Institut
University hospitals
Amager Hospital (12)
H:S Bispebjerg Hospital (27)
H:S Center for Klinisk Uddannelse CEKU
H:S Frederiksberg Hospital (12)
H:S Hvidovre Hospital (21)
H:S Institut for Sygdomsforebyggelse
H:S Rigshospitalet (65)
KAS: Forskningscenter for Forebyggelse og Sundhed
Københavns Amt Sygehus i Gentofte (16)
Københavns Amt Sygehus i Glostrup (17)
Københavns Amt Sygehus i Herlev (21)
Københavns Amt, Børne- og Ungdomspsykiatrisk Center
Københavns Amt, Psykiatrisk Center Ballerup
Københavns Amt, Psykiatrisk Center Gentofte
Københavns Amt, Psykiatrisk Center Glostrup
Københavns Amt, Psykoterapeutisk Center Stolpegård
Københavns Amt, Retspsykiatrisk Center
Odense Universitetshospital (38)
Psykiatrisk Hospital i Århus (11)
Sct. Hans Hospital (4)
Skejby Sygehus (15)
Aalborg Psykiatriske Sygehus (5)
Aalborg Sygehus (40)
Århus Sygehus (38)
Other institutions of higher education – University Colleges
CVU Fyn
CVU Handelshøjskolecentret Slagelse
CVU København og Nordsjælland inkl. partnerinstitutioner (12)
CVU Midt-Vest

CVU Nordjylland
CVU Øresund
CVU Sjælland
CVU Sønderjylland
CVU Storkøbenhavn
CVU Vest
CVU Vita
CVUalpha (4)
CVU-Jelling
CVUS-Fyn
CVU-Syd
Danmarks Biblioteksskole, København og Aalborg Afd.
Danmarks Erhvervspædagogiske Læreruddannelse
Danmarks Forvaltningshøjskole
Danmarks Journalisthøjskole
Den Grafiske Højskole
Den Sociale Højskole i København
Den Sociale Højskole i Odense
Ingeniørhøjskolen i Århus
Ingeniørhøjskolen i København
Ingeniørhøjskolen Odense Teknikum
Jysk Center for Videregående Uddannelse
Sundheds CVU Nordjylland
Vitus Bering Center for videregående uddannelse
Public centers of knowledge
Dansk Sygehus Institut
Amternes og Kommunernes Forskningsinstitut
Arbejdstilsynet
Beredskabsstyrelsen, Kemisk Laboratorium
Center for Regional- og Turismeforskning
Center for Selvmordsforskning
Center for Små Handicapgrupper
Center for Tilgængelighed
Central Forskningsenhed for Almen Praksis (v KU)
Danmarks Meteorologiske Institut
Danmarks Nationalbank
Danmarks Statistik
Dansk Center for Internationale Studier og Menneskerettigheder (DCISM)
Dansk Folkemindesamling
Dansk Sprognævn
Dansk Videnscenter for Stammen

DBL - Institute for Health Research and Development
Det Danske Sprog- og Litteraturselskab
Det Økonomiske Råd
Direktoratet for Kriminalforsorgen
Forsvarsakademiet (4)
Forskningsenhed for Almen Medicin (v AU)
Forskningsenhed for Almen Praksis (v SDU)
Forsvarsakademiet (4)
Fyns Amts Tale-Høreinstitut
Handicapidrættens Videnscenter
Hjælpemiddelinstitutet
Idrættens Analyseinstitut
IFM - Institut for Fiskeriforvaltning og Kystsamfundsudvikling
Kort- og Matrikelstyrelsen
Kulturarvsstyrelsen
KVINFO - Center for Information om Kvinde- og Kønsforskning
Lægemiddelstyrelsen
NORDITA - Nordisk Institut for Teoretisk Fysik
Retspsykiatrisk klinik
Statens Pædagogiske Forsøgscenter
Taleinstitutet i Århus
Teknologirådet
Teori og Metodecentret
UNI*C Danmarks IT Center for Uddannelse og Forskning
Universitetshospitalernes Center for Sygepleje- og omsorgsforskning
Vejdirektoratet, Vejteknisk Institut
Videnscenter om Kommunikation og Multiple Funktionsnedsættelser hos Børn og Unge uden et Talesprog
Videnscenter for Døvblevne, Døve og Hørehæmmede
Videnscenter for Døvblindblevne, Institutionen for Døve
Videnscenter for Døvblindfødte
Videnscenter for Hjerneskade
Public museums and libraries
Bangsbomuseet
Biblioteksstyrelsen
Bornholms Museum
Danmarks Kunstbibliotek
Danmarks Natur- og Lægevidenskabelige Bibliotek
Dansk Landbrugsmuseum
Den Hirschsprungeske Samling
Det Administrative Bibliotek
Det Danske Kunstindustrimuseum



