Neuro- Linguistic Programming (NLP) Techniques in Maritime Employment, Competency Assessment & Accident Evaluation.

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Abstract: Competency certification of seafarers in India involves a theoretical process and a viva voce which has a specific purpose of mind reading for various core competencies besides knowledge and experience. Similarly in maritime accident investigations besides the techniques of ascertaining causes of accident it has become necessary to go beyond stating only human error. This necessitated the involvement of behavioural techniques to ascertain specific shortfalls or inadequacies in a particular human being between training, competency examinations and accident. During the period of service on board ships a seafarer is supposed to perform to specific requirements. Any aberration in this performance needs to be identified, isolated and some means and methods to be found to rectify it. Experience has shown that application of NLP techniques has been very useful in correcting these inadequacies. This paper essentially explains the capabilities of NLP and its application techniques which have resulted in important findings that can help in avoiding accidents.

KEYWORDS

Human Factor, Marine Safety, International Safety Management, Accidents, Design, Measurement, Experimentation, Human Factors And Appropriate Interaction, Managing Human Attention, Context-Aware Computing, Sensor-Based Interfaces, Machine Learning, Behavioural Markers, Target

INTRODUCTION

Neuro-linguistic Programming (NLP) was developed in the USA in the 1970's. It refers to purported systematic, cybernetic links between a person's internal experience (neuro), their language (linguistic) and their patterns of behaviour (programming). In essence NLP is a form of Modelling that offers potential for systematic and detailed understanding of people's subjective experience.

The correct selection of competent seafarers for integration into a shipboard team is not a trivial task. It must account for technical competence, availability when needed, and the personal and social characteristics of the seafarer which will assure a successful integration of the seafarer in to the onboard team as it applies to the exercise of his attitude, behaviour, and beliefs with in the confines of the ship's culture. Often, a good working environment depends on the personal

characteristics of each seafarer. In addition to social factors, emotions play a critical role in rational decision-making, perception, human interaction, and human intelligence.

Maritime accidents involving human and human machine interface widely recognized as human error, accounts for the majority of causalities (IMO 1992). This performance of the humans in the case of seafarers gets magnified under specific adverse and critical conditions. To study this it is essential to understand a few specific areas of human capabilities of Targets (Seafarers). Consider the following:

Seafarers are trained under specific academic and physical curricula which is programmed to ensure that all participants should reach the minimum level of competency(IMO 1990).

To augment that capability minimal experience and service is prescribed (IMO 1990).

To ascertain that this capability and combination of experience is adequate to take up specific responsibilities, competency examinations and certification is carried out (IMO1990).

This is an on going process, however, since accidents still happen there is a traditional peer based assessment training and Test-Operate-Test-Exit (TOTE) process. Experience has revealed that it is adequate under many conditions but with a pattern of accident and the

enquiries that have gone deeper into behavioural aspects, it is observed that in most cases traditional training as prescribed does not have the desired effect. In order to get into a logical level model many companies and institutions have been resorting to aptitude test at entry level. The core findings in the aptitude test are a performance indicator of how the worker will perform during his service period; it also shows a remarkable correlation to performance / accident events. Thus, it is reasonable that the value for performing an aptitude test at the entry level has significant value to the organisations overall performance in operation. The process of application of NLP techniques during various levels of recruitment, certification and accident evaluation, rectification are discussed herewith.

By examining and monitoring behaviour during cognitive tasks (Feyen, et al.2001) either during training, service or competency examinations, we are looking to detect lapses of attention and reduced performance states. Assessing and predicting poor performance states on a moment-to-moment basis for tasks such as navigational, cargo and machinery operation and other strenuous tasks would be useful toward improving individual performance level.

We chose to treat the target individuals in the accident investigations first to identify the prominent and specific behavioural patterns (IMO 2000). 36 cases of accident investigation produced 24 cases of purely human error related causal effects. Off the 24 only 18 could be identified as specific errors relating to individuals as error initiator catalysts. When put through a modified REASONS analysis and GEMS analysis the predominant error marker was a **compulsive motivated error**. This was done by the application of the Lablaw principle of belief-behavioural-attitudinal questionnaires, enquiry and probing. Two prominent NLP methods "Meta – Model" and "Milton – Model" were applied during the investigation process and trained NLP practitioners were used for guidance.

A Meta-model response was, "what would happen if task was done some other way". Targets choose when to respond and when not to, using softeners and linkage phrases from the Milton model to maintain rapport.

