Chapter 3
Police Leadership During Challenging Times

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Part 1: The Work of the Police in New Demanding Contexts

The Context of Police Work is Undergoing Change, Leading to Demanding Challenges

The police services in a number of countries are undergoing changes. Traditional crime is declining in several European countries, while we can observe clear alterations in the types of crime occurring. For instance, organized crime, cross-border crime, various types of cybercrime, human trafficking and work-related crime have all been on the increase. Migration has also become a much more relevant issue in recent years. Over the same period, acts of terror have increased – many countries have been targeted by terrorist attacks. In addition to this general picture, natural disasters have grown more frequent. Crime is in the process of changing. The various communities that the police are set up to protect have become increasingly complex, leading to new and demanding challenges for the police and police leaders.[1]

In many countries, the police have been subjected to criticism, and their legitimacy has been challenged. Today, the media, politicians and people in general are directing a more critical light on the police than was the case a few decades ago. The police have faced criticism when operations fail, are drawn out, or are without results; when the police commit errors; when information emerges about police

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[1] https://cult.is/rastafarians-in-the-hills-of-saint-lucia/ Retrieved 4 November 2012

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corruption or when the police use undue force against individuals or groups. In particular, governments want a well-organized, modern and competent police force that can fight crime and contribute to safety and security. At the same time, in several European countries, governments have implemented financial cutbacks. In recent years, openness, accountability, quality, efficiency and results have been significantly strengthened.[2]

In a number of countries, the police have undergone major changes and reforms. These changes and reforms have been characterized by the development of organizational culture, new working methods, an increased use of technology, stronger central management and result orientation. There has been a centralization of the police forces in Scotland, the Netherlands, Belgium and in the Scandinavian countries. Van Dijk et al. (2015) consider that this has involved restrictions on the police's mandate in the respective countries. The diversity within the police has increased. And finally, there is an increasing awareness in many countries that the fight against crime cannot be prevented and tackled by the police alone. This has meant that the police need to develop partnerships with other service providers in the public, private and third sectors. An interesting feature that has become increasingly evident in some countries is the development of productive cooperation between the police and various professional communities at universities.[3]

This has been done in order to utilize the professional expertise at the universities, but also to challenge the traditional perspectives, views and knowledge that have characterized the police in their perception of society, trends, crime, risks, and problem solving.[4]

The developmental trends outlined above show that the context in which the police operate has increased considerably in complexity (Mitchell and Casey 2007). This has led to new and greater challenges for police leaders. In a number of countries, the police are now at a turning point in terms of crime development, tasks, organization, working methods, technology, cooperation and, not least, context.[5]

In tandem with the main challenges described above, the police need to exercise and carry out good and effective prevention, investigations and emergency preparedness. The police must ensure safety and security, in a world where these values have come under pressure.

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[2] One of the authors had an in-depth and chilling discussion with a member of the Dominican Police Forces who participated in a raid on a Rastafarian community similar to the assault on Mount Gimmie in St Lucia. One of the lasting memories from that discussion was his description of the killing of 'very attractive' Rastafarian woman from a middle class family and former university graduate who tried to save a child and duly shot dead. The police man's remarks 'what a waste' referred to the physical beauty of the young woman in question who was killed along with the child she was attempting to save. The police violence against generally law abiding Rastafarians is probably one of the ugliest periods in Caribbean policing history which has enjoyed little discussion outside Rastafarian communities.

[3] Rastafarians are well known for their use of marijuana.

[4] See Islamic State and the Mosques of Trinidad. www.dw.com. 25 March 2017. Retrieved 6 November 2017

[5] Michael Mathura PhD Thesis Police

The police have a monopoly on the legitimate use of physical force in society. This is an important and demanding responsibility, of which both employees and police leaders need to be fully aware. The responsibility, and the underlying tasks, will be put to the test when terror and insecurity threaten. The police are responsible for upholding various sets of important social values. Moreover, they are responsible for safeguarding democratic values, justice and human rights for individuals, groups and communities. Furthermore, the police are responsible for protecting economic assets through effective operations and services. And finally, professional values should characterize the operation and development of the police.

Police leaders are responsible for preserving democratic, economic and professional values in their capacity as leaders, in both the short and longer term. They should be able to master and deal with daily operations, emergency events and various types of crises, incremental developments and reforms, both separately and simultaneously. This comprises a large range of situations and management tasks. Against this background, we will argue that leadership both within and by the police has become more complex and challenging in recent years. At the same time, we believe that police leadership is a crucial resource in order to ensure the efficient operation and development of the police service, and essential if the police are to function efficiently with the level of quality and ethical standards that meet the demands and expectations of a liberal democracy.

Understanding Police Leadership

Leadership is an activity and a resource that is only partly linked to position and rank in the police. It is a resource that is needed at all levels in police organizations (Fleming 2015). Leadership is exercised at strategic, middle and senior levels, as well as on the front-line. Every police officer makes assessments and decisions, communicates, and thereby exercises leadership in their daily operations, when dealing with various problems and incidents. Effective leadership is important if the police organization is to be perceived as legitimate by both internal and external individuals. Effective leadership is also a prerequisite for police organizations to function effectively in an ever increasingly dynamic and complex landscape (Fleming 2015).

In his *Harvard Business Review* article "Skills of an Effective Administrator" (1955), Robert L. Katz found that managers needed three important skills: technical, human and conceptual. Northouse (2013) refers to this as the "Three-Skill Approach". Haberfeld (2013) refers to Swanson et al. (1998), claiming that police leadership may be understood by means of three sets of skills and/or competences. Swanson et al. describe similar managerial skills to those referred to by Katz in his 1955 article. We believe this approach to police leadership to be very useful.

In the Norwegian book on police leadership (Johannessen and Glomseth 2015), Glomseth writes the following: "The Police Leadership Qualifications Framework (PLQF), launched by the National Police Improvement Agency (NPIA) in England

and Wales, has formulated the following definition of police leadership: 'the ability to effectively influence and combine individuals and resources to achieve objectives that otherwise would be impossible' (Gibson and Villiers 2007: 7)". Gibson and Villiers claim that leadership may be perceived as "comprising five integrated levels: leading by example, leading others, leading teams, leading units and leading organizations" (Gibson and Villiers 2007: 7).

This approach is based on identifying the knowledge and skills necessary in order to maintain effective leadership roles and to exercise leadership. By following this model, police leaders can be educated and trained to perform competent leadership both individually and collectively in the police service.

Andreescu and Vito (2010) write that: "(police) leaders are expected to generate a sense of purpose that both motivates and directs followers so that they voluntarily make a meaningful contribution to the organization".

Haberfeld (2006) defines police leadership as follows: "The ability to make a split-second decision and take control of a potentially high-voltage situation that evolves on the street." Furthermore, she claims that "police leadership is the ability of each police officer, starting from the first day on the job, to take control of a situation on the street.

