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THE STATE OF THE ART AND THE STATE OF PRACTICE

Representing the Human Decision Maker in Combat Identification

Human Decision Making
Parametric Stochastical Modelling
Fratricide and Friendly Fire.

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Abstract:

The ability to correctly identify entities encountered on the battlespace is a critical aspect of warfare. When Combat ID is of poor quality, the consequences of fratricide and missed opportunity can have a severe impact on mission effectiveness. Dstl have created the Integrative Combat Identification Entity Relationship (INCIDER) model which has captured the Human, Operational and Physical parameters and relationships that impact upon the decision making processes associated with Combat ID. A demonstration version of INCIDER, which undertakes stochastical parametric simulation of a single entity on entity encounter, has been developed and shown to successfully capture the required aspects of system and human behaviour within an operational context. This paper will discuss the historical problems with Combat ID, and describe typical identification processes. It will then describe the INCIDER parameters and relationships, and how the INCIDER demonstration model represents the Combat ID process. Finally the paper will discuss use and exploitation of INCIDER.

1. Introduction

1.1 What is Combat ID?

Combat Identification is defined by UK military doctrine as:

‘The process of combining situational awareness, target identification, specific tactics, techniques and procedures to increase operational effectiveness of weapon systems and reduce the incidence of casualties caused by friendly fire’

The ultimate goal of Combat ID is to maximise combat effectiveness by providing rapid, secure, positive identification of platforms, equipment and people in the area of operations. High quality Combat ID will reduce the uncertainty associated with a commander’s decision to fire to a level that is acceptable within the prevailing circumstances and Rules of Engagement (ROE). Readily available, easily understood and accurate Combat ID information is essential for the prosecution of high tempo manoeuvre warfare.

Combat ID is therefore one of a number of ‘Joint Enablers’- activities that, while fundamentally important, are not an end in themselves and whose principal purpose is to enable other activities to take place.

Poor Combat ID can lead to a number of undesirable outcomes on the battlefield. These are listed below.

- Fratricide, defined as: ‘The accidental destruction of own, allied or friendly forces, a result of what is colloquially known as a ‘blue on blue’ engagement’ (Reference 1), is the most serious failing of Combat ID, occurring when a unit misidentifies and engages a friendly unit. This causes a number of outcomes:
    - Casualties, and damage to equipment;
    - Wasted time, effort and ammunition;
    - A drop in morale and levels of trust;
    - A drop in unit effectiveness, and subsequent excessive caution;
    - A strain on coalitions if casualties are inflicted on allies;
    - Political repercussions.
- Neutricide and collateral damage, occurring when civilians and civilian infrastructure (such as hospitals, religious sites, etc) are accidentally targeted (by engaging enemy forces nearby), or misidentified and deliberately targeted. The results of such accidents and mistakes can be far reaching and quickly reverse the results of “hearts and minds” operations. They can also represent

illegal actions if civilian casualties occur after disproportionate force has been used or no clear military objective has been identified.

- Unnecessary risk to own forces and missed opportunities, if enemy forces are misidentified as friends and allowed to manoeuvre unhindered.

- Disruption to tempo. If unknown forces cannot be identified with sufficient confidence, then operations may be forced to pause or divert while they are positively identified.

1.2 How serious a problem is combat misidentification?

Combat misidentification is a fundamental and unavoidable aspect of the 'fog of war'. Fratricide has taken place since the beginning of organised warfare, and it is highly unlikely that is can ever be completely eradicated. During the First and Second World Wars, fratricide rates are estimated to have run at between 10 and 15%. However, these statistics need to be taken in context. Firstly, the public were not made aware of these levels, and fratricide incidents tended be hushed up as official secrets. In addition, the combat situation was extremely serious with national survival at stake. This led to a public willingness to accept very high numbers of casualties. The high casualty rate overall tended to mask those specifically caused by fratricide.

Many of the Tactics, Techniques and Procedures (TTPs) currently used by the UK have been introduced in order to reduce the risk of misidentification (e.g. separation, land, air and waterspace management, and ROE). In addition, technology ranging from aircraft Identification Friend or Foe (IFF) systems to identification markings (such as those used at D-Day, and Thermal Panels used in the last Gulf War) have been deployed to improve the ability of forces to identify friendly units.

The only effects of failed Combat ID that have been routinely monitored and reported are Fratricide and Civilian harm. Near-miss incidents have not been identified, reported and investigated in the same routine way as air traffic incidents. The result is that fratricide tends to be the main benchmark against which the success of Combat ID is measured.

In Operation GRANBY in 1991 and Operation TELIC in 2003 the percentages of casualties caused by fratricide were significant (in particular, US force losses of Bradley and M1A1s due to fratricide was in the region of 70–80% of total losses (see Reference 1). In addition, a number of high profile events took place[1] that were widely reported in the media. The impact of these events had a measurable effect on the performance of the units involved.

In Operation GRANBY, the UK forces suffered nearly 80% of their combat losses from fratricide. US forces have assessed that 17% of their overall combat casualties resulted from fratricide (Reference 2), but as noted above, the proportion among AFVs was much higher. The relatively high ratio of fratricide related casualties compared to combat casualties was largely because the effectiveness of Coalition forces was an order of magnitude greater than the Iraqi opposition resulting in a fairly

[1] Including the death of 9 UK Army personnel, and the destruction of 2 Warrior AFVs during an attack by US A10s in 1991.

one sided conflict (and as a consequence few casualties being inflicted by the opposition).