Det Kongelige Bibliotek
Det Nationalhistoriske Museum på Frederiksborg
Esbjerg Museum
Faaborg Kulturhistoriske Museer
Fiskeri- og Søfartsmuseet i Esbjerg
Herning Museum
Jagt- og Skovbrugsmuseum
Købstadmuseet 'Den Gamle By'
Kulturhistorisk Museum i Randers
Lolland-Falsters Stiftsmuseum
Museet for Holbæk og Omegn
Næstved Museum
Nationalmuseet
Naturhistorisk Museum i Århus
Odense Bys Museer
Ordrupgaard Samlingen
Rosenborgsamlingen (Danske Kongers Kronologiske Samling)
Statens Arkiver
Statens Museum for Kunst
Thorvaldsens Museum
Tøjhusmuseet
Vejle Kulturhistoriske Museum
Viborg Stiftsmuseum
Aalborg Historiske Museum
Private non-profit institutions
Dansk Bibelinstitut
Gerontologisk Institut
Institut for Transportstudier
Kræftens Bekæmpelse (2)
Landbrugets Rådgivningscenter
Lejre Forsøgscenter
Rehabiliterings- og Forskningscentret for Torturofre
Steno Diabetes Center

10.2 Statistical estimation of the scope of the knowledge system

The list below states which specific branches (NACE) has been used in the estimation of the scope of the knowledge system in section 4.2

BRANCHE	CODE (DB03)	CONTENT
IT- and communication services	64.11.00-64.20.40	National post activities and tele communications
IT- and communication services	72.10.00-72.60.00	Hardware consultancy and other computer related activities
IT- and communication services	92.11.00	Motion picture and video production
IT- and communication services	92.40.00	News agency activities
IT- and communication services	92.20.20-92.20.20	Radio and television activities
IT- and communication services	74.81.10-74.81.20	Photographic activities
IT- and communication services	74.85.20	Secretarial and translation activities
Dissemination of knowledge and competences	92.51.20	Library and archives activities
Dissemination of knowledge and competences	92.52.00-92.53.00	Museums
Dissemination of knowledge and competences	74.50.10-74.50.30	Labour resruitment and provision of personnel
Education and competences	80.30.10-80.30.70	Higher education
Education and competences	80.42.10	Adult and other education n.e.c.
PR and advertisement	74.40.10-74.40-90	Advertising
PR and advertisement	74.13.00	Market research and public opinion polling
Technological services and development	73.10.00-73.20.00	Research and experimental development within all fields
Technological services and development	74.20.10-74.20.90	Architectural and engineering activities
Technological services and development	74.30.10-74.30.90	Technical testing and analysis
Technological services and development	74.87.10-74.84.20	Interior and and industrial design
Knowledge and business consultancy	74.14.10-74.14.90	Other business consultancy etc.
Knowledge and business consultancy	74.11.00-74.12.00	Advokatvirksomhed og revisionsvirksomhed

10.3 GTS participation in EU's Sixth Framework Programme

The tables below sums up the participation of the GTS in EU's 6. Framework Programme. Their participation is described in 5.4. Tabel 10.3 sums up participation for current GTS and former institutions while table 10.4 describes participation according to coordination, field of research and contract type.