The Milton-model has three primary aspects: First, to assist in building and maintaining rapport with the target. Second, to overload and distract the conscious mind, so that unconscious communication can be cultivated. Third, to allow for interpretation in the words offered to the target.

(Bandler and Grinder 1975a) claimed that in matching and responding to the representational systems what people use to think is generally beneficial for enhancing rapport and influence in communication. They proposed several models for this purpose including eye accessing cues and sensory predicates. The direction of eye accesses was considered an indicator of the type of internal mental process. The sensory predicates, breathing posture and gestures which are also considered important. In the shifts sensory predicate model, verbal cues are often coupled with posture changes, eye movements, skin colour or breathing. Essentially, it was claimed that the maritime training supervisor, the examiner or the investigator could ascertain the current sensory mode of thinking from external cues such as the direction of eye movements, posture, breathing, eye movements, voice tone and the use of sensory-based predicates. Conditions such as fatigue, stress, motion sickness, and increased workload typically reduce task performance, particularly on tasks requiring ongoing vigilance and decision-making. For example, recording eye movements during a tracking task, The oculomotor parameters (Van Orden et al. 2001) have correlated strongly with performance on the tracking task, including eye blink frequency and duration, re-fixation frequency, size, and pupil diameter which could be combined in a multi-factorial index to detect overload conditions.

THE PROBLEM AND ITS MITIGATION

Attitudes are assumed to play an important role in human behaviour theory as the crucial link between what people think and what they do. The attitude-based questionnaire framework (Ajzen and Fishbein's 1975) has been widely used for the purpose of predicting behaviour. The experimentation carried out in making attitudinal changes and thus behavioural patterns took into consideration various methods of analysis such as Gap Patterns, Innovative

Approaches and Neurological Model in Simulation Training.

Gap Patterns. There are two types of gaps, namely paradigm gaps and fallacy gaps. Paradigm gaps have to do with purpose and principles prevalent in training and certification processes, whereas fallacy gaps deal with process and practice in service.
Paradigm Gap. A paradigm gap is caused by unbalanced process thinking regarding purpose or principles. This is typical with a target which has not benefited out of training.
Fallacy Gap. In terms of the decision-making process, a fallacy gap is caused by unbalanced thinking in process or practice. A fallacy gap naturally follows from a paradigm gap. And generally this shows as an error initiator in service.

Therefore, the attitude concept can be viewed as a set of beliefs, each belief can be thought of as a separate attribute, and a person's overall attitude toward the object is a function of his or her evaluations of those attributes. Essentially the six attributes (Table 1) of Targets can be analysed by exercising GAP matrix on persons.

Table 1. Attributes for GAP Matrix analysis

Attributes	Lower Scale(1-3)	Medium Scale(4-5)	High Scale(6-10)
Beliefs	X	X	X
Attitudes	X	X	X
Intentions	X	X	X
Behaviours	X	X	X
Knowledge	X	X	X
Past behaviours	X	X	X

The above attributes are analysed using three levels of scaling such as Lower scale, Medium Scale and High Scale with a maximum marks of 60.

The another component of Lablaw's approach for predicting behaviour is people's actual behaviour; in particular, his/her approach emphasises the importance of past behaviour as a predictor of future behaviour. This is a consistent behavioural marker which could show up in confidential reports, service records, medical records or public records.

INNOVATIVE APPROACHES

To appraise the problem and consequent to GAP matrix analysis on the pattern of a targets behavioural pattern, certain behavioural markers are obtained and these are the predominant patterns on which the techniques of NLP have been applied. Some of the techniques (Table 2) used in the appraisal of a problem are enumerated below.

Table 2. Techniques used in appraisal of a problem

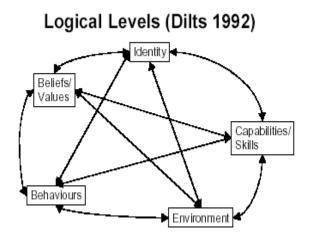| Types of techniques used	Essential features
Rapport	Matching speech and body rythms of others by recalling past resourceful state of the target
Anchoring	Anchoring unique visual, auditory, kinesthetic etc., states to make them available in new situations
Swish	Novel visualisation technique for reducing unwanted habits
Reframing	Responses and behaviour of targets to be changed so as the target to see the world in a different way and induces most creative way of thinking.
Six step Reframe	Identifies the intentions and create alternative choices to satisfy those intentions
Ecology and Congruency	Dealing with the relationship between the target and his/her natural social and created environment proposed goal or change might retreat the targets relationship and environment
Parts Integration.	Identifying different aspects which are in