The presence of the media on or near the front line provided instant visibility of the fratricide events from these conflicts. In addition the ‘signatures’ of weapons being used by Coalition forces (such as depleted uranium shells) increased the likelihood of fratricide events being identified as fratricide by post conflict analysis. Presented with media footage and official reports, the general public and politicians are unwilling to accept casualties caused by blue on blue engagements. There is also an overwhelming consensus from all branches of the armed forces that they are extremely undesirable events.

In 2002 the National Audit Office (NAO) reported on Combat Identification (Reference 3) and concluded that ‘the changing nature of modern warfare means that combat identification is complex, and that there is no simple solution to reducing the risk of fratricide.’

If Combat Identification is to be improved, and as a result reduce the incidence of fratricide, and other undesirable side effects, then there is a need to establish a better understanding of the factors that influence Combat ID. Looking at a specific incident will help to illuminate some of these factors.

In 1991, 2 US A10 ground attack aircraft attacked and destroyed 2 UK Warrior AFVs killing 9 soldiers.

A number of factors had potentially contributed to this event:

- the pilots were in the wrong place;
- the pilots had limited training in the identification of UK vehicles;
- the pilot was expecting to see enemy vehicles.

Militarily, this was an undesirable, but not significant event. It did not impact upon the outcome of the conflict; the overall force losses were far below expected levels. However the political significance was huge. Media reports gave extremely rapid and wide coverage. This immediately made the incident extremely visible to the UK viewing public. This was exacerbated by the hostile portrayal in the British media of US “Cowboy” tactics, backed up by pictures of grieving families.

The impact on forces on the ground was anecdotally significant[2]. Overnight tempo within UK units dropped, drastically lowering operational effectiveness. Trust between UK and US forces was severely diminished. Politically, a strain was placed on the coalition. Political leaders in the UK were under pressure to explain how, in the era of modern conflict, this sort of accident could still occur.

In the analysis of fratricide, it is important not to lose sight of the operational objective – combat effectiveness must be maintained. The more aggressive the units,

[2] The Authors heard accounts from serving officers of the resultant impact on tempo; however, as with many other aspects of combat ID, there were no available documented sources to describe the level of combat degradation.

the greater the risk of fratricide. However, over-hesitation can give the enemy the upper hand and lead to greater casualties due to hostile fire – the most effective way to avoid fratricide is not to fight!

Another aspect of combat effectiveness is the tension between combat ID, and camouflage and concealment. Effective camouflage, and concealment of a unit's location, could aid force protection. However, it may also increase the difficulty with which friendly forces are able to locate and identify their colleagues.

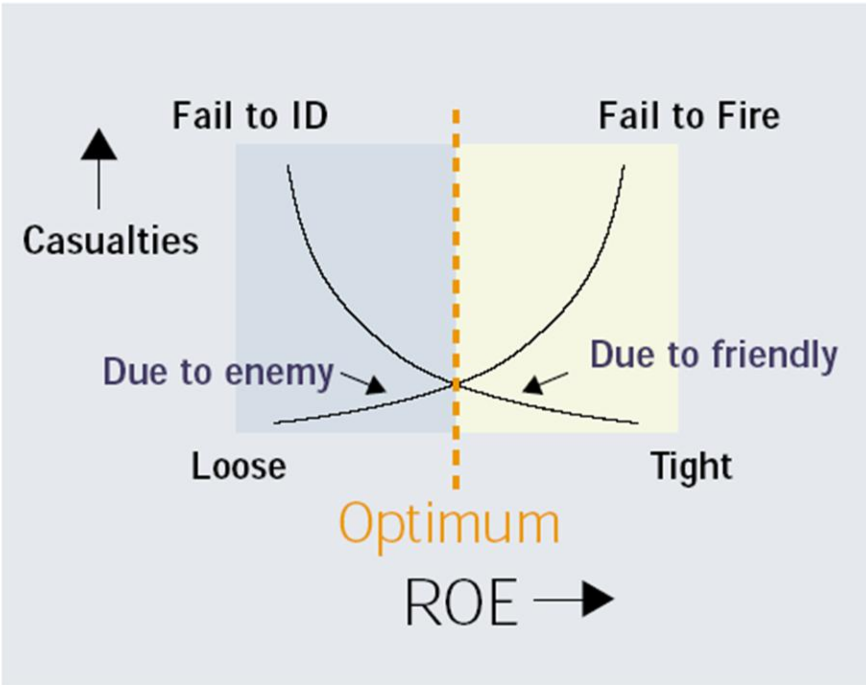

Figure 1 - The relationship between ROEs and combat losses

Figure 1 shows the relationship between casualty rates (shown as increasing on the arrow on the left) and rules of engagement. The two curves represent the numbers of casualties caused by enemy fire and friendly fire respectively. By increasing the constraints imposed by rules of engagement from loose to tight, the cause of casualties will change from being largely self-inflicted (due to a failure to identify) to largely inflicted by the enemy (due to a failure to fire upon hostile forces). In the centre, there will be an optimum level at which overall casualties are minimised. However, this idealised figure masks a great deal of complexity, Firstly, the ROE settings provide guidance, they do not provide an absolute measure of whether an individual is likely to engage or not – this is an emergent property governed more by the tactical situation and the human. In addition, the curves themselves are unlikely to be so linear, and the point of optimisation not so clear cut

Although simplistic in its representation, this figure does bring out an important point. There is a conflict between the need to minimise casualties, and the desire to minimise fratricide. The implication is that some level of fratricide will always be an unfortunate side-effect of the need to engage the opposing force.

