Combat Survivability Keynote Speech

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Ladies and Gentlemen: I feel deeply honoured to be with you today. But I ask myself. What can I tell all these experts? Who am I to address this audience who have studied for years how to develop new propellants including service life assessments etc? Who have studied how to improve the survivability of aeroplanes, helicopters, ships and ground vehicles and how to survive hits and fires if stuck in one of these vehicles.

It is obvious that I cannot. I cannot tell you anything within your field which you do not know already and which you have not heard before. So why am I here? I am here because I can tell you what a simple soldier thinks about the world in which you are living and how he perceives the future use of military power. I am here because this is the kind of decision-maker who decides what the nation wants to do or not to do within your field of expertise.

But first let me give you a little bit of my background. You have heard something, but let me present my background in another way.

I joined the Danish Defence in September 1962 (40 years ago) as a conscript during the Cuban Missile Crisis. That was made apparent to us through a sharpening of the readiness of the Danish Defence. We never thought of the nuclear weapons, which were really the big issue at stake, but accepted the decision to guard the barracks and to dig trenches. My wish at that time was to become a forester but I enjoyed the life in the Army and decided to join the Military Academy.

I left the Military Academy in 1968. The year of the Youth Rebellion and the Vietnam demonstrations. Something that young determined officers couldn't care very much about. My focus was on training soldiers and preparing the Danish Army against what was perceived as an overwhelming Soviet military threat.

During the 80's I served as a major in the General Staff and the Ministry of Defence. These were the years of the Weapons Race and the Double Decision on nuclear armament. A great challenge for a nation with reservations on nuclear weapons. A nation not able to provide the political and public support necessary to increase the budgets to the level required by the alliance. Much to our great surprise therefore the Alliance won the weapons race. The wall came down and the Soviet Union was history.

During the 90's I served in executive functions on the General Staff. From 96 as Vice Chief of Danish Defence. These were years of change. Force Levels were reduced (almost by 50%) and the military structures were adapted towards international engagements. The focus changed from confrontation towards co-operation. These were difficult years because with the disintegration of the Soviet Empire followed regional and local conflicts that required reaction and involvement from the international society.

Year 2000 brought me to my present position as a joint subregional commander in the NATO command structure. I am what is called a third level commander. The Supreme Allied Commander in Europe (Mons in Belgium) being the 1st level and the Commander in Chief of the Northern Region (Brunssum in

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the Netherlands) being the second level. I have an international staff of app. 350 people from 9 nations working for me.

My tasks are threefold. To promote co-operation with partner nations. To provide staff personnel, and to contribute to NATO's international engagements and to defend the area if need be. My focus is on the Baltic Approaches and I work with the Danish Army, the German Army, the Polish Army, the Danish, German and Polish navies and the Danish Air Force. I also hold the national function as Commander of the Danish Joint Forces. Allow me to stick to this national role in the following.

The change from an article 5 forward defence related armed forces to today's structures has been a major step and a major change. I can assure you that we have not yet seen the final changes of that process.

For Denmark it all started with the Gulf War. We were asked to provide a corvette. We did so, but it required a major discussion in the Danish Parliament to convince the opposition that we should contribute. The political prize paid was that it should be volunteer to participate in international operations. This was a major step for a mostly conscripted army. In the end we found ways to accommodate this.

The next step was to create a brigade size reaction force for further international engagements. This was a natural development but our method was a low cost one. We provided a brigade The Danish Reaction Brigade made up by 80 % volunteer reserve personnel. The brigade provided personnel for the Danish UNPROFOR, IFOR, SFOR and KFOR contribution among others within the Nordic-Polish Brigade and later Battle Group. This was all very good but it had the consequence that we could not deploy the brigade without mobilising the majority of this volunteer reserve personnel. During the Kosovo crisis we were faced with this and it gave us some serious problems.

A further step was to create additional reaction units within the navy: The Danish Task Group, which was established in the recognition that the navy lacked one authority focusing on operational and tactical development. Likewise there was a need for a staff to run national as well as multinational naval task groups, which would be part of a larger Peace Support Operation - maritime as well as joint. And within the air force: a Rapid Reaction fighter component in those days only assigned in a defensive role.

During the 90'ties these were all used. We contributed to the Balkans where we were the first nations to deploy and employ tanks for reason of force protection, and to Kosovo. We contributed to the blockade in the Adriatic and we lately contributed to the Afghan Theatre.