	conflict due to different goals perceptions and beliefs negotiating with each of this to resolve internal conflicts
Metaphore	Helps to create and deliver stories that will inspires invite change, heal, expand awareness open up possibilities and potential.
Strategies and Modelling Success	Teaches how to identify the requirements and modelling the same to create strategy that will give excellent results
Non-Directive Ericksonian therapy	Understanding the functions of conscious and sub conscious and higher aspect of mind and helps the target who wants to change the deep seated programming

Meta programmes	Powerful unconscious filters to help the target to understand their way of looking at the world which in turn helps to develop more skills to cope with their experience
Family therapy	Identifying the negative anchors that have built up over time and method of changing this for healing relationship
Values	Learn how to elicit core values and discover what supports or inhibits these precious values from manifesting and by healing negative emotions of target and there by re establishing the meaningful relationship with life

NEUROLOGICAL LEVELS MODEL IN SIMULATOR TRAINING

The neurological levels model allows us to look at how people use generalizations (one of the three filters in communication) to talk about a whole range of similar things that are grouped together. By using this model as a frame for understanding, it helps us consider the different ways in which people act. It is a good tool to help the target 'think outside the box'. Classic examples are simulator trainings where there is no recording of the pattern in which a target approaches its objective. Rather he is forced go on a "garden path" as described by (Dilts 1992).

Fig. 1. Logical level of Garden path

Logical Levels (Dilts 1992)

Ship in Campus. This is yet an another powerful type of simulator training programme. The Ship shape structure is built in the campus of the training institute, to simulate a working environment of a ship in which all the machinery and equipments are fitted as in a actual ship where the target's capability in resolving the problems of unpredicted breakdowns are analysed. From this the target's state of mind, attitude, aptitude, intentions, knowledge are found out. From this input corrective action is done using NLP technique.

Full mission Engine Room Simulator and Navigational Bridge Simulator.
The full mission Engine Room Simulator and Navigational Bridge Simulator Training is yet another tool which is of computer based competency level assessment training in which

the Instructor creates the faults and the Target has to take corrective action to rectify the fault. The Target's approach is carefully studied and based on his competency level the NLP techniques are employed to improve his/her competency.

TESTING CAPABILITIES BY MODELLING TARGET'S BEHAVIOUR

Modelling the targets behaviour is a great challenge due to "human nature" (Gore, B.F. et al. 2000a), that is Targets are unstable, unpredictable and capable of carrying out independent action and this will aggravate during rough weathers. The performance of individuals will fluctuate depending not only on their ability, training and education, but also on their physiological and psychological states and traits. They can be grouped into cognitive capabilities, personality trends, emotional states and social characteristics.

Cognitive Capabilities. Human cognitive capabilities involve several brain processes such as learning and memory among others. In our model, the cognitive capabilities of a person were defined as his degree of expertise in a particular domain. Thus, to represent the technical knowledge of a person within a team, a set of six cognitive classes was set representing the six core competencies of a certification system .

Personality Trends. We have taken into account two different psychological approaches to identify the personality trends that influence the behaviour of a person when performing his/her work. The first approach is based on the CLEAVER technique, used to identify the predominant personality trend of a person. The CLEAVER technique (Cleaver 2000) is applied to the candidates through several questions about his/her likely actions in front of different work situations. The result of this questionnaire is a numerical value between 1 and 99 for each of the following personality trend parameters (DISC):

    Drive –leadership; capability to achieve results, overcome challenges and display high initiative.

    Influence –capability to interact with people and motivate them to improve their behaviour.

    Steadiness –capability to follow routine and continuous activities without large variations in behaviour.

    Compliance –capability to execute work following established rules and procedures.

The other approach is from Schubert techniques described in (Biegler, Grossmann and Westerberg 1997). Schubert proposes four general personality trends that may influence behaviour of a person: Amiable, Driver, Expressive and Analytical. These four personality trends are closely related to the CLEAVER trend parameters: Drive – Driver, Influence – Expressive, Steadiness – Amiable, and Compliance – Analytical. We therefore consider that the parameter with the highest value from among the CLEAVER parameters defines the Schubert personality type.

