**Ergonomics Research Techniques**

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**Week 10: Lec 35- Workload and situation analysis methods**

**Situation Awareness Global Assessment Technique**

Welcome back. Today we will work on the situation awareness measurement and a particular technique named situation awareness global assessment technique. Situation awareness global assessment technique. Okay. So first let us understand what is situation awareness and why do we actually need situation awareness when we are talking about any kind of mental work. Okay.



So situation awareness is this is a kind of perception. Okay. It is a perception of the elements in the environment. It is a kind of perception that is there in the surrounding in the environment in 3 major area. First is time and space. Then is the comprehension of their measuring. Third is projection of their status in near future. So within these 3 major domain time and space comprehension of their measure and how do we project their status in near future. In these 3 major domain when we are actually perceiving things perceiving the elements of the environment you will call it as situation awareness. So situation awareness is an inferred mental construct. Okay. It is actually inference inferred mental construct somewhat elusive to the measure. Most common measure is based on subjective perception or rating of situation awareness. So it is very much connected it is

subjective in nature. The whole method is very much subjective in nature. So depending on the training, depending on the you know whatever the things are available near to your workspace awareness about that will actually help you to understand how you are working in that particular situation how you are in a position to decide the things properly.  So if someone is working in a particular situation, particular environment for many years the  kind of level of situation awareness he or she has it is of course is different. So if  someone is different than a person who is new to that particular situation. So training  no periodic evaluation of the situation is really helpful for someone to make the person  more aware about that particular situation. So let us go into more detail about these  techniques and more detail into the theory of this situation awareness.

**Situation awareness (SA)**

*Levels of situation awareness*

| Level 1 | • Perception of the relevant elements of the environment |
| Level 2 | • Comprehension of data mining |
| Level 3 | • Projection in the near future |

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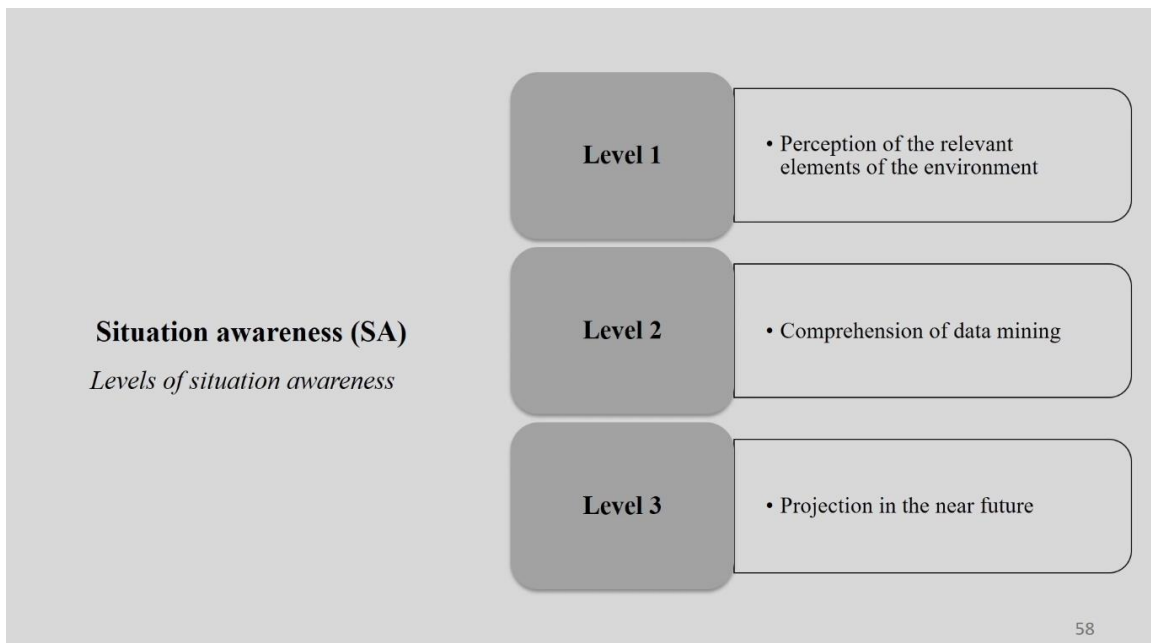
So it says that  it has mainly three level or three state. Okay. So first level second level and third   level. First level says the  perception of the relevant elements of the environment.   So whatever relevant elements are there in that particular working environment even if   you are perceiving it properly you are perceive the kind of perception you have, if you are  working and that elements that is that will be taking it as level one. Now once that that  particular level is over, the next level is the second level we call it the comprehension.  So you have data now you are trying to mine those data and you are trying to comprehend  that. That particular level is second level of course. It is not only you know the situation,  you are actually trying to comprehend that particular element. So you have seven, eight  elements in that particular situation. So you are doing the perception, if you are perceiving  it. Okay. Not only perception. Perception is the first level. Second level is from that  data whatever you have perceived from that data how you are actually comprehending the  situation that is the second level and third level is based on that comprehension based  on that data whatever is available with you those