Mid 1999 we looked back at this development and found that the decisions of this period had been mostly piecemeal, and that we needed to have an overarching policy for our further development. The result of this was Chief of Defence Denmark's Vision 2010 published in late 1999. In this three roles of Danish Defence is defined:

- Global Role
- Regional Role
- Other Roles

Global Role:

- Through military means, contribute to conflict prevention, peace enforcement, peacekeeping, peacemaking, humanitarian, and other similar tasks.
- Within the defence area participate in dialogue and co-operation with countries outside NATO.

Regional Role:

- As an integrated part of NATO, and in co-operation with Allied forces, participate in conflict prevention, crisis management and the defence of NATO's area in accordance with Alliance strategy.
- Detect and repel violations of Danish sovereignty.

Other Roles:

- Contribute to other tasks which benefit the civilian part of society – such as icebreaking, surveillance of the marine environment, maritime pollution control, fishery inspection, search and rescue, hydrographic survey, and explosive ordnance disposal as well as special assistance to the Police and the Customs & Excise Department, civil rescue authorities, medical emergencies, etc.

Now these roles are probably not very surprising. But with the roles goes the definition of the ambitions levels related to these roles. These are:

First the Army:

- We want to be able to take a leading role in a peace support operation by deploying a brigade-level HQ.
- We want to be able to deploy a battalion level formation for a prolonged period and for a shorter period two battalions. We also want to be able to take command of multinational brigade or sector.
- We want further to be able to deploy a recce squadron for up to 6 months.

Then the Navy:

- We want to b able to take command of a littoral operation including mine clearing.
- We want to be able to deploy and maintain 1 Frigate-type and 2 smaller vessels and up to one year 1 submarine.
- We want to be able to deploy 12 F-16s, 4 recce aircraft and an air defence unit in up to 2 years.
- We will see that the units for international missions are furnished with sufficient and up to date equipment.

In a similar way we define our ambition level with respect to the regional role (Defence of the country in an alliance context) and the special roles. I am not going to go into this. But let me mention that it is clearly stated we prioritise resources for the benefit of the global role and that the use of resources for the regional role must always be regarded a way to provide a solid basis for participating in international missions.

Of course we maintain structures for the regional role and the special roles but we realise that our budgets are limited. We keep in mind that we don't perceive an imminent threat against Danish or Alliance territory. In fact it is clearly stated in a report from the Danish Defence Commission from 1998 that within a 10 years period no military threat is possible. We therefore in the present situation find it reasonable to prioritise structures for the Global role.

We fully support the Combined Joint Task Force concept of the Alliance and we are fully prepared to make available forces for a NATO-led operation deploying a CJTF.

As I mentioned before all Danish personnel deployed for international operations are volunteer. It is obvious that if we want to maintain structures for these tasks we need to guarantee that we do our outmost

to bring our soldiers back. Therefore special attention needs to be given to the protection and security of our soldiers, sailors and airmen. Therefore allow me to dwell a little bit on this.

GENERAL

The development of the Danish Armed forces takes outset in the present and predictable international security political situation. The geopolitical developments have positively changed the stability in the region to a level unprecedented. However, within what I have called the global role, our forces will be faced with the full spectrum of warfighting within the future Crisis Response Operations, including Peace Support Operations, Combatting Terror, and Traditional Conflict. The safety of our trops in a military operations will be decided by an assessment of the operational environment into which the intervention is being considered and the political objectives and determination of the authorising political body taking into account the type of conflict, the geography and the threat. Combat operations would normally be mounted to counter a threat posed by an identified adversary and to defeat him by military means. The operational environment may be considered as being in a pre-conflict, conflict or post-conflict state, all of which may overlap in time or geographical space. The judgement of the operational intervention will be mission dependent and the profile of the military force will be dependent upon the mission, as well as political constraints and an assessment of the operational environment.

The military requirements to doctrine, concepts, forcecomposition and type of platforms are to some extent not similar in the different scenarios. This imposes additional challenges. In the future the majority of platforms have to be adaptable. In the context of international operations the armed forces should be able to react rapidly over long distances. This imposes the requirement for most ground vehicles to be air transportable. Bulk and weight now becomes important design factors in future ground platforms. This could indicate the feasibility of a modular design, where air transportable vehicles are fitted with additional protective measures after arrival in theatre. Let me as a side remark stress that this is all very true for entry phases, but in many situations it will be possible and prudent to deploy ground forces by sea.