Table 10.3: History of the GTS and participation in EU's 6th Framework Programme

GTS	HISTORY	NUMBER OF PROJECTS IN SIXTH FRAMEWORK
DBI Dansk Brand- og Sikringsteknisk Institut	1991: DBI is established as a merger between Dansk Brandværns-Komité, brandprøvningsafdelingen i DANTEST and Forsikring & Pensions' activities regarding inspection of and establishment of rules for automatic fire security facilities.	Dansk Brand- og Sikringsteknisk Institut: 0 Brandteknisk Institut: 0 DBI: 0 Brand: 0 Fire: 0
Teknologisk Institut	The oldest GTS institute. Has always been called the same	Teknologisk Institut: 4 (505711, 38644, 027767, 507139) Danish Technological Institute: 7 (8) (500311, 512950 (koordinator), 38496, 516251, 510506 (adresse), 19283, 507180, 502553)
DFM Dansk Fundamental Metrologi	1985: DFM is established as a replacement for Laboratorium for Fundamental Metrologi. 1991: DFM is approved as GTS 2006: DFM moves from being an independent institution to a non-profit organization owned by DTU.	Dansk Fundamental Metrologi: 0 DFM: 1 (16220) Metrologi: 0
DELTA Dansk Elektronik, Lys og Akustik	1993: DELTA is established in a merger between ATV-institutterne Elektronikcentralen, Lydteknisk Laboratorium and Optisk Laboratorium	DELTA Dansk Elektronik, Lys og Akustik: 1 (505504) Elektronikcentralen: 0 Lydteknisk Laboratorium: 0 Optisk Laboratorium: 0
DHI	DHI is rooted in three previous ATV-institutter Dansk Hydraulisk Institut (DHI), Vandkvalitetsinstituttet (VKI) and Dansk Toksikologi Center (DTC). DHI and VKI fusioned in 1999 and in 2006 DHI fusioned with DTC.	DHI: 12 (18311, 505287, 12409, 511231, 23168, 22441, 33234 (koordinator), 502158, 502701, 12560, 18309, 518120) Vandkvalitetsinstituttet: 0 VKI: 0 Dansk Toksikologi Center: 0 DTC: 0

Force Technology	Force Technology has roots in Svejsecentralen that was established under ATV in 1940 and later merged with Korrosionscentralen and Isotopcentralen. Force Technology has since 1991 taken over activities from Danest, Dansk Maritimt Institut (DMI) and dk-TEKNIK, Energi og Miljø.	Force Technology: 9 (503138, 12271, 31486, 516339, 505895, 31316, 503122, 505954, 516359) Svejsecentralen: 0 Danest: 0 Dansk Maritimt Institut: 0 DMI: 0 Dk-TEKNIK: 0
Bioneer	1995-2006: Bioteknologisk Institut is split into Bioneer and Teknologisk Institut. Bioneer is a non-profit organisation owned by DTU DTU.	Bioneer: 0 Bioteknologisk Institut: 0
AgroTech	2007: AgroTech is separated from Dansk Landbrugsrådgivning (Landscentret) and receives status as GTS.	AgroTech: 0 Dansk Landbrugsrådgivning, Landscentret: 1 (30348 (koordinator)) Danish Agricultural Advisory Centre: 2 (44292, 31499)
Alexandra Instituttet	1998: Alexandra Instituttet is established from Datalogisk Institut, Aarhus Universitet. 2007: Alexandra Instituttet is approved as GTS.	Alexandra Instituttet: 1 (002057)

Table 10.4: Description of the GTS' participation i EU's 6th Frammework Programme