elements of that particular environment you are trying to project what is there in the near future and that is the level three or third level of situation awareness. So it is very clear first you are making yourself aware about the situation so you are perceiving the elements of whatever relevant elements are there in that particular environment. Once you perceive it once the operator knows yes these are the elements need to be work on when you are working in that particular work environment then you are trying to comprehend it from those data and once you have you know comprehended data what you need to do you need to if you can do the prediction of the newer future then it is level three. So this way the intensity actually goes on the higher direction and these are the levels of situation awareness. So if someone is only aware about element but not in a position to comprehend then there will be always a chance that you know there will be an error in that particular situation or maybe an accident or something. Right. Now in the second level also it is possible okay. I could comprehend. But I do not know the person is not in a position to know how to predict that from that data what is going to happen in the near future. If that is not possible to predict then you will not be able to the operator, will not be able to take a precautionary measure if something goes wrong. Okay. So to make that data the person has to be in a position that they he or she you know can predict that what is going to happen in the near future using the data whatever is available with you like whatever you comprehended earlier. Okay. So these are the levels. So if any level there is a fallacy then there is always a chance to you know to make that to meet any accident or to there will be a situation where error happens and the productivity of the whole system will go down. So if we if we understand the levels of situation awareness in that particular scenario and what are the possibilities are there where there is a chance to do some kind of mistake and if we can do kind of you know intervention over there then there is always we are in the going going into the better direction that though the whole system will perform error free or with less error. Okay. So that is why situation awareness of any particular critical situation is very very important to analyze beforehand. So let us go ahead with the more detail.

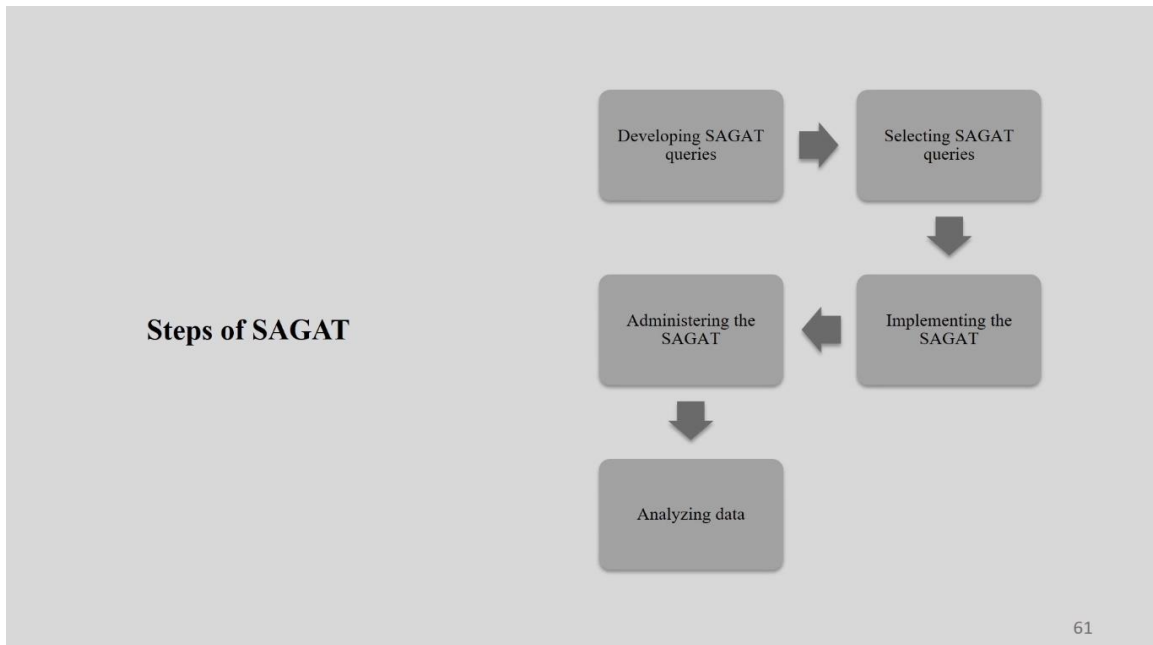| Situation Awareness Global Assessment Technique (SAGAT) | • A unbiased query technique to assess individual situation awareness.<br>• SAGAT is based on information-processing theory.<br>• SAGAT was developed by Endsley.<br>• It considers SA as an internal model that is derived from the environment prior to decision-making and performance.<br>• Directly querying operators regarding their current knowledge of the various elements in an environment and comparing their responses to the actual state of the environment.<br>• SAGAT involves temporarily stopping, or freezing, operator's activity (usually in a simulation)<br>• Administering a battery of questions that target the operator's dynamic information needs. |
|---|---|

So situation awareness this particular thing is like it is actually a technique. Okay. So we call it situation awareness global assessment technique. So we will know more about this particular technique in detail. So it is a unbiased query technique. It is it is actually you are raising the query in the whole process. So it is an it is an unbiased query technique to assess individual situation awareness. Who are these individuals? Individual means individual element of the system by the individual operator. Okay. So if it is a system definitely in practical always it is a complex system. So a number of elements are also more and the number of interacting persons are also more. So how these are happening at the individual level you are actually trying to raise the query or you are raising the query and based on that query you are giving the answer or you are giving to sort the problem. Okay. So this particular technique is based on the information processing theory. So we will come to know why it is information processing theory because when there is an input the input will pass to the next stage through some kind of information and once that information received by one another end what will happen it is going to be processed and once it is processed then again the feedback will come back to the next phase and then it will keep on going. So it is the same method that is happening in the information processing. This particular theory is going to be used for this particular technique and it is developed quite long back probably it is in 1988 by the N. Slay. Now there are lot of modification also happen over the period of time. Initially in 1988 probably this particular technique was being introduced. This particular technique considers situation awareness as an internal model. Okay. As an internal model and that is derived from the environment prior to decision making and the performance because if you are going to take the decision based on the situation awareness and once you do that then the whole system performance can be taken care. Directly querying the operators

regarding their current knowledge of the various element  in an environment and comparing their responses and whatever the elements are there you are  going to compare their responses to the actual state of the environment.  This particular technique involves temporarily stopping or freezing or operators activity. Okay. So it actually takes care of all these things. Administering a battery of questions  that target the operators dynamic information is required to complete this particular technique.