Modern battlefields are characterized with an ever-increasing array of weapons, with greater and greater lethality and accuracy. These weapons pose an ever-increasing threat to the participants in the battle. The air planes, helicopters, ships, submarines and ground vehicles should be survivable to existing as well as new threats. Combat survivability is defined as the ability to avoid or withstand these threats, taking into consideration the environmental conditions in which the vehicle or platform must operate. Vulnerability is defined as the inability to withstand the hostile threats quantified by the conditional probability of being killed if hit. Loss of mission capability is a mission kill. Avoid and withstand are therefore the key words.

This translates into the familiar mantra for full spectrum protection:

- Avoid being at the battlespace/in range of enemy fire
- At the battlespace, avoid being detected
- Kill the enemy before being detected
- If detected, avoid enemy targeting (Identification, prioritization, assignment)
- If targeted, avoid being hit by enemy weapons (engaged)
- If hit, avoid/minimize damage

Consequently protection of platforms is important.

This diagram shows the same phases, but I have tried to relate it to the importance for the individual services.

Protection of platforms has traditionally been done by applying amour of different types on the individual platform. The crew needs to be protected while maintaining their mobility to carry out the tasks. In modern warfare limitation on casualties is paramount, it is no longer neither politically nor militarily acceptable to sustain heavy losses. Survivability is therefore a key factor, however, in modern warfare it is perhaps also necessary to look at this problem from another aspect. In order to ensure survivability and protection of platforms against engagement, it is vital to be able to react inside your opponents decision cycle. This decision cycle is depending on his technological level and C2. You therefore have to look at the problem systematically.

One systematic approach to consider platform protection could be to apply the well known O-O-D-A loop the 4 elements of which are:

- Observation.
- Orientation.
- Decision.
- Action.

This is one way of considering the steps an enemy has to go through in order to conduct an engagement. Conversely our counter-action would be steps taken to prevent, delay, divert or protect from these enemy actions.

Thus in order to protect a platform one could consider the following steps in descending order of priority:

Step in cycle	Counter Measure	Means	Effect	"Facilitator"	
				Active	Passive
Observation (Detection)	Prevent	Low Observable in all spectrums. Blinding. Concealment	Detection prevented.	Laser, obscurants.	Absorbing and shielding materials, camouflage.
	Delay	Low Observable in some spectrums Masking, EW.	Detection delayed.	Tactics, Active EW.	Absorbing and shielding materials, camouflage. Dummies
	Neutralize	Break contact	Detection neutralized	Maneuver, tactics, absorbing and shielding materials, camouflage, ECM	
		Destroy opponent	Opponent destroyed	Hard kill (platform/sensor)	
Orientation (Identification, prioritization)	Prevent	Disguise (WISC).	Mis-identification,	Mimic other platform, change signature	Camouflage
	Delay	Deception. (SIWC)	Wrong/no prioritization.	Maneuver, tactics, Active EW.	Dummies
Decision (Assign)	Prevent	Disrupt C2.	No engagement order.	EW, Hard kill (platform/sensor/weapon)	
		Engage	Break engagement	EW, laser, hard kill (platform/sensor/weapon)	
	Delay/disrupt	Deception	Wrong/no prioritization.	Maneuver, tactics, Active EW.	Dummies
Action (Engagement)	Prevent	Avoid threat.	No engagement.	Stand-Off. Tactics.	
		Engage	Opponent destroyed	Hard kill (platform/weapon)	
	Neutralize	EW, destroy opponent	Unsuccessful engagement.	EW. Tactics. Hard kill (platform/weapon)	
	Protect	"Hardening".	Damage reduced.		Armor, lining.
		Create new targets	Breaking of target acquisition	Decoys	
	Minimize	Damage control.	Damage reduced.	Fire fighting.	Decoys/Dummies
		Back up	Redundancy		Back up system

Let me stress that this list is not all exhaustive.

OBSERVATION (DETECTION)

Of the four phases in the OODA loop, the Observation Phase is probably the most important as without inputs in this phase the others make no sense. In order to be ahead of the enemy's In this phase there are three important counter measures (Prevent observation, Delay observation and Neutralize observation in that order of priority) you will have to consider.