Any type of situation that requires assertion of control would fall under this definition. As police officers progress in their careers, the level and degree of control change. Due to the fact that police work is based on the mandate to use coercive force to achieve compliance, police leadership is about the ability to take control. (…) Police leadership will frequently be immersed in a clash between the concepts of doing things right and doing the right thing."

Golding and Savage (2008) distinguish between three types of police leadership:

- Command (commanding, instructing, ordering leadership)
- Leadership (leadership, leadership as interaction)
- Management (management/administration).

These three types may also be perceived as functions which police leaders must master in order to perform police leadership roles effectively and to solve various types of problems. Grint (2010, 21) accentuates these types of leadership, by claiming that leadership involves asking questions and inviting dialogue. Administration involves organizing processes and managing resources, while command-based leadership involves providing clear messages and instructions. Consequently, there are situations and problems that require different approaches in the exercise of leadership.

Grint relates the different types of management to three categories of problems: namely 'critical', 'tame' (ordinary) and 'wicked' (complex problems) (cited in Glomseth 2015: 149–150).

Moggré et al. (2017) claim that police leadership is considered as being more specific and context-sensitive than regular leadership, because of the continuous interaction with internal and external factors.

Police Leadership in Four Different Management Situations

Daily operational management concerns the daily running of a police unit, which is characterized by stable external conditions. Attention is focused on the organization's goals. Police officers undertake the regular tasks they have been allocated through the police operations center, and other police officers investigate the cases which they have been given. The police leaders need to ensure that the day-to-day operations run smoothly (Fig. 3.1).

Daily police operations constitute the main part of the police service's work, where tasks and problems need to be solved. The manner in which the organization addresses its tasks, develops working methods and practices, and how the police leaders gain experience, learn and develop, constitute the basis of the police service. The operational part of the police service probably uses the largest amount of resources.

Development management occurs in small steps and is a natural part of a police unit's activities. Tasks and problems are discussed and solutions reached, competence development is conducted, technology is developed and improved, and working methods are gradually altered. Employees cooperate with each other, and through this process they learn and develop. Development management means facilitating discussion, reflection and learning. Furthermore, it involves enabling situations where new and inexperienced staff can work together with those who are more experienced. It also means allowing employees to participate in and lead projects, coaching, mentoring, studying how other organizations function and learning from the practices of others. In addition, trimming work processes and the organization to exploit resources better will fall under this type of management, as well as the development and improvement of management processes.
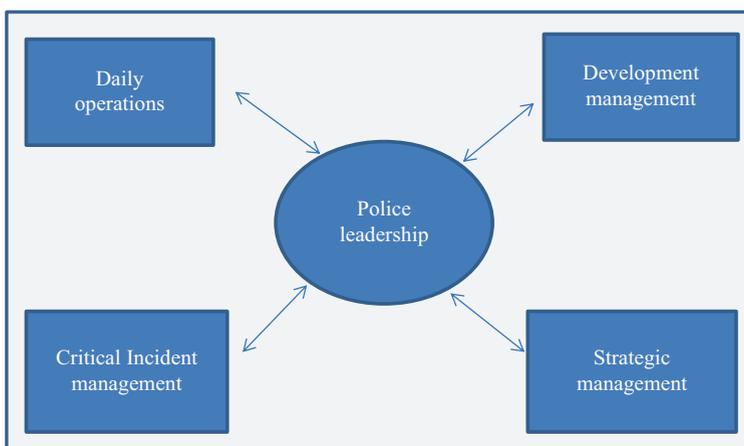

Fig. 3.1 The four main types of management in the police service. (Source: Glomseth 2015)

Strategic management in the police service may be understood in several ways. Strategic management can take place at all levels of the police organization when it is linked to an isolated task and solution. However, in this context, we understand strategic management as taking place at the organizational level; that is, where, for instance, the organization, an operating unit or a police district, need to carry out larger and more complex adjustments to adapt to the outside world. The 'outside world' may refer to a new and serious type of crime or threat. This may represent such a demanding challenge that the police service needs to reorganize, consolidate resources, or re-prioritize parts of its budget. Political decisions and new directions may result in a police district needing to change its strategy and priorities. This can also involve more comprehensive reforms, such as those facing the Norwegian police service today. Such situations, and other similar ones, require strategic leadership and management.

Finally, we will focus on *action-centered management* and *crisis management*, or what one might call *Critical Incident Management* (Alison and Crego 2008 and Turbitt and Benington 2015). The 22 July 2011 attacks required this type of management at all levels. The Torp Hostage Crisis on 28 September 1994, the Åsta Accident in 2000, the Nokas Robbery in April 2004, and the Lærdal Fire in January 2014, were all emergency situations characterized by great uncertainty and pressure of time, where decisions had to be made on the basis of limited and often uncertain information. In such crisis situations, the demands on and expectations of the police are very great from all quarters, and the consequences are also great. Outcomes and consequences will be seen as being related to police efforts (or lack thereof). These crisis situations place extremely great demands on police leaders, their competence, power to act, courage, wisdom and cooperation (Glomseth 2015: 162–164). In recent years, several countries have been hit by acts of terror; for instance, in Europe: London 2013; Brussels, 2014; Paris and Copenhagen, 2015; Berlin and Brussels, 2016; and London, Barcelona, Åbo and Manchester, 2017. This has led to great demands on personnel and leaders in the police.

Leadership, Management and Command

Grint, writing in Fleming (2015) refers to the complexity of police leadership. He has developed a model based on the concepts of leadership, management and command, in order to understand and explain various problems and decision-making processes. In the model, he also distinguishes between 'tame', 'wicked' and 'critical' problems. Grint uses the same concepts and categories as Golding and Savage (2008) – see (Fig. 3.2).
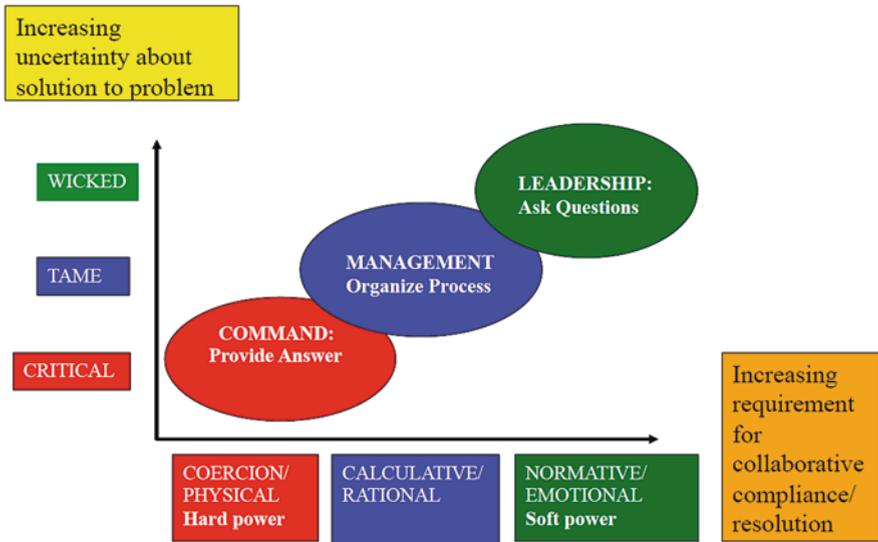
Fig. 3.2 Problems and decision styles. (Source: Grint 2005)

Part 2: Modeling Demanding Integrated Operations

Whatever situation a police leader is in, being wicked, tame and/or critical, today's work within the police force may thus be characterized as participation and/or leadership of operations involving personnel from different agencies or organizations, in addition to representatives of the general public. We will call such operations *demanding integrated operations*. What's typical with these integrated operations are that the different participants often have different "roles to play", and that they have rather insufficient knowledge and understanding of each other's roles. Furthermore, the different participants may have different background, both regarding knowledge of what's supposed to happen and experience from similar operations, different individual goals, and finally, sometimes surprisingly different perspectives of what's really going on.