Depiction of feedback system described in Endsley's "Theory of Situation Awareness" (1995).
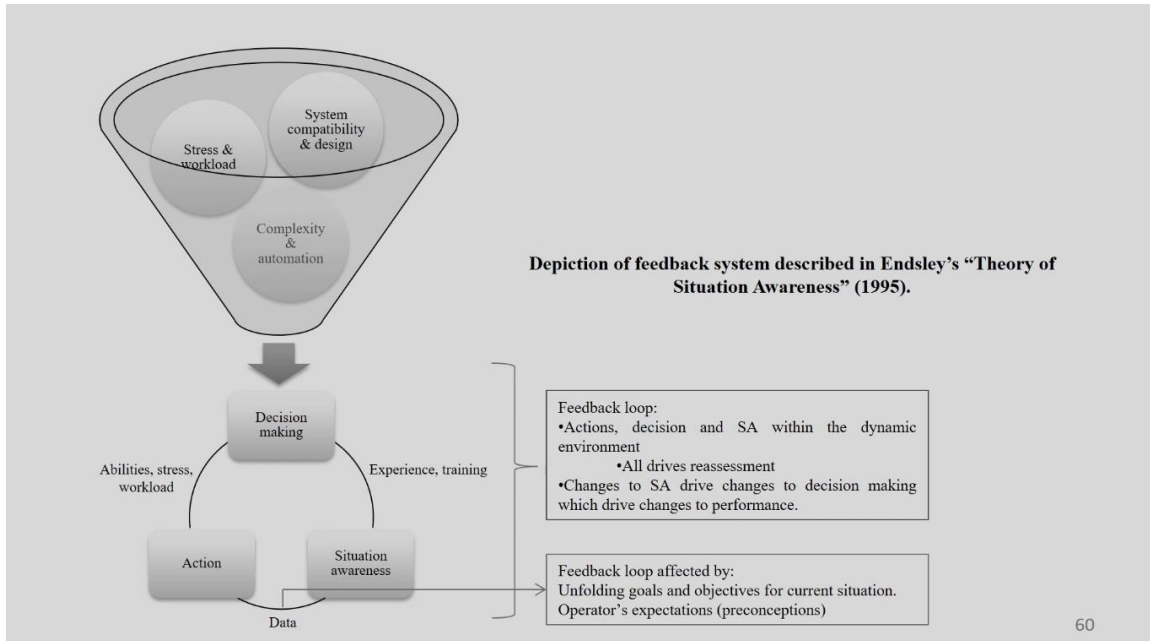
Now let us get into more detail. So this particular theory situation awareness it is  being modified and in 1995 in a particular research paper the same author described it  in this way. So this is a model and this model is being copied from this particular paper. So you can refer the original paper. So I am trying to describe their model over here.  So what it says that when in a particular working environment you have stress and workload  once you have system compatibility and design and the complexity of the automation. This  is very important. Okay. When you have all these things in a particular system and you have to take decision how it will interact with each other, based  on the decision you will be with the help of situation awareness you will take the action.  Right. So based on all these information the decision will be taken and decision will be  influenced by the situation awareness and their action will be taken. Now for this action  what it depends on? It depends on the abilities of the workers, stress and workload of those  worker. Okay. In that particular situation and this situation awareness will help in  the action performance based on the data available. Data available in that particular situation.  Now this data is all about the unfolding the goals and objective of the current situation  in that particular situation. How the goals are, how you are going to take the decision  and how it is going to affect it, what data says and all and the operator's expectation. Okay. So this will actually help in the or affect the feedback loop. Now when I am talking  about the

experience and training it says that action, decisions and situation awareness within a dynamic environment. Now this dynamic, why dynamic? Because when I am talking about situation awareness so there are n numbers of elements present. Okay. In a particular situation. Now these elements keep on interacting with each other and based on the type of interaction, the whole situation becomes dynamic in nature. So all these changes to situation awareness drive may change to the decision making which drives the changes in the performance. Because once the decisions are different definitely the performance of the whole system and performance of the operator also going to change. So this is the model is being described by the author in his this particular paper. Okay.