Obviously you would say, if you stay away from the battlefield you diminish the possibility of being hit. However, in the light of the events 11 September 2001 this is probably not quite true anymore. Maybe the battlefield is no longer a defined geographical area, and maybe the decision-makers always will be at the battlespace. Therefore protection of platforms have to be seen in this context, it might even be that you have to look at protection of platforms not as something physical like armour, which you are used to, but as protection of information. Information warfare is becoming more and more vital. Consequently intelligence information is vital, in order to prevent observation you have utilize all available intelligence information (Distributed: NATO, Coalition and National, and Organic: ELINT, SIGINT, COMINT, ACINT, and HUMINT). Because only by knowing the whereabouts of the enemy can you fully protect you own units. For that purpose you will have to take advantage of long range sensors, for example: Satellites, UAV's, Radar, Sonar, Electronic Support Measures, thermal equipment etc. and use your possible range advantage and have to protect that.

In order to conceal yourself from your opponent, you have to be low observable in all specter ranges, and minimize or change all physical and non-physical signatures (Radar Cross Section, Infra Red, Electromagnetic, Acoustic, Magnetic). To do this you can utilize different "Facilitators": Laser, obscurants including use of absorbing and shielding materials, camouflage (Painting, nets etc.), use of "smart fog" in order to suppress visual contours, Infra Red emissions, and radar reflections (use stealth in design), as you traditionally do. Tactics is also something you have to look into, like even mimic another platform. Employment of active EW (ECM), strict Emission Control (EMCON), maximizing use of non-electromagnetic communication) is also of paramount importance.

If you cannot prevent detection you have to delay observation by the enemy thereby buying yourself time. In order to delay observation you have to be low observable at least in some spectrums, this could, in addition to the previously mentioned "facilitators", be done either by use of active EW (jamming) or by "tactics" including masking, changing of positions, and/or use of dummies etc.

In order to neutralize observation by the enemy you can either break contact or destroy him, by for instance hard kill of his platform or sensors. Here it is again important to use the range advantage if possible. Use of tactics, camouflage, absorbing and shielding materials, ECM and use of "Dummies" can be very useful facilitators in breaking contact. The ultimate way to neutralize observation by the enemy is of course to destroy his weapon platforms or his sensors. This can for example be done by use of long range weapons, i.e. standoff weapons employing over the horizon targeting, so you avoid being at the battlespace or within enemy weapon range. In order to be able to do this you therefore have to make efficient use of combat information systems (Collect, Process, Display, all sensor data, to aid Command decisions), as well as use long range communications (HF, SATCOM, National Link, Link 11/16/22).

ORIENTATION (IDENTIFICATION, PRIORITIZATION)

If it has not been possible to prevent or neutralize observation and you are detected, the next thing you have to counter is the enemy's Orientation in order to avoid his targeting. This can be done either by preventing him from, or delaying his identification and prioritization and consequently assignment of weapons in his targeting process.

During the Orientation Phase it is important to disturb the enemy's identification of the target to a point were it is no longer relevant or important seen from your own point of view. This can be done by disguising yourself in order to make the enemy mis-identify you, you can do that by mimic of and camouflage yourself as another platform (Wolf In Sheep Clothes (WISC)) or change your signature as mentioned before. Maritime forces have for example during conflicts appeared like merchant ships by running the same kind of navigational lights as well as only shining commercial navigational radars thereby complicating the identification process. Furthermore tactics, including maneuvers, are integral part of this in order to ensure that the opponent do not recognize you as an important target.

Another way of delaying the enemy's identification of you, is to try to deceive him into making the wrong identification or even not to prioritize. Of course this can be done by utilizing the previously mentioned "facilitators", or this can be done by looking like another perhaps more dangerous platform (Sheep In Wolfs Clothes (SIWC)) thereby deceiving him into not being able to identify your high value targets. Of course this is a dangerous step, because even though this has the potential of deceiving him into not prioritize and assign weapons there is a great chance of actually making your high value targets the targets. As early as the late 60'ties B-52 were equipped with up to 4 Quail UAVs. When released from the bomb-bay these would mimic a radar signature comparable with that of a B-52 thus confronting the opposition air defence not with one target but with five all looking alike. In the Beka valley operation and during the Gulf conflict UAVs replicating manned aircraft in signature and flight profiles were released ahead of the actual attack. This resulting in the opposition air defence wasting missiles on engaging low value targets, the SAM positions were revealed and the utilization of fire control radars made them vulnerable to ARM engagements.