This goes for almost any situation from a typical accident or fire to a terror attack where all the blue light organizations, the government, the media and representatives from the general public are involved. Participants in any such "operation" may have completely different primary goals and may see the situation from completely different angles. A random bystander may wonder how he can participate to help, while a police officer may be occupied with keeping the general public away from the crime scene. Someone from the fire department may be focusing on how to avoid that a fire is spreading to the next building, when the paramedics are trying to assist someone wounded.

These differences in goals, attention, focus, perception, and roles to play are of course just as it should be, but insufficient understanding of the roles of the other participants may cause actions that have adverse effect. Here, we claim that in such demanding integrated operations it's especially important, and difficult, to understand *what's really really going on*.

It is vital to see that this is not just important during crisis operations, but also during e.g. monitoring and control, and not at least regarding planning of possible critical operations. During planning (*Risk Management*), we try to foresee most of the possible scenarios that might occur, while during monitoring and control (*Issues Management*) we're searching for signals that might indicate that a dangerous scenario seems to be unfolding. In crisis situations (*Crisis Management*) the questions are what has happened and what is happening now (Aarset 2016). Something has occurred, but what – and what is the best response? Is it, and how is it, possible to reduce the possible undesirable events, and how is it possible to prevent further escalation? And what kind of consequences will the decisions that have to be taken in a split second, often based on limited and uncertain information, have on the goals of the other participants in the operation?

Consciousness

How safe and effective such operations are executed will among other things depend on the level of the participants' overall understanding of the situation, or the participants' consciousness. By consciousness we here mean our immediate awareness of ourselves and our environment (Passer et al. 2009). Consciousness is often understood as some kind of a summary, a mental "picture" of what's going on in our world. Therefore, consciousness is subjective, private, dynamic, self-reflective and vital for our understanding of ourselves and what we believe is going on. Thus, consciousness will control our attention and influence how we decide to act.

The concept usually addressed with respect to such demanding integrated operations is *situational awareness* (or situation awareness, meaning exactly the same). Smith and Hancock (1995) describe situational awareness as *externally directed consciousness*. According to Endsley (1995), participants in demanding integrated operations make bad judgments when their overall understanding of what's going on is insufficient, i.e. when acquisition and/or maintenance of situational awareness is insufficient.

Both leadership style, system design, artefacts (e.g. supportive tools) and procedures should therefore be formed to strengthen the participant's and the system's situational awareness. But to be able to do so, we need knowledge of how situational awareness may be acquired and maintained in different situations. To succeed in constructing systems and procedures that makes it possible to acquire and maintain situational awareness, and thereby reduce the probability of human failure, we will therefore study this concept here.

Situational Awareness

Situational awareness was originally introduced as a concept within military aviation when it was identified as crucial for military pilots during the first world war (Endsley 2000). The concept was however not given much attention within academic fields until the late 1980's (Stanton and Young 2000), and then mainly within civil aviation and air traffic control. Real attention from the academic field was not accomplished until a special edition of the journal *Human Factors* was published in 1995 focusing on situational awareness.

In the scientific literature, there are several definitions of situational awareness. There is thus still no general scientific agreement on how situational awareness best should be defined and modelled, and neither which of the suggested definitions that's most applicable. With the understanding that no models are correct, while some are useful, we'd like to list the following definitions anyway.

"(Situational awareness is) the combining of new information with existing knowledge in working memory and the development of a composite picture of the situation along with projections of future status and subsequent decisions as to appropriate courses of actions to take" (Fracker 1991).

> "Situational awareness is the conscious dynamic reflection of the situation by an individual. It provides orientation to the situation, the opportunity to reflect not only the past, present and future, but the potential features of the situation. The dynamic reflection contains logical-conceptual, imaginative, conscious and unconscious components which enables individuals to develop mental models of external events" (Bedny and Meister 1999).

There is one definition of situational awareness that, especially in the applied field, has become more "popular" than the rest, though. We will focus shortly on this definition here because it also might be more intuitive and maybe easier to understand. As we shall comment on later, it has some drawbacks, though, but it's so often referred to that it is reasonable to introduce this model also here. Mica Endsley (1995) states that situational awareness is a cognitive product resulting from a separate process labeled *situation assessment* comprising the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and a projection of their status in the near future (see Fig. 3.3).

Endsley's definition and model is describing situational awareness as the result of a separate cognitive process (situation assessment) which is creating an inner mental model of the actual environment. This understanding is forming the basis for decision making and action. Furthermore, the model in Fig. 3.3 illustrates several additional relationships influencing both the process of information gathering, comprehension and forecasting, as well as decision making and behavior. The model is also illustrating that individual factors as goals, expectations and abilities, and task and system factors as workload and complexity all are influencing acquisition and maintenance of situational awareness.

We are discussing this model here basically because it seems to be how we ideally think we should behave. The model does not indicate that prior knowledge and understanding will influence an actor's attention, though, which again will influence
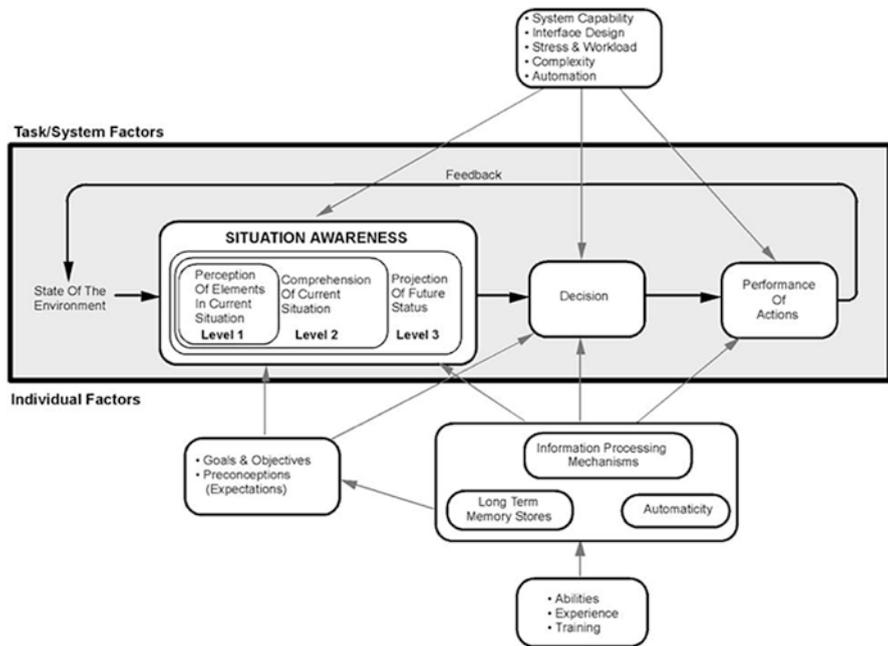
Fig. 3.3 Illustrasjon av Endsley's three level model