**Steps of SAGAT**

Developing SAGAT queries → Selecting SAGAT queries

Administering the SAGAT ← Implementing the SAGAT

Analyzing data

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Now let us understand if we want to perform this particular technique for our research work what are the steps to be followed. First is developing the SAGAT means the situation awareness global assessment technique queries. Okay. First you have to develop those queries. Based on the number of queries you have to select few, because you cannot answer all these queries. So you have to select few queries. Once it is there then you have to implement it, administering it and then analyzing the data. Okay. So let us go into detail one by one about these techniques. Okay.

| Step 1: Developing SAGAT queries | <ul><li>A operator's SA requirements must be defined through Goal-Directed Task Analysis (GDTA).</li><li>GDTA is similar to HTA.</li><li>It seeks to uncover operator's goal in a particular domain.</li><li>The Decision that must be made to achieve these goals and the dynamic information requirements is needed to support the decision.</li><li>A thorough and concise query is made, question should be designed in such a way that an operator's response will encompass knowledge of multiple SA requirements.</li><li>The wording of queries should be compatible with the operator's frame of reference and appropriate to the language of domain.</li></ul> |
| --- | --- |

Now developing how do we develop these queries. It is very easy. Okay. Normally in earlier  all the methods I suggested that we can go for the hierarchical task analysis. However  in this particular method, the author suggested that we should go for the goal directed task  analysis. G D T A. Okay. G D T A goal directed task analysis. Now this is very similar to  hierarchical task analysis. I will explain it in the next slide.  So this particular step it seeks to uncover the operator's goal in a particular domain.  It seek try to what it does it actually try to uncover the operator's goal in a domain.  The decision that must be made to achieve this goal and the dynamic information requirements  is needed to support this particular decision. A thorough and concise query is made. Question should be designed in such a way that an operator's response will encompass knowledge of multiple situation awareness requirement. The wording of queries should be compatible  with the operator's frame of reference and appropriate to the language of domain. So  this is very important whenever we are developing the questions you have to remember that it   should be compatible to the operator and their language domain. If some different varieties  of language are being used you will not be able to generate those specific query from  the operator. So this particular process is very very important when you take it to the  field.

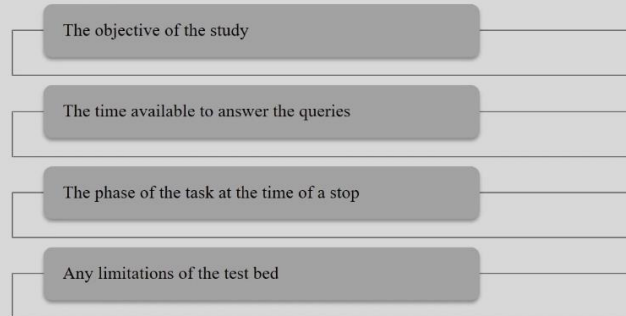**Depiction of Goal-directed task analysis (GDTA)**
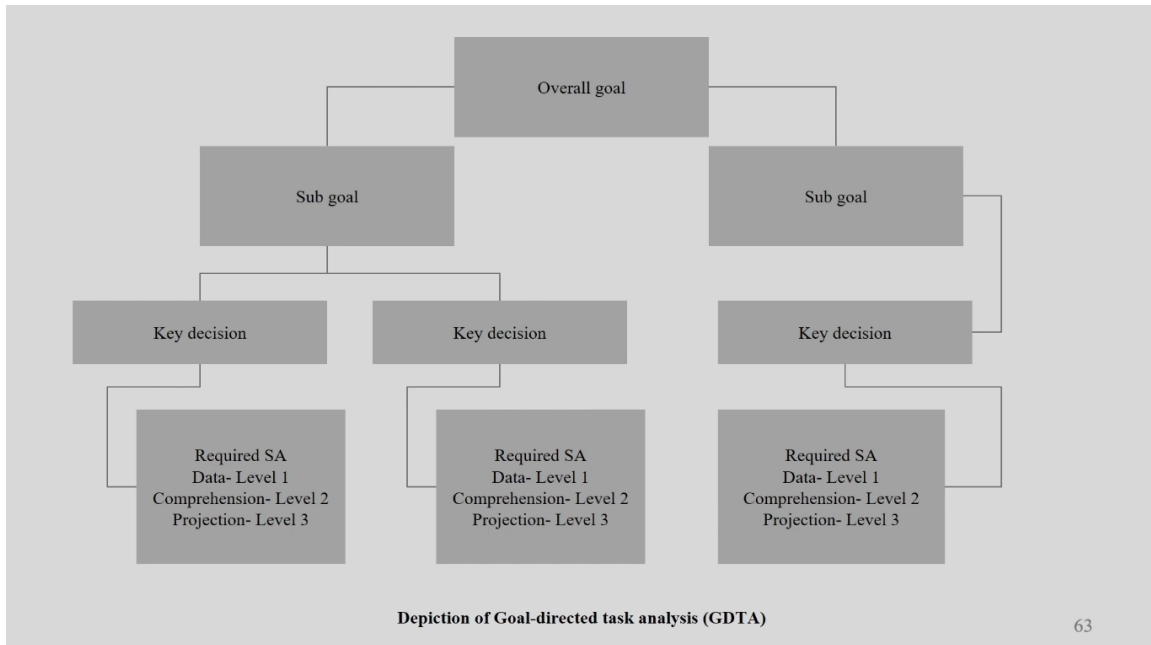
Now let us understand about this goal directed task analysis. What it says? In a particular system you have a major goal. You have a major goal under that goal you may have small small sub goals. In hierarchical task analysis what you do? One goal and then there are small small subtasks. Here we mainly talk about not the task we mainly talk about the goal of that particular task. So goal sub goal number 1 or sub goal number 2 for this particular example. It can have multiple sub goals. Now when there is one sub goal it may have to achieve that sub goal, it needs two specific key decisions. So for this particular portion of this case we have taken two decision maybe in this case it is one decision but it depends. It absolutely depends on what type of situation you are going to analyze. Now under each sub goal we have key decision which is influenced by the required situation awareness and this situation awareness has all three level, level 1, level 2 and level 3. For all these situation awareness we need level 1, level 2 and level 3. So level 1 says that you understand or you perceive the data. In the second level you comprehend the data and in third level after comprehension you project the data in the near future. So for all these situation awareness you can have this type of mapping and that is GDTA, Goal Directed Task Analysis. Now this is the first step of this particular method that you need to achieve and this takes little time because once a person or the researcher is going to collect data he or she may not be completely know the situation. So it takes several field visit and then only with the interaction with the stakeholder you can develop these this type of chart.