DECISION (ASSIGN)

When the enemy has conducted identification and prioritized, he then goes into the Decision Phase where he will assign weapons to targets.

In order to prevent the enemy's decision making you can interrupt his Command and Control thereby preventing him from committing himself to engagement and actually give the engagement order. This can be achieved either through the use of Soft Kill (for example EW by jamming of the threat or through use of "Smart Fog" or Chaff (Decoys)) or Hard Kill of the sensor or sensor platform or weapon platform. Or through the same means break engagement.

In order to delay or disrupt the enemy's decision making you can deceive him and thereby prevent him from prioritizing or making the decision on engagement. This can be achieved through tactics by maneuvering or through the use of active EW (Jamming, Decoys etc.). Likewise, "Dummies" can be used with good effect in this phase.

ACTION (ENGAGEMENT)

After going through the targeting process, the last Phase in the OODA is the Action or Engagement Phase. This phase erupts as a result of our failure to interrupt the other three phases. Here two important rules apply:

- In order to prevent and neutralize engagement you can either avoid the threat or destroy your opponent by attacking him before he attacks. Here Airborne Early Warning, Combat Air Patrol, long range surface to air missiles, and Jammers amongst others are important features. If he is successful in launching his weapons you will have to avoid these weapons either though tactics or hard kill (Medium to short range surface to air missiles, Guns, CIWS (Close In Weapon System). Even soft kill is possible against an incoming raid for example by using "smart fog", Chaff and Chaff with IR flares (Decoys), as well as "Dummies".

- If enemy fire gets through you can minimize the effect of the enemy's engagement by different kinds of passive protection like armor and use of shock resistant equipment and mounts. Furthermore you can minimize the effects by having an effective damage control organization as well as having integrated damage control features in the design, and have redundancy and back up systems.

NATIONAL STRATEGY

As such Denmark has not formulated a national survivability strategy. However, as formulated in the mentioned Vision Paper: The Armed Forces shall comprise responsive, well-equipped, well-trained and well-motivated military forces, which will take a leading role in carrying out both national and international tasks. In this sense we focus on:

- Deployment and mobility. [Procurement of C-130J and EH-101 and shipping contracts].
- Logistics. [Establishment of DANILOG and mobile logistic equipment for the Air Force].
- Efficient and precise weapons use. [Laser Guided bombs and GPS guided JDAM and JSOW].
- Robust command and control systems. [Active and engaged participation in the ACCS project].
- The ability to protect the personnel most efficiently during international operations, being it running a weapons platform, being on guard or in a camp.

It is therefore a key issue to protect the personnel as well as the equipment, because as mentioned before, loss of mission capability is a mission kill. [Special revetments for camp protection].

CHARACTERISTICAL TECHNOLOGICAL CHANGES IN SERVICES

Generally the technological changes in developing weapons and sensor systems as well as command and control forces a development of counter measures. As we see it the trends for the future most likely lies within the following areas:

- Data Processing & Connectivity
- Advanced Sensors
- High Density Power Sources
- Miniaturization
- Robotics
- Next-Generation Stealth
- Directed Energy
- Hypersonics
- Biotechnology
- Nanotechnology

Consequently you might see the following developments within the services.

These developments include conceptional changes as well as technological changes.

NOW	FUTURE

- **ARMY**

Protection against enemy fire -> Armor, movement and terrain.	Never take a hit.
Concentration of forces in time and space.	Spread of forces, standoff weapons, Concentration of fire in time and space.
Direct firing weapons.	Smart weapons.
Organizational C3I.	Geographical C3I.
No IFF	IFF

- **NAVY**

Conventional design	Stealth. Use of signature related materials. Composite Structures. Lightweight armor.
"Dumb weapons"	"Smart weapons": Day, night, All weather. Improved engagement range for Standoff weapons. Extended Range Guided Munitions. Improved Accuracy. Use of UAV as sensor and weapon platform. Torpedo and Mine Counter Measures. Laser Warning Functions / Counter Measures.
Terrestrial Systems	Space Based sensors: Real Time Information. Optical Sensors (High Resolution). Radar (High Resolution). ESM.