which information the actor will seek, and which impressions will be emphasized. This model may also promote a belief that the world is rich in information which objectively is presented to an observing actor – who is without preconceptions. Alas, maybe except a person like Sherlock Holmes, we believe no human being will act like this. Mostly, we don't perceive all signals that's available, and we even have a tendency "to see what we expect to see". We interpret the signals we observe based on our prior understanding (Plous 1993).

This model also has so many similarities to how our working memory is understood that it is an open question if situational awareness constitutes a separate term at all (see Fig. 3.4.) Before we proceed in our quest to define and explain what situational awareness actually is, and how the concept can be defined and applied, we therefore will point out some key memory-related relationships.

The Modal Model of Memory

Our memory contains everything we know and make us who we actually are. Memory constitutes three logical stages; encoding, storage and retrieval, as illustrated in the modal model of memory in Fig. 3.4 (Atkinson and Schiffrin 1971 as redrawn in Braisby and Gellatly 2005).
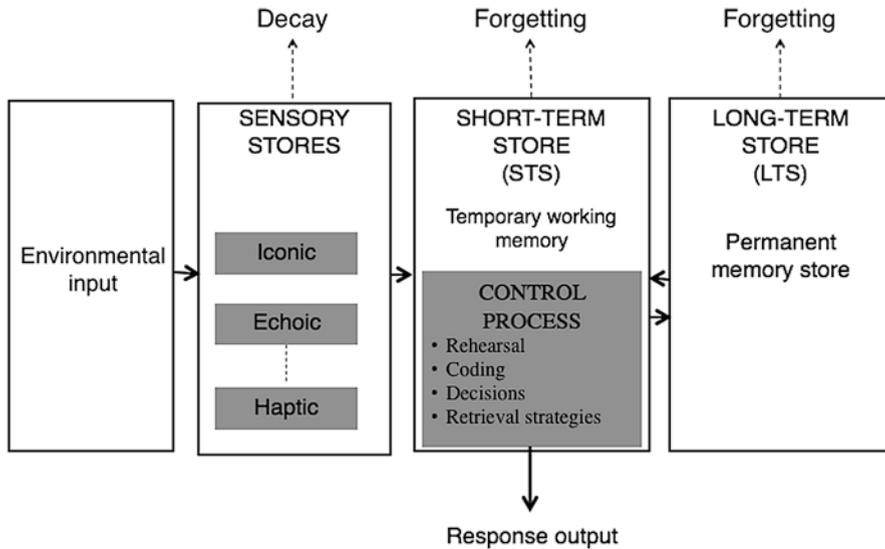
Fig. 3.4 The modal model of memory

The model illustrates that we receive information through our senses, which are then transferred to our working memory (which earlier on traditionally was named short-term memory). Working memory is coordinating our mental processes with transient stored information during cognitive activities such as planning, participating in or leading e.g. a demanding integrated operation.

After information is leaving one or more of our sensory stores, it must be represented by some code if it is to be kept in working memory and eventually transferred to the long-term memory store. Such memory codes are mental representations of some kind of information or stimulus, and have the form of visual codes, phonological codes, semantic codes or motor codes (Braisby and Gellatly 2005).

What we store in our long-term memory is thus processed information, as we perceive what we have sensed. Our memory works further so that we do not memorize isolated senses, we interpret new information in light of our previous experience and the context the senses are presented, and then construct and memorize larger scenarios (Braisby and Gellatly 2005). Retrieving such stored information from our long-term memory involves finding, activating and sometimes further processing pertinent memory representations.

Schema Theory

Schema theory was first introduced early in the 1900's (Head 1920 and Piaget 1926) and describes how individuals possess mental templates of past experience that are combined with information from the real world as the basis for actions. The

schemata are the active knowledge structures that govern our attention, exploration and interpretation of the information available to us, which in turn are updated as a basis for further exploration.

Therefore, our expectation of what might happen is guiding what we decide to do, which information we're seeking and what information we actually become aware of. We seek to understand what we sense in light of our prior understanding, and we are continuously updating this understanding. Schema-based theories assume that this cognitive process is not only cyclic (rather than linear), but also parallel (as opposed to processing a stream of information at a time). The schemata are modified by new experiences, while they themselves affect information retrieval and interpretation. This seems to be in contrast to Endsley's model of situational awareness.

Bartlett (1932) introduced the concept of schema as active organization of earlier reactions and experience combined with information received by our senses. Furthermore, Bartlett argued that recall was a process of reconstruction and that memories showed evidence of consolidation, elaboration and invention, using material from other schemata.

Norman (1981) used schema-theory to explain human failures. Either, he suggested, we are:

- activating an erroneous schema (e.g. based on a similar experience)
- activating the wright schema too late or not at all (e.g. because we don't understand that a situation has changed)
- activating the wright schema too early (e.g. because we misunderstand a situation).

Neisser (1976) presented a model for this process as illustrated in Fig. 3.5. This model is based on schema, prior knowledge and selective perception.

Neisser's model illustrates that any actor in a given system has a cognitive map of the world, and especially a "smaller" cognitive map of the current environment (the triangle at the bottom left). This controls a top-down process, of several possible ways, where we seek to explore the environment (the triangle at the bottom right). With our senses we then manage to collect some, but not all, of the available information (the triangle at the top), which in turn leads to an update of our perception of what's happening (back to the triangle at the bottom left).

Adams et al. (1995) suggested that "Schema of the environment" in Neisser's perceptual cycle is illustrating "Working memory", and that "Individual cognitive map of the world" is illustrating "Long term memory" in the modal model of memory.