Now moving to the second phase that is the selecting the queries, selecting those queries. It says that SAGAT queries can be presented in there entirely at each freeze, each sections. Whenever there is a freeze you select a query. So otherwise the query set can be customized for the specific needs of the experimental design. So that is always available. So the selection of these queries to administer during the trial which depends on several factors. Now what are these factors? I will explain it. First factor is the objective of the study. Based on the objective the factors will change. The time available to answer these queries because what is the time span you have. The phase of the task at the time of a particular stop. Any limitation of the test bed not all questions have to be asked at each stop. It is not possible. It is really not possible that you should answer at every stop. But however you should be careful you have to take care that avoid the narrowing the question set. Because if it is too narrow then it becomes very difficult for you to get those answers. And allow the operators to prepare for specific queries because you know if you just like that you ask, maybe they are puzzled they are not in a position to answer it correctly. So you allow some preparation time. If the time allotment is not proper probably it will not help you to select proper query and asking only high priority question at a particular point of simulated scenario. Otherwise it will be very difficult to narrow it down your the questions and get the exact query or selecting the know critical query. Otherwise it may happen there are no multiple things are coming and the researcher will not be in a position to go ahead in a correct direction.

**Step 2: Selecting SAGAT queries**

- *1st question presents participants with a map of work environment with boundaries and reference point.*
- *Asking them to fill in the locations of the various elements in the scenario.*
- *This map usually forms the basis for the other questions administered during stop.*

**GOAL #1**

State one goal of the anesthesia providers when performing a standard induction of general anesthesia with oral endotracheal tube intubation

_____

List of key decisions necessary to successfully achieve this goal

_____

Describe the level 1, 2 and 3 situation awareness requirements necessary for the key decisions that listed above

Level 1 SA refers to the basic perception of cues/ important information
Level 2 SA refers to the comprehension of those cues, including how information is combined, interpreted and retained
Level 3 SA refers to the ability to use the current situation to predict further events and situation dynamic and the implications of these potential events

Can you think of any other goals necessary for achieving induction of general anesthesia with oral endotracheal tube intubation?

YES
NO

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Now to do so this when we are talking about the selecting the this particular queries  what we have to keep in mind while developing this question paper these factors. What are these? First question should present participants with a map of work environment with boundaries  and reference point. If you do not give these boundaries and reference point at the very  beginning the participant may not be able to tell you the exact elements present in  that particular environment. The second thing is asking them to fill in the location of  the various element in that particular scenario. So that should be there in the set of questions  and this map should usually form the basis of the other question administered during  the stop. So these are the basic fundamentals you should follow while developing the questions  for selecting the queries. Now this is an example. This example is quoted from this particular paper. What it says in  a particular situation where you know you are trying to understand a situation where   you know anesthesia. Anesthesia provider when performing a standard induction of general  anesthesia with oral endotracheal tube intubation. For this what is happening? So this is the  place where you can write your answer. This is just copied or just referred from this  particular paper. So what you have to do? List of the key decision necessary to successfully  achieve this goal. Now that you have to generate. So this is the objective that listing the  key decision. Now one example is given. So this is one particular question is being quoted from this particular  paper. Can you think of a way any other goal necessary for achieving induction of general  anesthesia with oral endotracheal tube intubation? Okay. So now if he or she says yes or no, based  on that next further questions to be asked. Okay. So now these are the levels possible.   So level 1, level 2, level 3. Level 1 says the situation awareness refers to the basic  perception of cues and important information as I mentioned in the beginning that knowing  the elements, knowing the elements of that particular situation. So when I am talking  about the anesthesia, so anesthesia like you

know through the oral endotracheal anesthesia  for that if you are trying to do, what are the basic elements are present in that particular  environment the person should be aware of it. Okay. Now based on the previous data how  you are actually comprehending the data. So whatever information is coming on the monitor  based on that how you are changing the movement, how you are changing the doses, how what is  happening. So that is the second level and based on that how you are taking decision,  what is the changes in the dose, what is the changes in the position, how you are taking  it that is your prediction. If you do this then what is going to happen that has to be  done. So you are going to ask all such varieties of question using this particular model and  you can put it down in a particular format. From there only you are going to select those  queries because all are not be selected, so you can select some specific queries.

**Step 3: Implementing the SAGAT**

- The timing of SAGAT stops should be randomly determined and not occur only at times of increased activity.
- A SAGAT stop should not occur within the first 3-5 min of an experimental trial.
- SAGAT stops should not occur within 1 min of each other.
- Multiple SAGAT stops can be incorporated into a single scenario (as many as three stops within 15 min have been used with no adverse effects).
- Over the course of an experiment, 30-60 sampling should be collected per SA query (across subjects and trials in a within-subjects experimental design) for each experimental condition.