- **AIR FORCE**

Deployable forces and Concentration of forces in time and space.	Small, home based but operational ready and deployable forces. Forces with strategic mobility.
Platforms performing direct hits.	Stand off weapons/ long-range delivery/precision guided munitions/ UAV for recognizance and weapons delivery.
Weather depending platforms.	All weather/multi-role capability.
Protection against enemy fire is movement/maneuvering or armor.	Advanced self-protection. Implement/upgrade EW equipment. Changes in design and materials (stealth).
Organizational C3I.	Geographical C3I that make scattering of forces/units possible.

EMERGING THREATS

This symposium intentionally will focus on NATO's efforts to improve the survivability of combat vehicles to ballistic and blast threats, the most prevalent on today's battlefield. This to some extent is conventional, and we already seem to have at least some kind of protection in that field. However, there is research into weapons that we currently have no counter measures against, but these will probably in the future become widespread. Here I will just mention a few.

Thermobaric Weapons

A weapon using a thermobaric rather than conventional explosives creates a relatively sustained overpressure and temperature, it is therefore well suited to inflict significant damage to personnel and materiel in confined spaces. The weapons can be used to reach targets that are further away from the source of detonation such as in caves and tunnel complexes and because thermobaric materials are by design oxygen deficient. Their lethality and effectiveness are enhanced when they are detonated in closed structures. Development of new thermobaric explosive-filled weapons will make it possible to strike urban and deeply buried targets. These weapons are not only usable in bombs but can also be used in smaller weapons like manpads or even small robots. Furthermore there are projects developing penetrating warhead for air-to-surface missiles. The importance of these weapons was highlighted during Operation Enduring Freedom in Afghanistan.

Non-lethal Weapons

Non-lethal weapons are weapons, which are designed to incapacitate or repel personnel, with a low probability of fatality or permanent injury, or to disable equipment, with minimal undesired damage or impact on the environment. NATO has over the years developed the political framework for the development and use of Non-lethal weapons. The target for Non-lethal weapons are personnel, military equipment and permanent installations.

An example of this is:

High Power Microwaves

It is well known that electronic equipment in the vicinity of High Power Radars is disrupted in a way that it malfunctions or is destroyed. It is also well known that nuclear explosions can produce powerful electromagnetic pulses (EMP), and it is possible to create something similar by conventional means. Modern military command and control and weapon systems are highly digitized, and therefore vulnerable to electromagnetic shocks, even though equipment, which has a great demand for reliability, therefore to some extent is protected against EMP, it is not fully protected. The technological development in High Power Microwaves (HPM) has made it possible to produce increasingly powerful microwave generators for big operational installations, but in the same time has made it possible to generate relatively powerful energy fields with compact systems which can even be as small as a briefcase. The first mentioned systems can possibly be used against military targets at a range up to several dozen of kilometers, while the latter compact systems you can imagine being used against all types of electronic equipment in civilian and military relations with ranges from a few meters. HPM-weapons are in the "non-lethal" category as it is possible to disturb and destroy electronic equipment without interfering with personnel in the vicinity. It is possible to produce a small HPM weapon with components available in any consumer electronics shop, while the larger systems are legally available from several suppliers in Europe and USA, and from several institutes and suppliers in the former USSR both legally and illegally.

I understand that a NATO Study Group has worked on the subject, and in June held a Workshop on Tactical Implications of High Power Microwaves in Copenhagen. This Study Group has now completed its work and will produce a report by the end of this year.

Frustration after 11 September

NATO support coalition (force generation, force planning, political support)

NATO lead an operation (NATO US command structure)

AIM OF THE SYMPOSIUM

It is the ambition of the Danish Armed forces, in the framework of NATO, the UN or OSCE, to be able to participate in international operations at the same qualitative level as our alliance partners, including platform protection. By participating in international operations we have the foundation to ensure the quality in force contribution for the non-reaction forces in the regional role should this be necessary.

I hope that this symposium will be an inspiration and eye-opener into further development of protection for air, land and sea vehicles.

It is my hope that you will have some interesting days with intense and productive information exchange. I also hope that you will enjoy the hospitality of the town and of the Danish Defence.

Welcome to you all.