Smith and Hancock (1995) based their understanding of situational awareness on Neisser's perceptual cycle. They suggested the following definition; "Situational awareness is the invariant in the agent-environment system that generates the momentary knowledge and behavior required to attain the goals specified by an arbiter of performance in the environment, with deviations between an individual's knowledge and the state of the environment being the variable that directs situation
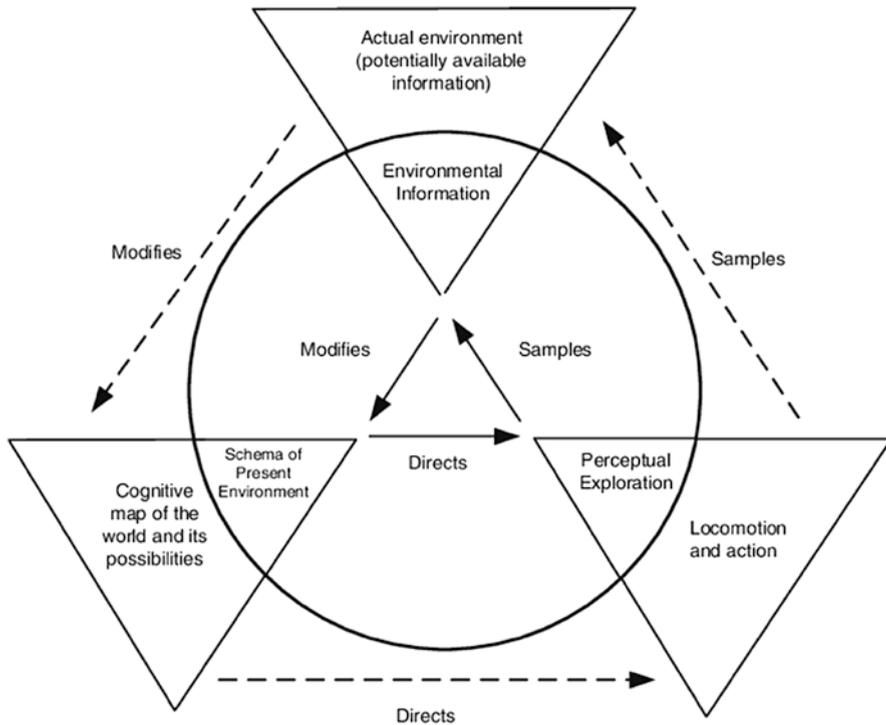
Fig. 3.5 Neisser's perceptional cycle

assessment behavior and the subsequent acquisition of data from the environment."

Studying this definition more in detail, we see that it points out conditions that concern a decision maker/agent (i.e. "an arbitrator of performance in the environment") in some situation (i.e. "in an agent-environment system"). Linked to this decision maker in the current situation there are two concepts; the variable (that change during "a circle" in Neisser's perceptional circle) and the invariant (that doesn't change).

The variable is related to the deviations that exist between the decision maker's understanding of what is happening and what really happens (i.e. "deviation between the individual's knowledge and the state of the environment"). This deviation will typically vary as the process evolves. As illustrated in Fig. 3.5, this deviation will affect what tools the decision maker seeks to utilize, what information he manages to understand and how he interprets this information (i.e. "conducts a situation-based assessment and subsequent acquisition of data from the environment").

Smith and Handcock define situational awareness as what is constant in the agent-environment system that generates the momentary knowledge and behavior required to attain the goals specified. That is to say that if the decision maker has a correct understanding of what's going on, then he won't change neither how he

decides to collect information, his perception nor his interpretation of what's going on (i.e. "being invariant").

What we can see based on the models and the definitions we have mentioned so far is that situational awareness can be perceived both as a product of a process, as a process in itself or as a mixture of both.

- As a process, i.e. it is the state of the perceptual cycle at any given moment, the process of gaining awareness (e.g. Fracker).
- As a product, i.e. it is the state of the active schema, the product of awareness and the conceptual frame or context that governs the selection and interpretation of events (e.g. Endsley).
- As both a process and a product, i.e. it is the cyclical resetting of each of the other, the combination of the two (e.g. Smith and Hancock).

Situational Awareness in Collaborative Systems

When performing demanding integrated operations, there is typically a group of people who jointly perform activities to achieve a goal. We shall define a team as a distinguishable set of people who interact dynamically, interdependently and adaptively toward a common goal, who have each been assigned specific roles or functions to perform and who have a limited life span of membership (Salas et al. 1995).

We will classify the activities to be carried out by such a team as either teamwork or taskwork. Teamwork is activities where the behavior of the actors is affecting each other, or they coordinate their behavior in relation to each other to reach the system's partial or overall objective. Taskwork means activities where the actors are performing individual activities separately and (in part) independently of input from the other actors.

When performing demanding integrated operations, the actors (agents) and the tools that are available (artefacts) will form a so-called *joint cognitive system* (Hollnagel and Woods 2005). Furthermore, cognitive processes will occur and be distributed in this joint cognitive system. It is not trivial to define situational awareness in such situations, and it is clear that situational awareness associated with such a system is somewhat more than just "a sum of the individual's understanding."

When researchers have attempted to define situational awareness for a team, focus has typically been on what is called *shared situational awareness*. The idea behind this wording is that there is a "part" of the current situation that all (or some) of the team understand in the same way. This is usually illustrated as shown in Fig. 3.6.

Endsley (1995) defines shared situational awareness as "the degree to which each team member has the same situational awareness on shared situational awareness requirements". However, as discussed above, we point out that situational awareness depends both on the individual's starting point and prior knowledge, and that the individual actors typically have different backgrounds and experience. This indicates
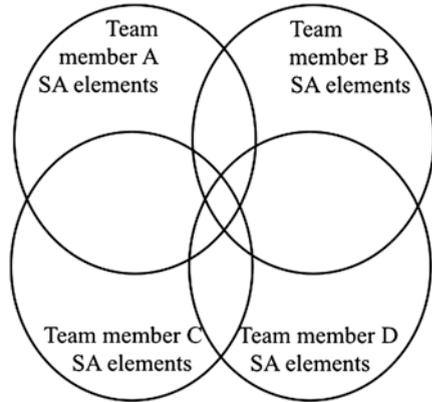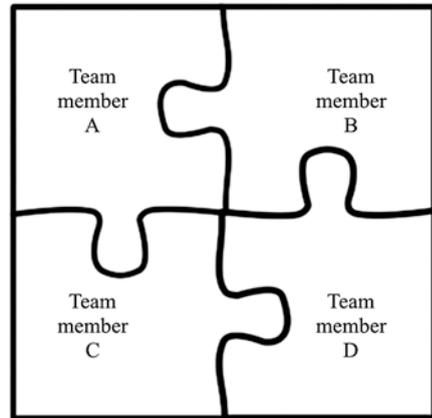
Fig. 3.7 Illustration of
compatible situational
awareness (Stanton et al.
2006)

that shared situational awareness not at all is easy to acquire and maintain, if possible at all. Such a common understanding can therefore be too strict to ask.

A less strict, and perhaps more realistic, relationship we may wish for a team to achieve may be what Stanton et al. (2006) calls *compatible situational awareness* (see Fig. 3.7). Here we see that in order for a team to achieve compatible situational awareness, it is sufficient that the different actors have an understanding of what is happening that is consistent with the understanding the others have.