ACTOR	PROJECTS	PROJECT COORDINATOR	FIELD	TYPE OF CONTRACT
AgroTech	Has under the name Dansk Landbrugsrådgivning, Landscentret participated in 3 projects (30348, 44292, 31499)	Coordinator on 1 project (30348)	FOOD (1), POLICIES (1), SME (1)	Cooperative research contracts (1), Networks of Excellence (1), Specific Support Action (1)
Alexandra Institutet	Has participated in 1 project (002057)	Never project coordinator	IST	Integrated Project
Bioneer	Has participated in 0 projekter			
Dansk Brand- og sikringsteknisk Institut	Has participated in 0 project			
DELTA	Has participated in 1 project (505504)	Never project coordinator	NPM	Coordination action
Dansk Fundamental Metrologi	Has participated in 1 project (16220)	Never project coordinator	COOR	Coordination action
DHI	Has participated in 12 projekter (18311, 505287, 12409, 511231, 23168, 22441, 33234, 502158, 502701, 12560, 18309, 518120)	Coordinator on 1 project (33234)	FOOD (1), INFRASTR (1), NMP (1), POLICIES (1), SUSTDEV (8)	Coordination action (3), Integrating activities implemented as Integrated Infrastructure Initiatives (1), Integrated Project (1), Specific Targeted Research Project (6)
FORCE Technology	Has participated in 9 projects (503138, 12271, 31486, 516339, 505895, 31316, 503122, 505954, 516359)	Never project coordinator	AERO (1), NPM (2), SUSTDEV (6)	Coordination action (2), Integrated Project (2), Networks of Excellence (2), Specific Targeted Research Project (3)
Teknologisk Institut	Has participated in 11 projects (505711, 38644, 027767, 507139, 500311, 512950, 38496, 516251, 5105063 (adresse), 19283, 507180, 502553)	Coordinator on 1 project (512950)	IST (2), MOBILITY (1), NMP (3), POLICIES (1), SME (2), SUSTDEV (2)	Coordination action (1), Integrated Project (1), Marie Curie actions-Research Training Networks (1), Networks of Excellence (1), Specific Support Action (4), Specific Targeted Research Project (2), No contract type (1)

10.4 Overview of selected universities' business interaction

DAMVAD has initiated a dialogue to the universities to map their cooperation with the business enterprise sector (see paragraph 7.3). IT-university, Roskilde University and Aarhus University has provided information, which is summarized below:

Tabel 10.5: Selected universities' business interaction

	Number of partners of cooperation	Number of contracts and arrangements	Amount	Remarks
The IT-university	32 (Many larger actors for example Microsoft, IBM, Grundfoss, Danfoss but also smaller actors as Borholms Museum)	33 arrangement on cooperation (hereof 2 on ph.d. education, 5 on EU financed research and 26 on co-financed research)	No amount stated	-
Roskilde University	35 (Largest partner is BUPL, Dansk Sygeplejeråd, Villim Kann Rasmussen fondation, Friluftrådet and Red Barnet. Also cooperation with private companies – however to a smaller degree)	44 contracts (no specificaiton stated)	22.5 mill. DKK Average: 510.000 DKK., Spread 10.000 DKK to 1.9 mill. kr	RUC has informed that they do not have available data for the amount of cooperaion with private companies through EU – and other grants to research projects.

	Number of partners of cooperation	Number of contracts and arrangements	Amount	Remarks
Aarhus University – Patent and contract unit ⁹⁶	-	404 arrangements (hereof 246 arrangements with Danish partners and 178 with international partners)	No amount stated	Aarhus University has informed that some arrangements are dealt with at faculty level and therefore not listed here.
Aarhus University – Budget and planning	442	512	1,4 bill. DKK Average: 2.7 mill. DKK Spread: 0- 227 mill. DKK (largest amount are EU fonds. Largest amount from a private fund: 185 mill. DKK)	Aarhus University has informed that the information does not cover all activities under Aarhus University. The base does not cover Danmarks Jordbrugsforskning, Danmarks Miljøundersøgelser, Aarhus School of Business and DPU

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University of Aarhus has sent to separate data bases:

- 1.Data base from the Patent and Contract Unit. Main purpose is overview of legal agreements
- 2.Data base from budget and Planning. Main purpose is budgetting and accounting

The two data bases overlap, so the numbers should not be added

2009

Evalueringer og effektmålinger

1. Effektmåling af innovationsmiljøernes støtte til danske iværksættere
 - Innovation: Analyse og evaluering 01/2009
2. Rammer for innovativ IKT-anvendelse – erfaringer fra Den Regionale IKT-satsning
 - Innovation: Analyse og evaluering 02/2009
3. Måling af additionalitet af deltagelse i innovationskonsortier
 - Innovation: Analyse og evaluering 03/2009
4. International Evaluation of the Danish GTS-system
 - Innovation: Analyse og evaluering 04/2009
5. Proof of concept-finansiering til offentlige forskningsinstitutioner - Midtvejsevaluering
 - Innovation: Analyse og evaluering 05/2009