It is possible that there is an in-built level of risk for forces that will mean that they will take more risks until their perceptions of the likelihood and consequences of error maintain a similar rate of accident. This kind of emergent property is well recorded in the automotive industry. For decades now, vehicles have been fitted with safety measures of ever-increasing complexity including seatbelts, crumple zones, side impact bars, disk brakes, ABS and air bags. However, with each improvement, drivers subconsciously feel safer, and take greater risks. Reason (Reference 4) refers to this phenomenon as risk compensation (or risk homeostasis) in which individuals and organisations will sacrifice protective benefit for an alternative gain (such as financial profit or combat effectiveness).

This is the crux of the Combat Identification problem. The main issue is one of perception and political impact, the main metric is impossible to define, and will change anyway depending on the situation. The acceptability and expected occurrence is determined by operational context, and a wide range of different factors contribute at a wide range of different levels to give rise to fratricide outcomes. The introduction of solutions may be thwarted by operators who trade the gains for improved combat effectiveness.

2. The Combat ID Operational View

Figure 2 provides a pictorial representation of Combat ID within the land environment. The figure represents a blue formation advancing through mountainous terrain towards a known and reported enemy location. The decision maker is within a small group to the right of the picture. There is a flanking formation to his left, and another allied (US) formation across the Corps boundary (shown by a dotted yellow line).

As the decision maker advances, he becomes aware of an unknown entity at an 8 o’clock position. The question the decision maker must answer is:

> “Is the unknown entity a friend or a foe?”

The decision maker will have a number of organic sensors (including his own eyes) with which to identify the entity. These will be range and environment dependent. In addition, the nature of the entity (and other entities on the battlespace) will determine its effectiveness in terms of determining identity (for instance, if the enemy is equipped with US vehicles, there may be no visual means of identification except for reliance on markings and identification panels).

Formation HQ will pass on situational awareness (SA) (possibly in the form of a compiled SA picture derived from other sources in the area. This will include the Flanking formation own position reports, and contact reports from the forward observer (FOO) and surveillance assets (in this case aircraft/UAVs). The decision maker also has the option to send forward part of his force as a scout.

The decision maker is aware of civilians in the immediate vicinity; he is also aware that the flanking formation is advancing in that direction. The presence of civilians on the battlespace greatly complicates the situation. The nature, location and numbers of civilians will never be completely known. The consequences of unintentionally engaging civilians can be severe (and if disproportionate force is used, may be illegal). A farm building is shown on the figure for two reasons:

- Firstly, objects on the battlespace are often mistaken for battlespace objects when they are not. A good example of this occurred during the first gulf war, when two buzzards sitting on a water tower were mistaken as sentries in a lookout tower.
- Secondly, the farm building could be mistaken for the location of the civilians, thereby providing a false reference to the decision maker.

Also shown on the figure are strike aircraft and supporting arms who have the potential to engage the unknown entity. Both are nominally operating under the control of the FOO (or Forward Air Controller (FAC) for strike aircraft). The FOO may be responsible for undertaking the identification decision. The pilot of the strike aircraft will have this responsibility if no FAC is present.

A media reporter is also shown, because in the case of Combat ID, the media have a major say in how the incident is reported and presented to the public. Press releases and press conferences will put forward the government view; a true, informed and unbiased representation of an incident is unlikely to be obtained from a single source.

The Formation HQ will be part of the command chain which goes through battlegroup command and divisional command before ultimately ending at the defence staff and crisis management organisation (CMO).

However, media reporting and world opinion will exert a political influence on the decisions taken by the CMO. This is an important relationship to capture and understand, since hostile reporting, or unfavourable world opinion exerted through organisations such as the UN, could directly lead to a curtailment of military operations.

Shown within the purple box on the left of the figure are the organisations that have the potential to influence the Combat ID capability deployed to theatre. This includes the owners of the lines of development[3] of different Combat ID solutions, the MoD customer and provider organisations (DEC, DLO and DPA) and the equipment or service providers represented by industry.

Political influence can direct the priorities for future combat ID capability, but can do nothing to impact upon the effectiveness of the Combat ID capability already deployed to theatre.

[3] Such as Training, Logistics, Personnel

This figure illustrates the complexity of the CID problem space and solution space and the complex relationships between the various stakeholders.