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Now once it is there you have 2 or 3 selection now you have to implement it. The timing of  this particular technique stops should be randomly determined and not occur only at times of increased activity that you have to keep in mind. So a SAGAT stop should not occur within first 3 to 5 minutes of the experimental trial because in that particular duration  maybe the person or maybe the operator is not really acquainted with the environment.  So you should not take any information from there and this stop should not occur within  1 minute of each other. That you have to keep in mind and multiple SAGAT stops can be incorporated  into a single scenario as many as 3 stops within 5 minutes have been used with no adverse  effect that is the normal or general procedure. Over the course of an experiment 30 to 60  sampling should be collected per situation awareness query for each experimental condition. So these are the process or these are the methods to be remembered during the implementation.

Now moving to the administering that SAGAT you have to remember the participant should be fully briefed on this particular methodology. If the participant is not briefed about this methodology the query identification and selection will be very very difficult and the person will not be able to contribute properly. So examples of the queries that will be asked and the manner in which the queries will be presented. Several training trials should be provided in which these particular stops are administered. The SAGAT is implemented by temporarily freezing a simulation. How do you do? You freeze a particular simulation at predetermined random times and blanking task displays. That way you actually administer it. What else? A set of queries is then administered to the participant. When more than one participant is taking part in a particular study all participant should be given the SAGAT battery at the same time without any communication between the participant. So when there are more number of participant you can take the information at a time. However you have to make sure that they are not communicating with each other. Once a participant completes the SAGAT test battery the time interval has elapsed. The simulation is resumed from the exact point at which it was frozen for the SAGAT query. That way you actually need to do the experiment. Now the correct answer to the queries must be recorded. Must be recorded at the same time the participant is completing this particular battery, SAGAT set of battery. When possible the data on the actual state of system should be recorded directly by the simulator. The simulator should be able to record those data. For queries whose answers cannot be collected using simulation computer a subject matter expert who is fully versed with this particular domain and the specific test scenario should be used to supply the correct answer because it may happen these all types of techniques are very much skilled based job. You really need subject matters expert. So if you have such situation,
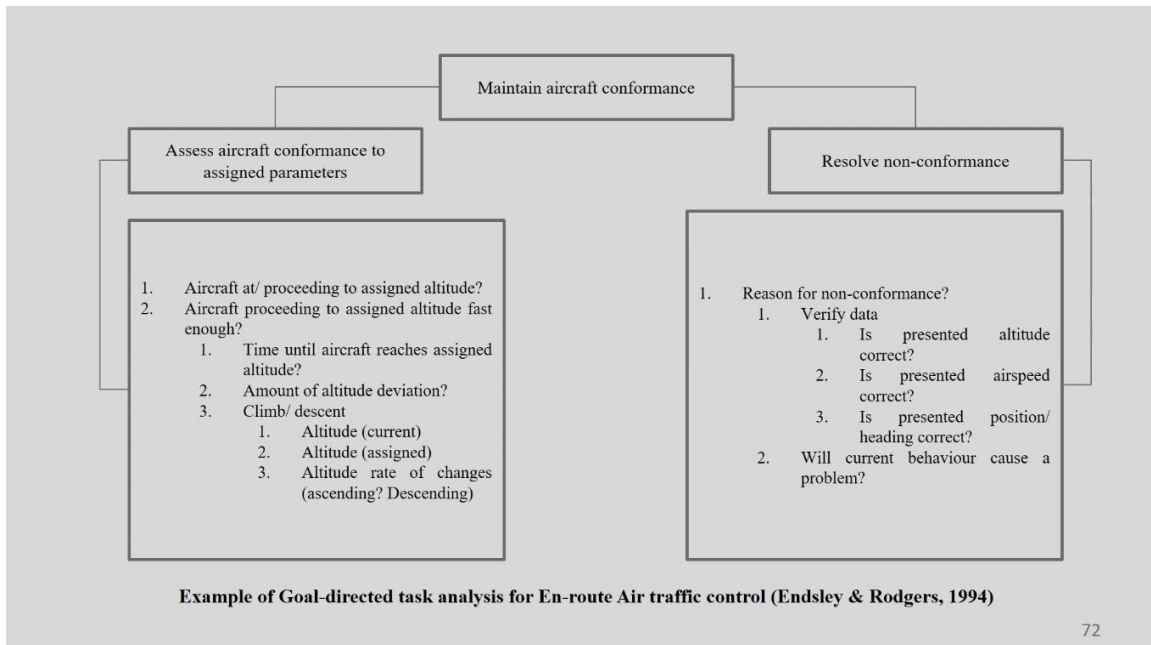
if the simulator is not in  a position to answer in that case the person who is really aware about the whole thing  they should be in a position to answer it.

**Step 5: Analyzing data**

- Responses to SAGAT queries are scored as either correct or incorrect, based on acceptable tolerance bands.
- When evaluating SAGAT data, each query is typically analyzed separately.
- Example- percentage of correct responses to Query 1 under Condition 1 should be compared with the percent correct responses to Query 1 under Condition 2.

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Now you are going to analyze those data. Now  responses of SAGAT queries are scored as either correct or incorrect. It is you know either  correct or incorrect based on the acceptable tolerance band. When evaluating these data  each query is typically analyzed separately because maybe each query is not interconnected  or maybe connected we do not know. But for the purpose of analysis every query will be  analyzed separately. For example percentage of correct responses to query 1 under condition  2 should be compared with the percent correct responses to query 1 under condition 2.  Two condition, condition 1 and condition 2 same query it should be answered separately  and analyzed separately and then they can be compared with each other. So that will  help you to understand the scenarios in a better way.