Emotional State. From the large set of basic emotions presented by (Ortony and Turner 1990), a small set of four basic emotions have been chosen to model the Targets' emotional state at work. Two of them are positive emotions and the other two have a negative influence over performance. Positive emotions: Desire and interest of a person to execute a specific task in a given moment. Negative emotions: Disgust and anxiety generated by a specific task in a given moment. In addition to these four basic emotions, we also consider the stress parameter as part of the internal state of the Targets. The stress is not an emotion, but its influence over the performance of a worker is recognised in several studies. In our model, the difference between the basic emotions and the stress parameter is given when the behaviour of the Target is generated.

Social Characteristics. Human relations are important to achieve a good communication and co-ordination among the group members. In a work team, in particular, an environment with good human relations is crucial to achieve common goals. The following social characteristics are considered in each of the Targets: Introverted / Extroverted , that is Prefers to work alone/Prefers to work in a team. Once the characteristics that affect performance at work are identified, the next step is to determine how to model the interaction between the internal characteristics of the different team members for the generation of overall behaviour. The following section explains our proposal to

confront this challenge through the use of fuzzy logic. According to the presented questionnaire, the inadequate performance of officers on watch constitutes the most frequent type of human-driven marine accident; this failure applies mainly for the categories of collision/ramming, power grounding and foundering,

Based on the Fuzzy Logic, Time Delay versus Drive Attitude Targets Model as described below is developed.

Given: The target A1 is in charge of task T1,

IF T1 presents a high delay AND A1 has a driver personality with high intensity THEN
- The desire emotion will have a high increase
- The interest emotion will have a high increase
- The disgust emotion will stay equal
- The anxiety emotion will have a low increase
- The stress will have a low increase

IF A1 is introverted AND T1 must interact with other people THEN
- The desire emotion will have high decrease
- The interest emotion will have a low decrease
- The disgust emotion will have a high increase
- The anxiety emotion will have a low increase

The factors that influence the Targets on the above described performance is the following assigned task level of the targets:
- Difficulty level.
- Specialisation level.
- Personal characteristics
- Cognitive: experience and creativity level.
- Emotional: desire, interest, disgust and anxiety.
- Stress
- Personality types (CLEAVER): drive, influence, steadiness and compliance.

From the above model which is developed based on the questionnaire and using Fuzzy logic, the performance of officers on watch is influenced by the following factors:

- P1: Introverted/Extroverted

- P2: Prefers to work alone/Prefers to work in a team
- P3: Creativity
- P4: Experience
- P5: Drive
- P6: Influence
- P7: Steadiness
- P8: Compliance
- HE: High extroverted
- HI: High introverted
- HT: Highly prefers to work in a team

The second model is based on the Target's creative level and personality versus the task's requirement of specialisation. Here the Target's high creative level and Driver Personality with high integrity versus Task requirement of high specialisation level has been considered for developing the following model.

Given the Target A1is in charge of task T1,

IF A1 has a high creativity level and has a driver personality with high intensity AND T1 requires a high specialisation level THEN
- The goals achievement is normal
- The timeliness has a medium advance
- The quality has a medium increase
- The team collaboration level is normal
- The individual contribution has a medium increase
- The required supervision level is normal

IF A1 has a low experience level AND T1 is a high difficult task THEN
- The goals achievement has a medium decrease
- The timeliness has a high delay
- The quality has a medium decrease
- The team collaboration level has a medium decrease
- The individual contribution is normal
- The required supervision level has a medium increase

Also the factors that influence the updating of an Target's emotions and stress values are

- Agent performance results
- Goals achievement
- Timeliness
- Individual contribution level
- Quality

- Internal characteristics
- Personality types (CLEAVER): drive, influence, steadiness and compliance.

Another human-oriented problem to be included in the above targets emotion is the misunderstanding due to language problems. Severe human error is cognitive gap that may grow to severe misunderstanding. Human error can be defined as disagreement between operator's expectations and actual results. Even though minor cognitive gaps are common and not preventable, severe misunderstandings of users must be prevented. This is the common interface problem during training when intended objectives and acquired skills are a total mismatch. Assuring human error safety is preventing cognitive gaps from growing to severe accidents.
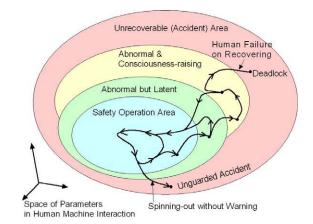
The Parameters for initial internal state of the people are:
- HA: Highly prefers to work alone
- H: High
- M: Medium
- L: Low
- MH: Medium high
- ML: Medium low

When analysed the accidents with respect to the above parameters of initial state of people shows that a very large portion of human-driven causes for marine accidents has to do with incorrect decisions and actions due to stress, fatigue and lack of appropriate training. The interesting revelation is that ascertain combination of the above parameters can be a irreversible behaviour of complex motivational error.