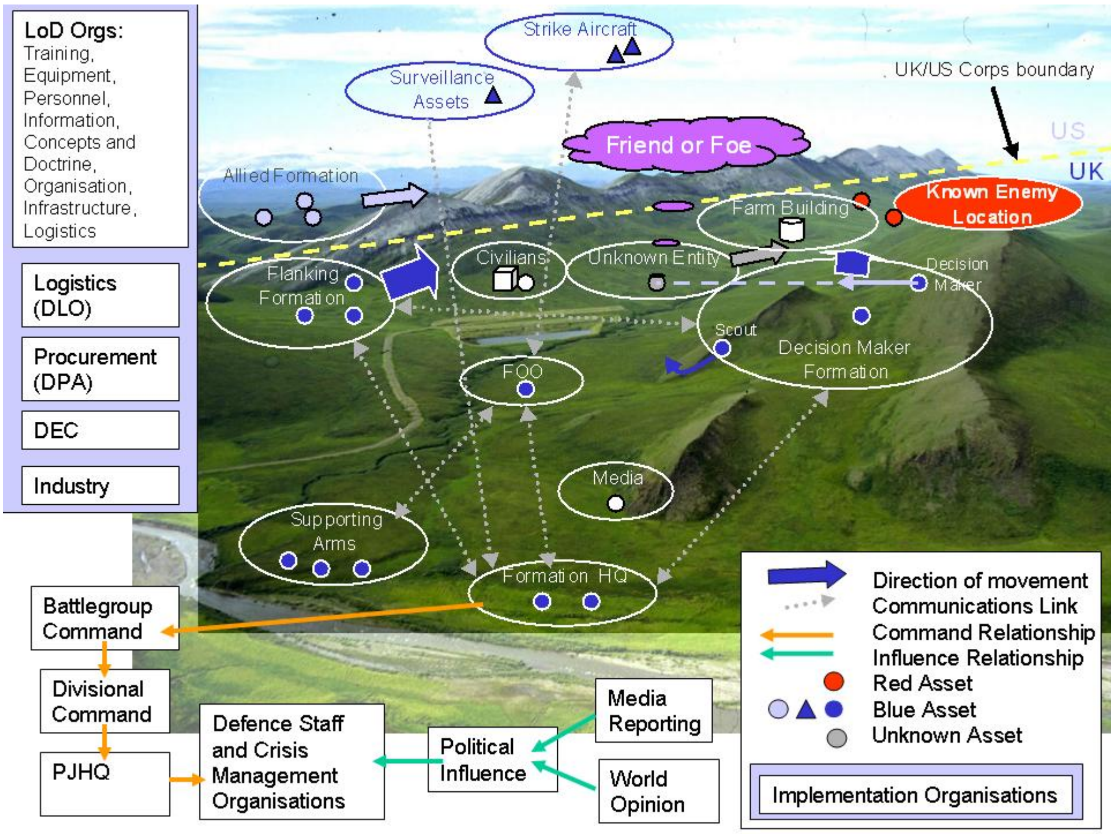

Figure 2 – The Combat ID Operational Context

2.1 What can be done to improve Combat ID?

The current UK view is that Combat ID comprises three strands:

- Tactics, Techniques and Procedures (TTPs) – Technology has to be operated within an overall military process. TTPs define that process, and should be designed to supplement the characteristics of the personnel and technology deployed in the battlespace.

- Target Identification (TID) – 'The process that allows the immediate determination of a contact's identity by friendly, discrete platforms or individuals.'. TID also refers to specific types of system, which can either be co-operative (exemplified by IFF transceiver systems) or non co-operative (exemplified by submarine passive sonar and Electronic Support Measure (ESM) systems[4]).

- Situational Awareness (SA) – The aim of SA is the provision of a timely, high fidelity, operating picture to enable commanders to understand their operational environment. For the purposes of this report, SA concerns the understanding derived by an observer about their situation; Situational

[4] These systems detect physical emissions from the target and compare them with a reference database in order to make an identification.

Information (SI) is used to represent the information available to them through aids such as a tactical picture and other reference information derived from reports, databases etc.

Although useful from a military viewpoint for expressing the pillars supporting Combat ID, they do not provide a useful basis for describing combat ID from an analysis viewpoint.

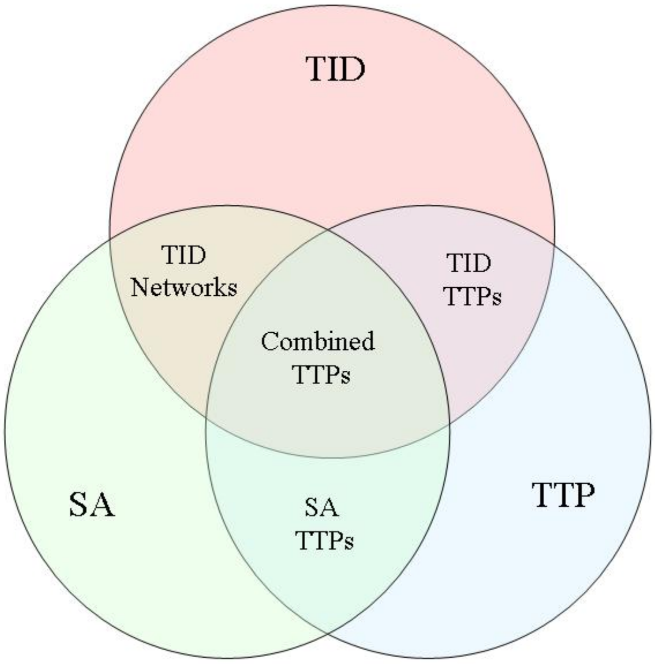

Figure 3 – The strands of Combat ID

The three strands of Combat ID are not mutually exclusive, as shown in figure 3; common solutions can span two or even all three. As an example, TID systems can be used to contribute SI to an SA picture certain TID systems can even form their own SA network. The use of the TID system needs to consider procedures for use, doctrine for deployment and tactics for operations. Underlying all of these, personnel need to be trained, and the equipment needs to be supported, to provide a viable capability.

Solutions in all of the strands are likely to make an improvement to Combat ID. However, there is currently little or no understanding of how great this difference will be, what form the difference will take, and which solution (or combination of solutions) will be most effective (and cost effective). Also, any improvement in Combat ID which led to a degradation in the overall capability would not be operationally acceptable and could lead to higher overall casualty rates.