It is this interpretation Salmon et al. have build on when they defined *distributed situational awareness* (Salmon et al. 2009). Their model (Fig. 3.8) uses schema theory as its basis and treats distributed situational awareness during demanding integrated operations as "a systemic property that emerges from the interaction (referred to as situational assessment transactions) between system elements (human and non-human)" (Salmon et al. 2009). They view distributed situational awareness as "the system's collective knowledge regarding a situation that comprises each element's compatible awareness of that situation."
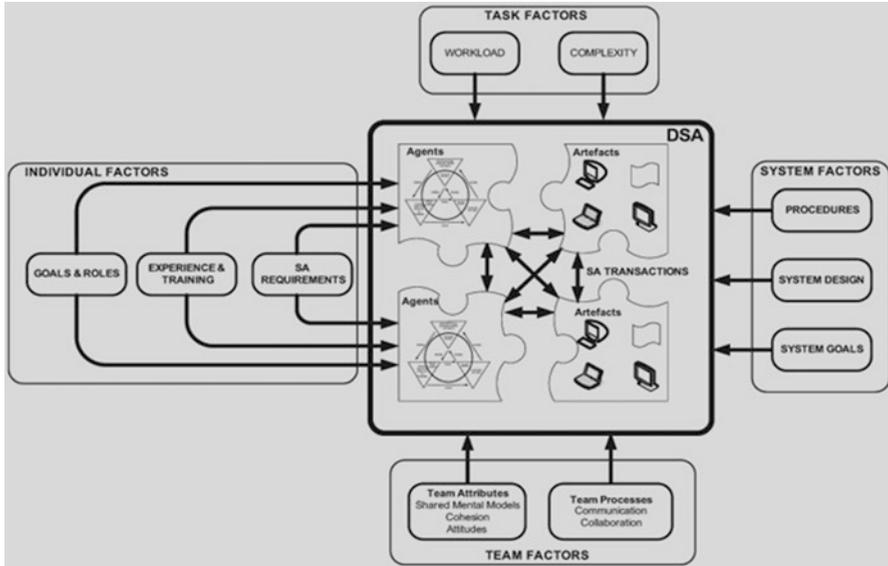
Fig. 3.8 Model of distributed situational awareness according to Salmon et al. (2009)

According to the model depicted on Fig. 3.8 four groups of factors, in addition to the individual situational awareness as illustrated by Neisser's conceptual circle, are influencing a system's distributed situational awareness. When a demanding integrated operation is to be planned or executed, these are the factors we suggest should be optimized.

System Factors

The system factors first of all include the overall objective of the operation, the sub-goals of the system, and the constraints which the operation is to be executed within. The design of the system is including "the interface design of the artefacts that are used to present situational awareness information to the agents within the system", the structure of the network of agents, and the communication channels that are available (Salmon et al. 2009). Furthermore, the system factors include the procedures established for the operation, and the redundancy implemented in the system.

Individual Factors

Each agent within such a system as described here will have individual goals, constraints and roles to play during a demanding integrated operation. These will all influence the agent's individual situational awareness. According to Neisser's perceptual model, all agents will furthermore have their own subjective prior

knowledge and understanding of what's going on, and at any time their own subjective situational awareness requirements. Both the prior knowledge and the situational awareness requirements will be influenced by the agent's competence and commitment, established through e.g. experience and training.

Team Factors

The team competence and commitment will also influence the distributed situational awareness. These are depending on e.g. leadership, mutual performance monitoring, and redundancy behavior. Furthermore, the team factors may be split into team attributes and team processes. Team attributes include e.g. shared mental models, cohesion, and attitudes, while team processes include communication and collaboration.

Task Factors

There are several task factors that influences the distributed situational awareness, as e.g. task design, complexity, workload and different kind of constraints (time, place, environment, etc.) for the execution of the tasks.

Acquisition and Maintenance of Distributed Situational Awareness

The model in Fig. 3.8 provides us with a tool to organize our thoughts when we are trying to improve the probability of success of a demanding integrated operation. The model may be utilized for directing actions to improve acquisition and maintenance of distributed situational awareness, and thereby improving both efficiency and reliability.

Part 3: Techniques for Improving Distributed Situational Awareness

Leaders should facilitate for acquisition and maintenance of distributed situational awareness both during planning, monitoring and control, and execution of demanding integrated operations. For leaders to be able to accomplish this, we suggest utilizing the following illustrative techniques, in addition to individually and collective training; objective hierarchies, Structured Analysis and Design Technique (SADT), agent-based flow charts (ABFC), and Neisser's perceptual cycle model.

Objective Hierarchy

As illustrated also on Fig. 3.8, it's of vital importance to identify and share the vision (overall or main objective) of an operation (Aarset 2016). To clarify, a main objective should be subdivided into several more detailed sub-objectives or sub-goals and constraints. Such sub-goals can be organized in a meaningful way by using a hierarchical structure, although such a hierarchical structure will rarely be entirely unambiguous. Furthermore, this can easily result in sub-goals that vary strongly in terms of clarity and level of detail, and the sub-goals can even be mutually conflicting.

Also, such a specification can often lead to important parts of the vision or main objective disappearing. Therefore, be careful not to forget important factors when attempting to specify the vision. On the other hand, an overly extensive or detailed subdivision can lead to the main idea behind a vision being pulverized. Sometimes, this structuring of objectives can be very complex, while at other times it can be quite simple. Anyhow, it will improve the agent's consciousness, which basically is the general idea.

The desired level of detail will usually depend on what this specification is to be used for. If it is only intended for use in a planning phase, a less detailed specification will probably suffice. It is recommended to specify the objectives to one level lower than the level at which you wish to define targets and attributes. The level below the "attribute level" can then be used to justify the values assigned to the attributes or be seen as means of achieving the targets (Aarset 2016).

Whether we wish to define the individual sub-items as constraints (barriers) or sub-goals is often a matter of preference, but a preference that should be addressed. A constraint (barrier) is a factor that must not be exceeded under any circumstances, but that we don't necessarily wish to improve beyond meeting that constraint. A (sub-)goal is typically something we would like as much (or as little) of as possible (Aarset 2016).

If, for example, quality and time are of importance, then time as a sub-goal and quality as a constraint will suggest executing the operation as quick as possible, as long as the quality is acceptable. Quality as a sub-goal and time as a constraint are suggesting executing the operation of as high quality as possible, as long as the time frame is not exceeded (Fig. 3.9).
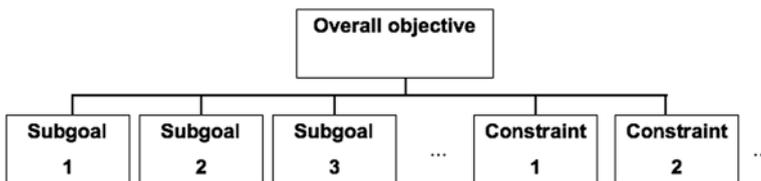

Fig. 3.9 The hierarchical breakdown of a main objective with pertaining targets and attributes

For attributes, measuring if the (sub-)goals are met or the constraints are exceeded, to be useful in an analysis, they should satisfy the following requirements. The attributes should be (Aarset 2016):

- *operational*, so that they can tell us with a certain amount of precision the extent to which the objective has been achieved
- *complete*, so that they cover all aspects of the objective
- *disjoint*, so that the same factors are not measured in several attributes at the same time
- *minimal*, so that the dimension of the issue is kept as small as possible
- *quantifiable*, so that we can both assign a probability to the different values the attribute can have and specify preferences between these values.