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Fig. 2. Error Escalation.

From the above Error escalations figure it is noticed that the Errors that are detectable in recoverable period are rather safe and the Errors that escalate under cover may cause severe accidents.

Cognitive gaps are necessary to explain spontaneous recovery behaviour of Target. Cognitive discord between subjective understandings and objective state drives Target to check situation. When a mismatch between the subjective understanding and objective condition of circumstance is detected, users begin to check the objective condition and recover errors.

NLP ANALYSIS

Generate Unexpected Error Modes.
Severe error is unexpected error. Predicting erroneous behaviour is more difficult than estimating normal behaviour. While normal operations can be major dangers and become safe after countermeasures are taken Conventional user error estimations tried to forecast human error probability under limited contexts. Most of the traditional simulation systems are likely to estimate human error probabilities (HEP). Although HEP implies an aspect of usability, they do not represent processes of unexpected error occurrences. Accuracy of results for usability experiments is often discussed. Estimations made by traditional user models, such as error rates, are described as one-way sequences; erroneous behaviours have mutual and complex dependencies. Causes and consequences of errors will be a stochastic event and often unexpected. Designing safety is finding unexpected error modes. Detected safety holes are no longer repeatedly questioned. 'Theoretical values' of usability estimations are

unlikely to exist. Even if some formulas would be correct for particular users and situation, they are not useful for unexpected error modes. Usability simulation should not be considered as a weather forecast.

To validate and integrate the ship board tasks under adverse conditions, Targets are given four levels of difficulty on a goal based system to verify whether the NLP methods used have had the desired effects. The levels of difficulty are presented as five tier system with the goals as one of the tiers (Kobylinski, L.2005).
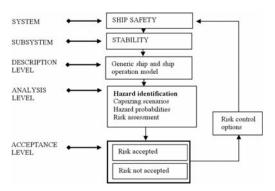
Five-tier system for goal-based requirements are

- Tier I: Goals
- Tier II: Functional requirements
- Tier III: Verification criteria of compliance
- Tier IV Technical procedures and guidelines, classification rules and industry Standards
- Tier V: Codes of practice and safety and quality systems for shipbuilding, ship operation, maintenance, training etc

SYSTEM AND RISK APPROACH TO SHIP SAFETY

Risk Analysis

Fig. 3. Block diagram of risk analysis

This section explains the experiments on risk which has been presented to explore human estimation of interruptability (IMO, 2000). The experiment showed that human estimators performed only slightly better than chance when asked to estimate interruptability on a 5-point scale from "Highly Interruptible" to "Highly

Non-interruptible". These human estimators appear to have systematically interpreted the video subjects as being more interruptible than the video subjects reported. By reducing the problem to distinguishing between "Highly Non-interruptible" conditions and other conditions, we establish a human estimator accuracy of 76.9%.

Intentions Surveys. One possibility is to ask participants how they will act in a given situation. The advantage here is that in addition to having information about the environment, they also understand their own motivation. On the negative side, they may be unwilling to reveal their true intentions. Projective tests ("What would your friend do in such a case?") might be considered, but the chief difficulty would arise in getting participants to respond to the survey. Furthermore, participants may lack insight as to how they would behave when large changes occur.

Extrapolation by Analogies. By examining analogous situations, one may be able to predict for a new situation. Regrettably, violence generally proved to be a good strategy for protesters. Extrapolation by analogies is less relevant, however, for large changes, new strategies, or new situations.

Role Playing. Role -playing offers some of the advantages of experimentation while overcoming some of the disadvantages. This section goes into detail about role-playing.

Auditory Task. The secondary task was an auditory task, a version of the PASAT. A series of numbers was played through a computer speaker. Volunteers were required to add each new number to the previous number and verbally state the sum. In this task, difficulty was a function of the number presentation speed. Typically, a subject started with a number presentation rate of1.8 seconds and the speed was objectively changed to reflect an approximate 60-70% correct response.