To further complicate matters, the solutions associated with the strands are very different in terms of the metrics which can be used to describe them:

- TID systems are measured in terms of range, angular separation, and speed of response.
- SA systems are measured in terms of completeness, consistency and latency.
- TTPs are measured by the results of wargames, exercises and constructive simulations.

To comprehend the influence and effect of the three Combat ID strands, the underlying behaviour, relationships and parameters of the entities within the battlespace which impact upon Combat ID need to be better understood. This needs to be related to future scenarios and the personnel and equipment that are to be deployed within them.

To support Balance of Investment (BOI) studies, future OA and future procurements, this understanding must be able to:

- determine the changes to these relationships that solutions based on new technology or processes will cause;
- calculate the impact that these changes will have on fratricide rates; and
- ensure that the impacts caused by different types of solution can be compared against a common benchmark.

It can therefore be seen that Combat ID is an extremely complex problem, with multiple causes, multiple stakeholders, and a wide range of different system solutions. In the following section an alternative high level breakdown of the factor effecting combat ID is proposed (as the top level Integrative Combat ID Entity Relationship Model (INCIDER) conceptual model).

3 What factors impact upon Combat ID?

Scoping the problem

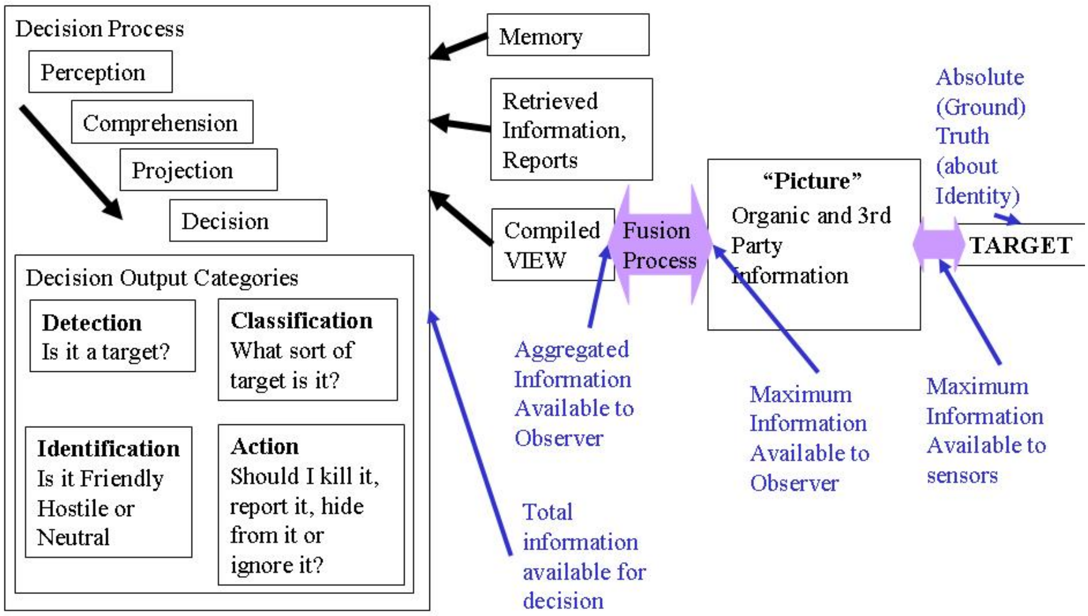

Figure 4 – Combat ID Factors

A qualitative description of the factors impacting Combat ID has already been given; another description of the problem space for Combat ID is illustrated in Figure 4 above. A battlespace entity is being observed by a decision maker through a number of detection channels that make up a "picture" of the entity. The situation and conditions relating to this observation (such as preconceptions, environment and decision pressure) form an operational backdrop to the detection and classification process. The battlespace entity is associated with an absolute truth (ground truth) about its identity.

The sensing channels can be third party sources or organic sensors. The amount of information that they possess about the entity will be based on their relative location to the entity and the nature of the detection mechanism. There will also be parameters relating to how well the observer can use and understand these sources and the degree of trust that is placed in them. The combination of this information will give rise to the "picture" of the entity. This will represent the maximum amount of information that is available to the decision maker. In reality, the decision maker is not likely to be able to view all of this information due to time considerations.

Through a mixture of fusion processes (typically the observer will glimpse information in a number of 'snapshots' from each of the sources and combine the information together), the observer will aggregate the information contained within this picture into a compiled view of the real world.

The decision maker will also have access to relevant knowledge contained in memory, which will include his expectations derived from the pre-operation briefing and contextual information concerning the history of events up to the point of identification. There will also be other reference sources that may be available (e.g. an electronic copy of the plan, a marked-up map, etc).

After detecting an entity, the observer will develop his SA through the stages of perception, comprehension and projection, and evaluate his SA via a series of iterations whereby he will decide if his level of confidence is enough for him to make an identification decision, or whether he needs to undertake additional activities to improve the amount of information he has.

The speed and manner in which the decision maker goes through this process is mediated by a number of factors that will be described in the next section. An identification decision is one of a number of different types of decision that will come out of this process. Broadly speaking the decision categories are:

- Detection: Is it actually a target? An initial detection will allow the observer to decide whether the entity is a target or background clutter. Detection will also involve a degree of localisation.

- Classification: Assuming that the decision maker is confident that something has been detected, this process will determine what it is. This could be based on physical identifying features or behaviour.

- Identification: What allegiance does the entity hold?