Unfortunately, it is not always easy to find good attributes that, together, satisfy all the above-mentioned requirements. It is also easy to argue that no attribute will be able to fully measure the extent to which an objective has been achieved. It is common, therefore, to instead define "proxy" (or contingent) attributes. A proxy attribute is an attribute that only reflects the objective, but that does not directly measure the extent to which the objective itself has been achieved (Aarset 2016).
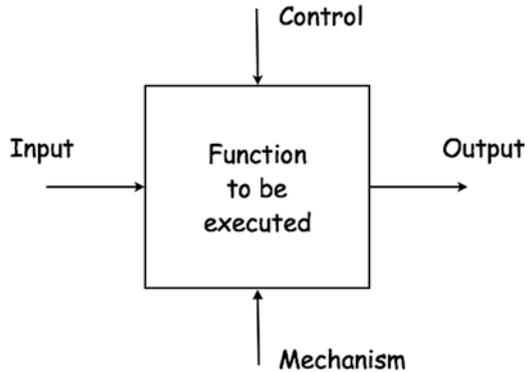
SADT-Charts

To illustrate (part of) the system design and the overall flow of phases during a demanding integrated operation, we suggest drawing a flow chart – and more specifically, a *SADT chart* (Marca and McGowan 1988). (This technique is also known as a part of the IDEF family of programs.)

SADT is an abbreviation of Structured Analysis and Design Technique. SADT charts have a lot in common with traditional (functional) flow charts. They also use activity boxes and arrows that, among other things, indicate the order in which activities are to be carried out. There are several software packages for computers that help in drawing and organizing SADT sheets. (The software package usually comes with a good introduction.)

Each activity to be performed is represented by an activity box, and each activity box is given a name and an alphanumerical designation called a node number. The name of the activity box is a verb that describes the activity the box represents. The node number identifies the box and describes the box's position in the SADT chart.

In SADT sheets, the side from which the arrows point at the activity box has a specific meaning. An ICOM system is normally used, where ICOM is an abbreviation for Input, Control, Output and Mechanism. Here, "Input" or input data stands for something that is changed by or is starting the activity in the box. "Output" or output data is a result of or something produced by the activity. "Control" decides when and how the activity is to be performed and is not changed by the activity. "Mechanism" indicates the agents or artefacts (i.e. actors, subsystems, departments

Fig. 3.10 Example of an activity box with ICOM arrows

or units) that perform the activity. A comment, which could be a noun, a designation containing a noun or a verb, is linked to each arrow. An activity box can have several ICOM arrows on each side (Fig. 3.10).

The construction of SADT charts is most often done using a "top-down" procedure. You start with an activity box, often called "A – 0". This box indicates the highest level of the activity to be described.

The activity in this box, named the parent box, is then specified in more detail in several underlying activity boxes. Input data in the parent box are input data in one or more of the activity boxes at the level below. However, the input arrow can also be, for example, the Control for one of the activity boxes at the level below. The same applies to the other arrows from the parent box.

Further analysis of the ICOM arrows at the level above or below is sometimes not desirable. In such situations, you create a "tunnel" instead. If you do not want to include an ICOM arrow at the level below, you put brackets around the arrow nearest to the activity box. If you do not want to include an ICOM arrow at the level above, you put brackets around the arrow furthest from the activity box.

Agent-Based Flow-Charts

SADT charts are practical for illustrating the "flow" of an operation. The internal communication between the different agents and/or the artefacts may on the other side be difficult to see from such an illustration. As this communication often may be vital to avoid human failure, we will introduce an alternative way of illustrating which functions are part of an activity and in what order they are to be performed. We therefore introduce and recommend utilizing so-called *agent-based flow charts* (ABFC) (Aarset 2016).

As the name indicates, the emphasis here is on visualizing the connection between the different agents (i.e. actors, subsystems, departments or units), and how they relate to each other. Using such agent-based flow charts, it is often more

difficult to see how a function is performed from beginning to end, but it is significantly easier to see what information and what resources each agent needs to be able to perform his sub-functions, and what information and what result each agent should pass on. It is also often easier to see where and to which other agents this result is to be sent.

The agents that make up the system are identified from the mechanism inputs in the SADT sheets. An agent-based flow chart is then constructed for each agent. Each such agent-based flow chart is constructed by listing all the functions that shall be performed by this agent in a box placed in the middle of the chart. Then identify for each of these functions separately whether or not the function needs input data (information, commands or similar) from another agent. These input data are marked by drawing smaller boxes from each of the other agents to the left of the main box and marking which input data these agents will transfer to the agent in focus here.

Correspondingly, boxes are created on the right of the main box for those of the other agents that are to receive something from this agent. A schematic illustration is shown in Fig. 3.11.

It can be seen as a good test of any group of procedures to check if there is a corresponding "out-put arrow" to each "in-put arrow". Because if some agent is expecting input from some other agent (or artefact), there has to be some agent (or artefact) that needs to have this as an output communication in their procedure.

To improve acquisition and maintenance of distributed situational awareness during execution of demanding integrated operations, we therefore is suggesting to construct an objective hierarchy (including both main objective, sub-goals and constraints), identify and discuss such flow-charts as SADT charts and agent-based flow charts, and seek to improve understanding of human behavior by utilizing the concept of distributed situational awareness (including Neisser's perceptual circle) as illustrated in Fig. 3.8 in Salmon et al. (2009).
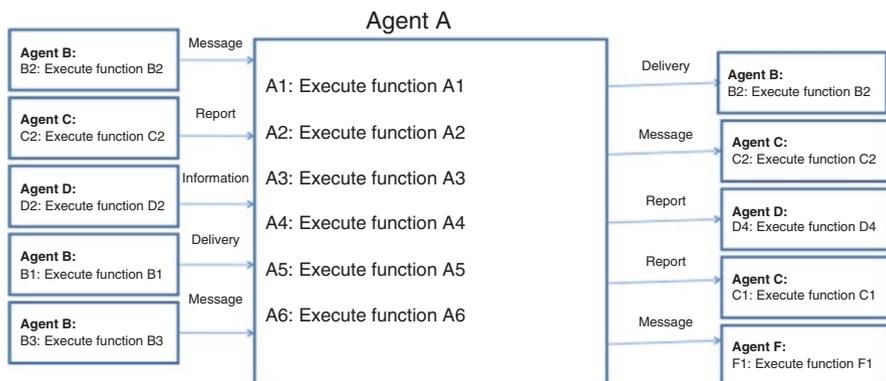

Fig. 3.11 Schematic example of an agent-based flow chart

Part 4: A Short Illustration of the Techniques

From the Police Emergency Preparedness System, Part 1, Norway – Emergency Management Manual (PEPS I) (2007), we see that during a major incident, the police levels of command should be structured as strategic level, operational level and tactical level as illustrated on Fig. 3.12.