**Example of Goal-directed task analysis for En-route Air traffic control (Endsley & Rodgers, 1994)**

So this is an example of goal task analysis for en route air traffic control. This is again you know this particular example quoted from this particular paper. So it says that what is the major goal? The major goal is the maintain the aircraft conformance. So that is the major goal. Now under that you have two sub goal. What is assess the aircraft conformance to assign those parameters and resolve. If there is a problem in that conformance then you resolve it. First is one task, one sub goal is you assess it. Second is if there is a problem you resolve it. Under this first sub goal what it say what you are going to do? Aircraft at proceeding to assigned altitude, you are asking. Is this aircraft proceedings to assigned altitude fast enough? If then answer yes based on that then second portion will be the time until aircraft reaches the assigned altitude or not? Amount of altitude is in deviation or not? Now if I am talking about the climbing or descending then what is the altitude, current, what is assigned and rate of change. So based on all these information you will be able to understand that that you know aircraft no conformance is correct or not. Now if it is not correct then second sub goal will come into picture that is resolving it. To resolve that first you have to identify the reason why it is not. Now what you have to do? To identify the reason you have to verify those data. Data on what? No presented in is that presented altitude whatever is available is correct or not? Air speed is correct or not? And position of position or heading is no corrected or not? So based on that what whatever decisions you are so you know the situation you are aware about the situation you are going to take the decision. What is said that will that current behaviour may cause a problem or not? Now once you have answer of all those things then we will be able to take a decision how do we resolve the issue? So this is just an example for more detail about this particular example you can read this paper and if you have still, if you have a query, you can get back to us in the discussion session.
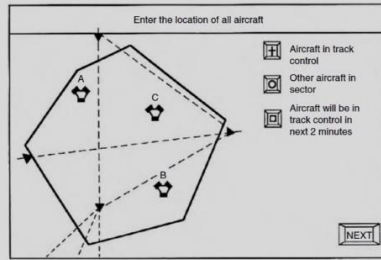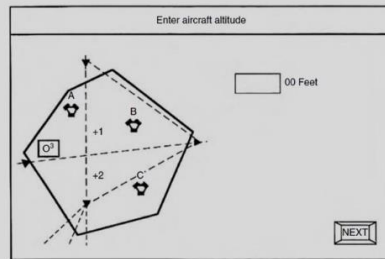
TABLE 42.1  SAGAT Queries for Air Traffic Control (TRACON)

1. Enter the location of all aircraft (on the provided sector map): aircraft in track control, other aircraft in sector, aircraft that will be in track control in next 2 min
2. Enter aircraft call sign (for aircraft highlighted of those entered in Query 1)
3. Enter aircraft altitude (for aircraft highlighted of those entered in Query 1)
4. Enter aircraft ground speed (for aircraft highlighted of those entered in Query 1)
5. Enter aircraft heading (for aircraft highlighted of those entered in Query 1)
6. Enter aircraft's next sector (for aircraft highlighted of those entered in Query 1)
7. Which pairs of aircraft have lost or will lose separation if they stay on their current (assigned) courses?
8. Which aircraft have been issued assignments (clearances) that have not been completed?
9. Did the aircraft receive its assignment correctly?
10. Which aircraft are currently conforming to their assignments?

Source: Endsley, M.R. and Kiris, E.O. (1995), *Situation Awareness Global Assessment Technique (SAGAT) TRACON Air Traffic Control Version User's Guide*, Texas Tech University Press, Lubbock. Reprinted with permission.

FIGURE 42.1  Query 1: Sector map for TRACON air traffic control.

FIGURE 42.2  Additional query on TRACON simulation.

• Figure 42.1 and 42.2 show example of a computerized presentation of two SAGAT queries developed by Endsley and Kiris (1995) based on a TRACON air traffic control simulation.
• A partial list of the SAGAT queries developed for this domain (Table 42.1).

**Handbook of Human Factors and Ergonomics Methods (Neville Anthony Stanton, Alan Hedge)**

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Now this table says or elaborates again it has been quoted from a particular  book and it talks about all these projections. Again I suggest that you should take a look  of this particular book and you can read it. This is all about describing the example.  So if you have any difficulties you can come back to us.

Example data: Participant

| Condition 1 | Stop 1 | Stop 2 | Stop 3 | Stop 4 | Stop 5 | Total |
|---|---|---|---|---|---|---|
| Query 1 | 8/10 | 2/4 | 5/5 | 6/6 | 3/4 | 0.828 |
| Query 2 | 1 | 0 | 1 | 1 | 1 | 0.8 |
| Query 3 | 1 | 0 | 1 | 0 | 1 | 0.6 |
| Etc. | --- | --- | --- | --- | --- | --- |

• The number of correct and incorrect answers is initially counted for each participants across stops on a query-by-query basis.
• 10 aircrafts were present in the simulation scenario at the point in time at which the first SAGAT stop (Stop 1) occurred.
• If participant 1 correctly recalled the position of only 8 aircrafts, the score for the participant/ stop/ query would be 8 out of 10.
• Once score have been determined for each query and stop, the percentage of correct responses to a specific query is calculated across all stops.
• Many queries are simple either correct or incorrect  and thus would have binary scores of 0 or 1 only.