- Action: Does the decision maker need to close on the target to get more information, or is he confident enough to engage?

These actions are not sequential, and they also occur at different levels; for instance it might be possible to detect an ESM signal identifying the presence of an enemy before its type and location are known. Classification may go through the stages of: vehicle; armoured vehicle; tank; T72; before identification (a Polish T72).

Using this simple description of the process, 3 categories of parameters were identified.

- Human: parameters relating to the decision maker's psychology, physiology and history. There is also an underlying decision making process (briefly described above) that the human performs when identifying an entity.

- Physical: parameters relating to the physical detection channels.

- Operational: parameters relating to the history, identity, location and environment within which the identification is taking place.

4. The Conceptual INCIDER model

4.1 Influences between factors

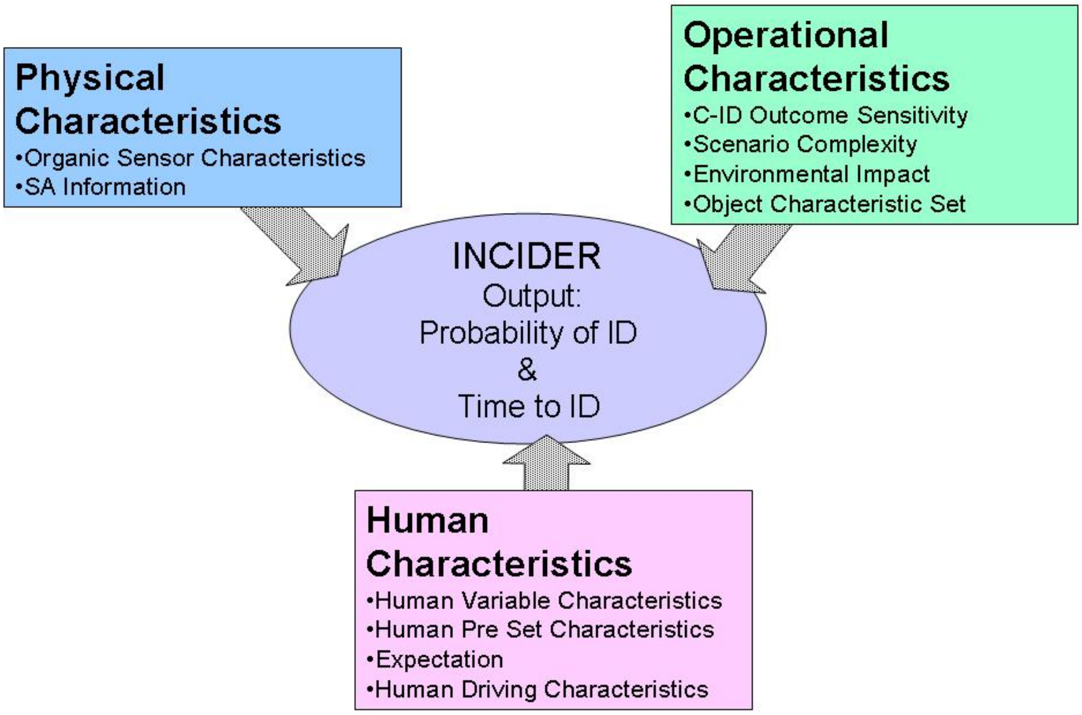

Figure 5 – The INCIDER Conceptual Model

The top level parameters of relevance to INCIDER are shown in Figure 5 above. The scope represented by this model is vast, and it is impractical to consider an attempt to represent all of these parameters within a single model. In addition, many of these parameters either cannot be varied or are not relevant to the solutions to be addressed by a BOI study. It is likely that some parameters will also not become apparent until more detailed experimentation has taken place (such is the nature of emergent properties). Therefore the top level of INCIDER can be considered to be a repository of parameters that will grow and be refined as time progresses.

The next consideration is how these parameters can be meaningfully exploited to investigate an area of interest. The Close Tactical level is where the effects of all of the Combat ID parameters come to bear. A decision was therefore taken to create a demonstrable version of the INCIDER model to specifically investigate the factors represented by Figure 4 for a single decision maker observing a battlespace entity via a number of sensing channels.

4.2 Representing the Combat ID process

This section describes the basic principles behind the development of a generic decision-maker representation based on INCIDER parameters.

Figure 6 represents the basic concept for the INCIDER demonstration model. At present it concentrates on the land environment (in terms of manoeuvre and sensing characteristics); however, it is intended to create versions that represent the air and maritime environments.