At the very high level the objective hierarchy of a police operation may be as illustrated on Fig. 3.13.

A preplanned operation, again at a high level, may be divided into three phases as illustrated in Fig. 3.14. (Here, realistic Command and Mechanism arrows have only been included for the Preparation phase.)
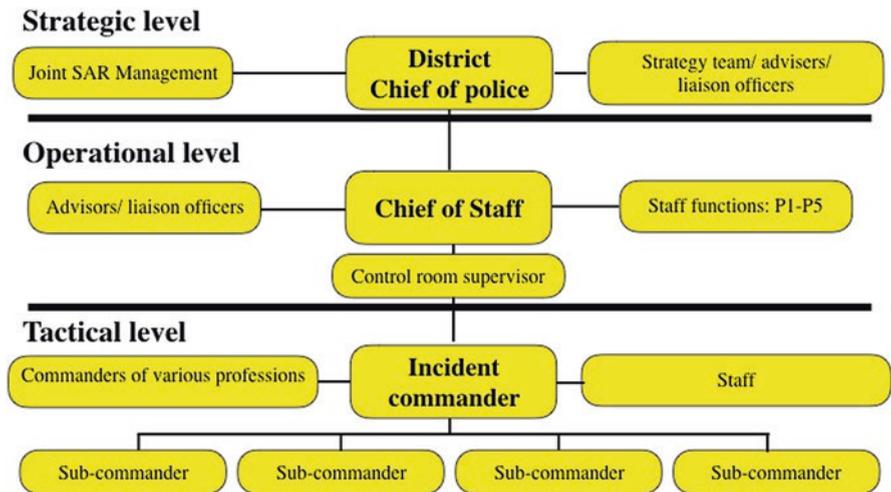

Fig. 3.12 Level of commands
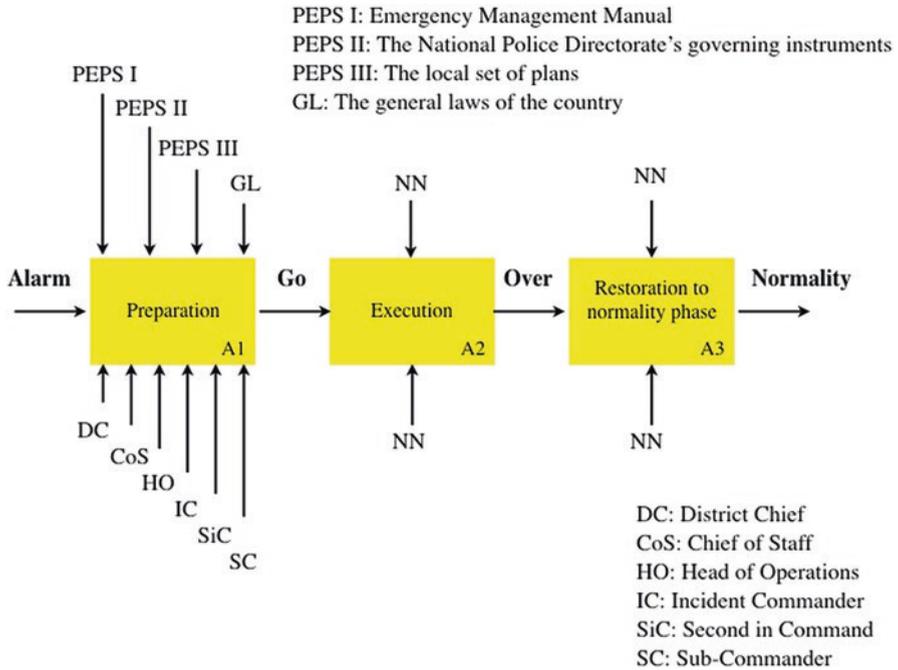

Fig. 3.13 A simple objective hierarchy

Fig. 3.14 A simple SADT chart for a preplanned police operation

If we focus on the incident commander (IC), we may illustrate the functions he or she is expected to execute during the preparation phase, and the respective interface between the IC and the other agents active in this phase, by introducing the ABFC in Fig. 3.15.

Performing a more thorough analysis we would have been more specific in the objective hierarchy and extending the description of the operation by producing more and more detailed SADT and ABFC flow-charts. Now, comparing with the distributed situational awareness model in Fig. 3.8, we may observe that these kinds of illustrations may improve vital parts of what that model identifies as required to acquire and maintain situational awareness.

- *System factors*: Procedures, system design and system goals may all be visualized with an objective hierarchy, some SADT charts and some ABFCs.
- *Individual factors*: Individual goals may be visualized with an objective hierarchy to be compared with the system goals and roles may be visualized with an ABFC. Neisser's perceptual circle may improve understanding of individual SA requirements, while Experience and Training are handled as of today.
- *Team factors*: Both team processes (communications, collaboration) and team attributes (shared mental models, cohesion, attitudes) may benefit from the visualization of the ABFCs.
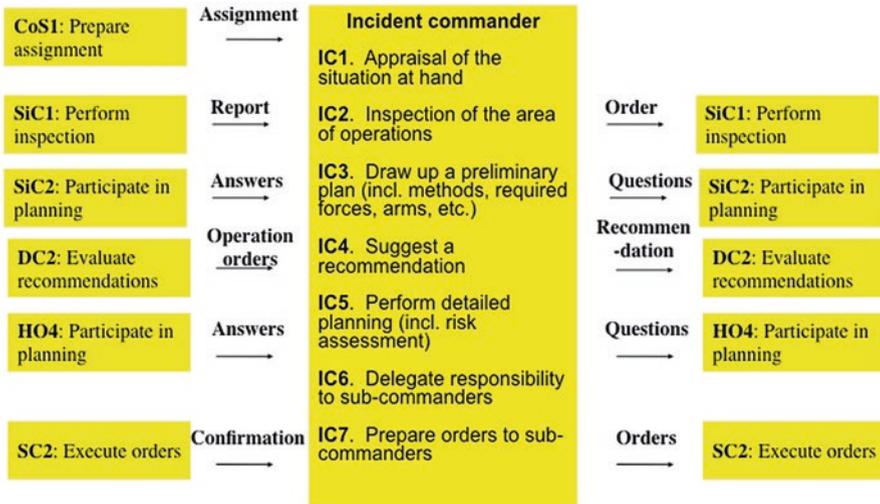
Fig. 3.15 An agent-based flow-chart

- *Task factors*: The process of identifying both workload and complexity in an operation may also benefit from the visualization of the operation by SADT charts and ABFCs.

Thus, utilizing these relatively simple techniques of visualization may considerable improve the distributed situational awareness of an operation – which again is improving both the efficiency and the reliability, and reduce the risk of human failure.

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