Analyser

6. Mapping of the Danish knowledge system with focus on the role and function of the GTS net
 - Innovation: Analyse og evaluering 06/2009
 7. International Comparison of Five Institute Systems
 - Innovation: Analyse og evaluering 07/2009
 8. Desk Study on Science and Technology Foresights Aiming at Technological Service in Denmark
 - Innovation: Analyse og evaluering 08/2009
 9. Små og mellemstore virksomheders deltagelse i internationale FoU-samarbejder
 - Innovation: Analyse og evaluering 09/2009
 10. Små og mellemstore virksomheders anvendelse af ikt til innovation
 - Innovation: Analyse og evaluering 10/2009
 11. Virksomhedernes alternative strategier til fremme af privat forskning, udvikling og innovation
 - Innovation: Analyse og evaluering 11/2009
 12. Redegørelse for metrologiindsatsen 2007 - 2009
 - Innovation: Analyse og evaluering 12/2009
-

2008

Performanceregnskaber

1. Performanceregnskab for Videnskabsministeriets GTS-net
 - Innovation: Analyse og evaluering 01/2008
2. Kommercialiseringsstatistik
 - Innovation: Analyse og evaluering 02/2008
3. Performanceregnskab for Videnskabsministeriets Innova-tionsnetværk
 - Innovation: Analyse og evaluering 03/2008
4. Performanceregnskab for Videnskabsministeriets Innovationsmiljøer
 - Innovation: Analyse og evaluering 04/2008

Evalueringer og effektmålinger

5. Evaluering af IDEA
 - Innovation: Analyse og evaluering 05/2008
6. Effektmåling af forsknings- og innovationssamarbejder
 - Innovation: Analyse og evaluering 06/2008
7. Open innovation and globalisation: Theory, evidence and implications, VISION era-net project
 - Innovation: Analyse og evaluering 07/2008
8. Brugeranalyse af GTS-nettet
 - Innovation: Analyse og evaluering 08/2008
9. Evaluation of Danish Industrial Activities ind the European Space Agency (ESA)
 - Innovation: Analyse og evaluering 09/2008
10. Evaluation of the Danish Contributions to Space Research
 - Innovation: Analyse og evaluering 10/2008
11. Evaluering af public service for opfindere (Opfinderrådgivningen)
 - Innovation: Analyse og evaluering 11/2008

Analyser

12. Den danske erhvervsstruktur – udviklingstendenser og dynamikker
 - Innovation: Analyse og evaluering 12/2008
13. Innovation og innovationsbehov i servicesektoren
 - Innovation: Analyse og evaluering 13/2008
14. Kortlægning af iværksætter- og entrepreneurshipkurser ved de 8 danske universiteter
 - Innovation: Analyse og evaluering 14/2008
15. Kortlægning af indsatsen for fremme af innovation og entreprenørskab i de danske uddannelser – 2008
 - Innovation: Analyse og evaluering 15/2008
16. Matchmaking mellem virksomheder og videninstitutioner
 - Innovation: Analyse og evaluering 16/2008
17. Innovation i IKT – indsatser og effekter
 - Innovation: Analyse og evaluering 17/2008
18. Major challenges in national research and innovation policy governance: Comparison and assessment of the approaches in the VISION era-net partner countries
 - Innovation: Analyse og evaluering 18/2008
19. Inside Service Innovation – Challenging Policy
 - Innovation: Analyse og evaluering 19/2008
20. Håndbog om Innovationsnetværk
 - Innovation: Analyse og evaluering 20/2008
21. Videnpiloter – eksempler på vækst og innovation i små og mellemstore virksomheder
 - Innovation: Analyse og evaluering 21/2008
22. Fra inspiration til innovation – casesamling fra offentlige og private organisationer
 - Innovation: Analyse og evaluering 22/2008
23. Barriereanalyse for ErhvervsPhD-programmet
 - Innovation: Analyse og evaluering 23/2008