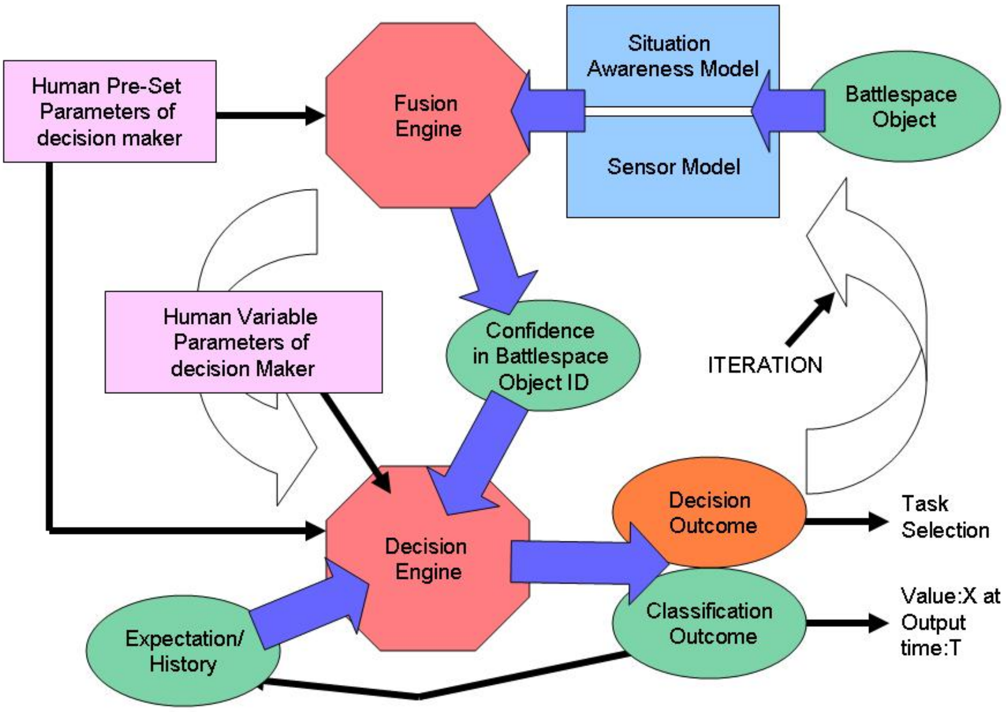

Figure 6 – INCIDER demonstration concept

The battlespace object is shown top right of the figure. For the purposes of the demonstration model, the target is assumed to be stationary and passive (although modifications to this behaviour could be implemented at a later date).

The battlespace object is observed by models representing SA and organic sensors. These models represent the individual sensing channels possessed by or available to the decision maker; each will provide a PID based on range (and PID based on time in the case of SA sources[5]). The identity of the object can be either hostile, friend, neutral or non-target (i.e. wildlife, an empty building etc).

The information items from the sensor models are then combined by the Fusion Engine described below. The Human Pre-Set Parameters represent the decision maker's level of trust, preference, experience and competence with these sources;

[5] SA sources are dependent on the reporting unit transmitting information, and this being received by the decision maker. They are therefore dependent on the time that the reporting unit is in contact, and the latency of the contact report from the point of view of the decision maker.

these are also input to the Fusion Engine. The output from this process is an overall level of confidence in the identity of the battlespace object. This is fed into the Decision Engine.

Prior to the operation, the decision maker will have a previous expectation for the identity of any objects detected within a particular area. The model takes an initial set of confidences for identity which can be altered to represent different start conditions. As the decision maker progresses through the scenario, the expectation will change as new evidence is received. Therefore at a given point in time, the expectation can be considered to be the start condition followed by the expectation history.

The Decision Engine compares the fused sensory information with the Expectation/History. According to the confirmatory bias of the decision maker, a certain amount of evidence will be required in order to change this expectation[6]. The amount of evidence required will be related to both the Pre-Set Human Parameters such as personality type and Human Variable Parameters such as stress and fatigue.

The output from this process is a revised view of classification (which will become the new Expectation/History for the next iterative cycle) and a decision on the next task selection taken. The tasks are simple interactions with the entity such as: move closer, use sensors/SI, report to base, pause etc. These will be selected based on personality preference (a set of preferences for the tasks have been derived from the Human Pre-Set Parameters) and Human Variable Characteristics. There is also scope to extend the selection criteria to represent cultural bias, and doctrinal rule sets within future studies.

The selection of the action will lead into an iterative cycle, with the distance between the entity and observer decreasing, and the time increasing until one of a number of trigger conditions are met. This will lead to a decision being taken on the identity of the object. This trigger will be a level of certainty, a particular time, or a level of stress.

This will be the point at which identification takes place. The model does not address engagement, as its scope does not include assessing the effect of the Combat ID decision on mission progress or outcome.

4.3 The SA and Sensor models

The Situation Awareness and Sensor models represent the detection probabilities for each of the sensors against the selected target. These probabilities are range dependent (for organic sensors) and time dependent (for SI sources):

- The representation of SA sources represents a particular problem, as the probability of identification (PID) will depend on the communications latency. These issues have been discussed in section 3. For the purposes of the demonstration model, a constant confidence mass was defined for the SA picture. This can be degraded to represent the effects of latency and increased when a new contact report has been generated by a third party asset.

[6] A strong bias will need more evidence to refute than a weak bias.

- The organic sensor models will be populated with PID information against range, based on detailed physical models (this has also been discussed in section 3)

4.4 The Fusion Engine

The Fusion Engine is a mechanism for combining the physical probabilities from the sensor and SI sources, with the levels of trust associated with them. These relationships have been abstracted to simplify the situation to a manageable level, by multiplying the confidence mass by a degrading factor.

It is possible to incorporate more complex behavioural algorithms at this point; however the required source and calibration information is not currently available to develop these accurately; this will be an area for future work.

The factors that could potentially be represented here are:

- Training. The better trained an operative is, the better he will be able to use the equipment, and the more confidence he will have in its abilities. This will also lead to specific knowledge about strengths and weaknesses in particular situations (i.e. a particular sensor may be less reliable in humid conditions, and hence the confidence will drop). The strongest training factor expected to impact upon confidence would be target identification training. Even with the best sensor in the world, an operative will not be able to identify something that he does not recognise.