NLP APPLICATIONS

Applications of NLP in all three areas of accident investigation, competency certification and recruitment have set forth the concept of behavioural, attitudinal and belief markers. These are termed as alpha**, beta** and **gamma**

markers and these markers have validity and can be improved upon or modified by specific NLP training. The sum total of all the readings in a team of seafarers on board a ship would indicate a target with a definite probability of bend of mind with compulsive motivational error characteristics. That sum total value would depend upon the total acceptable in a mixed crew environment as well as type of ship, condition of ship, routes, contracts, etc., For an Indian ship with Indian crew of different regions a mix of 150-beliefs, 200-behaviour, 250-attitudinal would be considered adequate by peer judgemental method. In this there is no aptitude markers as they were found to be inconsistent with findings in evaluation. It has been seen that in 80 percent of cases the recipient was able to clearly overcome compulsive motivational error under simulated conditions. The remaining balance of 20 percent required further in depth study to analyse the behavioural aspects of the attitudes since they needed more probing.

The score sheet used for the markers was stated on a scale of 1—100 giving five grades of weightage from uncertain to supremely confident and the average scores within a random sampling of 25 targets out of a population of 50 gave the following readings. It clearly shows that a φ marked target has strong chances of making compulsive motivational errors than a target with more flexible beliefs, whereas the aptitudes show completely different results.

Table 3. Belief - Behaviour – Attitude – Aptitude Test Results

Symbols	Belief	Behaviour	Attitudinal	Aptitude
A	30	52	45	37
B	40	65	55	24
Φ	60	60	75	13
Total	130	177	175	54

RESULTS

With NLP, you can easily learn, how excellent people do what they do, how you can model this behaviour and use it over and over again, how you can consistently get great results in every situation and whenever you need it, how to manage your thoughts, how to understand the people around you better, their body language, their way of speaking and what it actually means how to become so flexible in your behaviour and language that you are able to master your life. The results obtained after application of the techniques has been very encouraging and the marked attitudinal changes brought about showed its effectiveness.

CONCLUSIONS

Safety is a crucial attribute relating to maritime transport; more specifically, it has many facets and it is difficult to deal with – even more in a proactive sense. At the same time, marine safety is considered to be indispensable for a viable and "attractive" maritime transport network. Its deficiencies can have an important impact on various maritime transport stakeholders (e.g. crewmembers, passengers, cargo, shipping companies, sea and coastal environments etc), as well with damages to third

parties. The development of a full proof structure from safety point-of-view is definitely not a trivial task, yet an efficient approach should be configured in order to achieve the best possible results. Statistics show that the most common accident types for commercial vessels are, fire/explosions, mechanical problems, collisions, groundings and hull damages. Moreover, the pivotal cause for the occurrence of these accident lies on human behaviour and performance; that is on human element. Its interference can militate on various procedures and event chains, causing more problems and provoking unpleasant consequences, or on the other hand improving difficult situations and even preventing the escalation of threatening incidents. The term human factor is an umbrella that covers various human-related aspects, such as training issues, problems on watch, lack of concentration, communication problems, fatigue etc. Additionally, marine safety can be enhanced through management practices, knowing that a suitable framework can mitigate certain difficulties encountered in the maritime transport system. It is obvious, that the passage towards safer ships and cleaner seas crosses the sector of human behaviour and performance; the reduction of human faults should be viewed as the key achievement, in the context of such an effort. Fewer human errors can be safely translated into less accidents, fewer fatalities and oil spills and enhanced levels of safety concerning all

maritime transport practices and procedures. Eye behaviour trends reported in this study may provide insight to human behaviour corresponding with cognitive workload, which may in turn be utilized to produce reliable workload indicators and applications that predict poor performance in real-time.

Monitoring near real-time performance to evaluate operator state could increase reliability in critical workforce settings. The changes in eye activity are related to the type of activities engaged in by the subject as well as other factors including age, time on task, experience, and the external environment. Selection of appropriate parameters will be critical in providing design specifications for monitoring systems to engineers. For example, our observation that vergence angle metrics could be very useful suggests that measurement of both eyes and the relative angle between their two directions of gaze will be important. Evaluating information processing and the occurrence or disruption of visual information could help assist in detecting fatigue. However, even more provocative is the possibility that behaviour such as fixation duration might predict possible error states. Prediction would be useful in both training and operational conditions. Future studies will increase reliability of oculometric indices through development of multi-parameter monitoring systems.

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