Now again when we have such data  this is the table again, this is quoted from this particular standards handbook. It is  just an example. So you have a condition and you have query 1, query 2, query 3 and you  have 5 stop. You have 5 stop. Now this is the data and what it says? The number of correct  and incorrect answer is initially counted for each participant across stop on a query  by query basis. So for query 1 what is happening?

For query 2 what is happening? For query 3 what is happening? 10 aircrafts were present in the simulation scenario at the point in time at which the first SAGAT stop or we call it stop 1 occurred. That we came to know. If participant 1 correctly recall the position of only 8 aircraft the score of the participant or stop or the query should be 8 out of 10. So here it is there. Now if it for stop 2 it is 2 out of 4 something like that they have identified in this particular example. Once score have been determined for each query and each stop the percentage of correct response to specific query is calculated for the all stop. Many queries are simple either correct and incorrect and thus would have binary score either 0 or 1. So for these cases like maybe in query 1, 2 and 3 it is either 1 or 0, either 1 or 0 something like that. So that has been calculated for this particular example. In the next case here we calculated it for stop by stop, stop 1, stop 2, stop 3.

Example data: query summed across Participants

| Condition 1 | Participant 1 | Participant 2 | Participant 3 | Total |
|---|---|---|---|---|
| Query 1 | 0.828 | 0.765 | 1 | 0.864 |
| Query 2 | 0.8 | 0.5 | 0.9 | 0.733 |
| Query 3 | 0.6 | 0.7 | 1 | 0.767 |
| Etc. | --- | --- | --- | --- |

- The scores are averaged across all participants for a single query (within an experimental conditions).
- These scores are then ready for comparison with other experimental conditions using an appropriate statistical technique.

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Here we will go for the participant wise. Participant 1, 2 and 3. So what it says? The scores are average scores of all participants for a single query. For a particular query what is the average score and these scores are then ready for comparison with other experimental condition using an appropriate statistical technique. Because you have the answer for query 1, you have the answer for query 2 and this is for one single experiment. When you have another experiment then these data can be compared. Then you can understand which situation is more beneficial, which situation is more error free. There are which situation causes less prediction of accidents. So these things you can develop or you can analyze from using this particular technique.

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| **Advantages** | • Objectively measures SA; no subjective judgments required.<br>• Directly measures SA; no inferences based on performance or behavior.<br>• Maximizes data collection in minimal time.<br>• Provides diagnostic information on specific elements of SA as well as composite representations of all levels of operator SA.<br>• Collects SA information throughout activities; avoids pitfalls associated with collecting data after the fact. |

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Let us go ahead with the advantages of this particular technique. So objective measure, you know you have lot of objective measure, no subjective judgment required, direct measure, no inferences based on the performance and behavior and it maximizes the data collection in less amount of time. It provides diagnostic information on specific elements of situation awareness as well as composite representation of all levels of operator situation awareness. Collect situation awareness information throughout activities because it is not only for a particular moment. It is throughout the activities and it avoids the pitfalls associated with the collecting data after the fact because it collect the data during the activities not after that. So it is very essential that you know the whole scenario very correctly before you take any kind of decision. So these are the major advantages.

| Disadvantages | • Requires extensive preparations; delineating SA requirements through GDTA is time consuming and can be tedious.<br>• Requires access to simulation facilitates.<br>• Requires ability to stop and restart simulation.<br>• May be intrusive to performance, depending upon the task circumstances and the individual.<br>• Not well suited to actual operations. |
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However, disadvantages  are there. It requires extensive preparation because you know situation awareness requiring  through goal directed task analysis is time consuming. That is why you need lot of time before actually you do the analysis. Before you do the analysis  you should have the GDTA and GDTA takes lot of time. It requires access to simulation  facility because if you are not in a position to simulate those situations, situation 1,  situation 2, situation 3 like that if you cannot simulate that then you will not be  able to do any such analysis. So simulators are important. Requires ability to stop and restart the simulation because if the simulator neighbor allows you to stop and restart then you will not be able to do stop by stop analysis and may be intrusive to performance depending  upon the task circumstances and the individual and not well suited to actual operation.  It may happen because you actually do the things in a simulator. So it may not be very  much connected to the actual operation. So these are the disadvantages. However, as we  have lot of advantages of this particular tool in some cases where it is very much relevant  we are going to use this tool to get the awareness data of that particular situation.

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| **Approximate training and application times** | • Training time for the actual administration of the SAGAT is minimal.<br>• Participants simply need to be presented with example queries at appropriate times in the training trial. |
| **Tools needed** | • Administering of the SAGAT can be through pen & paper.<br>• Can be developed through a program on a personal computer.<br>• Colleting SAGAT data can be through personal computer. |

Now let us understand what is the kind of time it takes to train a person who can collect data. So training time for the actual administering SAGAT is very minimal. However, the person should be aware about the basic techniques like GDTA or you know situation they should know the subject very well and participants simply need to be present with the example queries at appropriate time in the training trial. What do you need? Administering this particular technique can be through pen and paper, can be developed through a program on a personal computer and collecting these data can be through a personal program. However, simulator is must based on the what is your objective or objective of the study. What kind of simulation situation you are going to analyze based on that those simulators are absolutely important. So this is all about situation awareness global assessment technique and I suggest again as I do for every technique you practice it, you get your own data if you have any difficulties in you know analyzing those data or collecting the data or interpreting the data come back to us in the discussion session. Thank you. .