- Competence. Competence would be increased by training, but there would also have to be a degree of personality or proficiency that would lead to a better level of performance by an operative with a particular system (some people are simply better at particular tasks).

- Interpersonal relationships, culture and experience. Particularly for SI sources, a decision maker will have varying degrees of confidence in the sources of information that are received (perhaps due to the decision maker having had bad information in the past). Some allies may be perceived to be more trustworthy than others. Also, the source information may be caveated with a confidence marking.

4.5 The Decision Engine

The Decision Engine represents the comprehension process by which the decision maker compares his expectation with the sensory input (i.e. compares his previous SA with new SI to derive a revised SA). This part of the model represents the impact of confirmatory bias. There will be conditions where the output will directly reflect the SI (typically the base case, with no bias or stress), there will also be situations where a decision maker will require irrefutable evidence before he will change his initial assessment.

A further output from this process will be the decision on the next action to take. Assuming that the decision maker is not 100% confident in his assessment, he may want to gather more information (by getting closer), pause, or take some other management action.

An iterative cycle will now take place as the decision maker takes a series of ‘glimpses’ of the target entity, as time increases, and distance decreases. This iteration will continue until a condition is reached whereby the decision maker is confident enough to make a decision or will be forced to make a decision (due to time or distance constraints).

All of these decision processes will be determined by the initial SA (intended to represent initial bias), Pre-Set Characteristics (which will determine the personality type of the decision maker), and the level of stress (which will degrade the decision maker’s abilities).

As well as the confidence in classification, the time taken to make the decision will be an important measure when considering operational effectiveness, as it will determine the number of engagements that a unit can undertake, and dictate the tempo of an operation.

4.6 Linking PID to Combat Effectiveness

Three main levels of representation of Combat ID have broadly been considered as part of INCIDER.

The first level of representation, described above, is that of the single decision maker. The output of this representation is limited to a series of probabilities of identification related to a ground truth, and a time taken to make a decision.

To transform this representation into measures of combat effectiveness using only the single decision maker model requires calibration against historical events, and making assumptions about the relationship between PID and Time to engagement on Fratricide Rate, Blue on Red and Red on Blue Kill rates, and Tempo.

The second level considered would involve incorporating the behaviour of the INCIDER model into a number of constructive simulations. This would mean changing the behaviour of the entities within a constructive simulation so that their detection was based on the INCIDER process. This would provide a potentially very powerful way of modelling Combat ID at a highly aggregated level, providing an immediately apparent link to combat effectiveness in terms of simulation outcome.

The risk to this approach, however, is that firstly, adding the additional constructs to represent the INCIDER model within every entity within a constructive simulation would be complex (and costly) to instantiate. A simpler model with a reduced set of aggregated parameters could be used but this could greatly limit the fidelity of outputs. A second problem is that the processing power required would be immense, and could be a limiting factor for the immediate future.

The final level considered is the use of Synthetic Environments (SE). This involves designing SE based experiments using INCIDER parameters, and changing the parameter settings within the SE in order to monitor vignette outcomes. This is essentially a real life instantiation of the INCIDER demonstration model. Such a representation is manpower intensive, and very narrow in scope. Each simulation would take several hours to run and represent only a single small vignette, as such it is better suited to the investigation and validation of data rather than analysis linked to combat effectiveness.

4.7 Calibration and Validation

The model as it currently stands contains a number of postulated and theoretical relationships derived from source material and analysis. They have the ability to represent human decision making behaviour, but have not been validated or calibrated.

Initial validation can be achieved through the use of subject matter experts (SMEs) to confirm relevance, and the expected behaviour emerging from simulation runs. This can be extended by using the model to represent historical events and attempting to replicate good and bad Combat ID behaviour.

The ultimate aim is to introduce a more rigorous validation process based on the use of synthetic environments. A programme of experimentation would enable participants to be calibrated against simple personality profiles, and their decision making processes investigated whilst immersed within a stressful high-resolution environment.

A programme undertaking multiple runs using a variety of volunteers in a variety of different vignettes would provide a suitable way of validating the accuracy of the INCIDER representation. In addition, the parameters representing human behaviour, operational complexity, environmental and physical effects could be calibrated.

To verify this process, a number of test vignettes could be run within either a large scale simulation environment or live exercises.

It is important to note that calibration will have to investigate a range of environments, and it will therefore be necessary to identify suitable SEs to represent all domains, as well as models to represent indirect fires and high-level C2

5. Conclusions and Future Work.

INCIDER has developed a unique method of combining knowledge from the Human, Operational and Physical domains.

The INCIDER Model has been able to represent misidentifications associated with Fratricide and Civilian harm and has been described by serving military personnel as providing the best representation of the combat ID process that they have seen.

The human decision making processes used by INCIDER are, being based on sound human factors principles, generic, and could potentially be applied to a wide range of cognitive command and control applications.

The INCIDER study is currently looking at extending the representations within the model to include different environments (including Air and Maritime) and different levels of command and control (from Close tactical to operational). This also includes investigation of group and team decision making.

A prototype version of INCIDER has been successfully used on a UK systems programme. The model was used to represent a range of combat situations and provided a subjective measure of the benefit of a range of TID, SA and TTP intervention. It enabled a level of comparison for the BOI process not possible by any other means.

INCIDER is soon to be validated by the first stage of a programme of Synthetic Environment (SE) experimentation in which factors such as level of briefing, personality type and scenario complexity will be assessed for impact on fratricide rates within a set of vignettes.

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