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Implication of Culture: User Roles in Information Fusion for Enhanced Situational Understanding

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Abstract – *Information Fusion coordinates large-volume data processing machines to address user needs. Users expect a situational picture to extend their ability of sensing events, movements, and activities. Typically, data is collected and processed for object location (e.g. target identification) and movement (e.g. tracking); however, high-level reasoning or situational understanding depends on the spatial, cultural, and political effects. In this paper, we explore opportunities where information fusion can aid in the selection and processing of the data for enhanced tacit knowledge understanding by (1) display fusion for data presentation (e.g. cultural segmentation), (2) interactive fusion to allow the user to inject a priori knowledge (e..g. cultural values), and (3) associated metrics of predictive capabilities (e.g. cultural networks). In a simple scenario for target identification with deception, cultural information impacts on situational understanding is demonstrated using the Technology-Emotion-Culture-Knowledge (TECK) attributes of the Observe-Orient-Decide-Act (OODA) model.*

Keywords: *Fusion, Situational Assessment, Interface Design, Knowledge Representation, User Refinement*

1 Introduction

Cultural implications for information fusion (IF) design includes: (1) machine-level data preprocessing to output estimation, (2) user-level defined sensor queries to display metrics, and (3) system-level operational design to afford diplomatic coordination. IF designs are employed and utilized by different users with individual differences for a variety of missions. These differences require that IF designs be tailored, flexible, and amenable to different cultural needs (e.g. harbor data collections of supply distributions, communication network patterns, and linguistic variable analysis).

Machine data collection from sensors, user queries, and operational systems seek to gather information to answer questions about tactical situations and relationships. Driven by operational needs, user desires, and target behaviors; cultural importance is paramount for future IF designs. For instance, a user would adapt the data collection plans based on the targets, environment, and sensors available. The targets of interest would also be culturally different (e.g., large cars would be found in open highways versus bikes in urban cities).

User situational understanding would be affected by the machine-processed information, individual differences in determining what operational developments are unfolding, and the known and unknown observations. An example is targets of interest, but also the *a priori* feature information used in the estimation process.

Finally, **organizational** cultural details of social-political relationships affect the strategic data use, display design for teams of operators, and the estimation results across networks. Strategic networks include the organization and mission assessment.

Issues surrounding Situation Understanding (SU) [1] are confounded by culture:

(1) Addressing the user in system management / control
(2) Assessing information quality of *a priori* statistics
(3) Evaluating Fusion systems to deliver user info needs,
(4) Organizational culture adopting large-scale IF designs
(5) Designing displays to support a user's mental model

The key for SU the user's *mental model* which is the world representation through aggregated data and the user's social, political, and military perception. This paper explores the importance of ***culture*** (i.e. attitudes and beliefs) for SU. The *motivation* for the work is to develop a way to utilize cultural knowledge in IF design and analysis (i.e. Bayes' rule) that would aid a variety of users. Section 2 discusses SA/User research and Section 3 details User refinement and instantiating models. Section 4 develops issues of cultural importance for Section 5 of fusion processing. Section 6 presents a deception example with discussions and conclusions in Section 7 and 8.

[1] Understanding includes user/machine situation assessment [1], situation awareness [21,22] , and situation analysis [43].

2 Background

The role of the user has shown to be important in IF design in Level 5 "user refinement". Since users are part of the system, they need to play an active role in planning collections, controlling sensors, and addressing anomalies. Historically, the user requires information to make timely, accurate, and robust decisions as exemplified by Boyd's Observe-Orient-Decide-Act (OODA) cycle. [1, 2]

The user's impact on the fusion design is categorized as high-level data fusion [3] as contrasted to low-level tracking and identification methods [4, 5]. Addressing the user roles for SU encompasses expert system rule extraction [6], decision-making constructs [7], and decision support [8]. The user must also address situational and threat analysis and prediction through support from such things as an "impact matrix" [9], cross-impact and synchronization matrices [10], conflicting data [11], and sensor allocation [12].

The user's roles have been employed in traditional areas of air-to-ground target tracking [13] and maritime awareness [3], object data aggregation for SA [14], as well as emerging areas of hard-soft fusion such as cyber [15, 16] and linguistic analysis [17].

2.1 Situation Understanding Models

SU is an important concept of how people become aware of and prioritize things happening in their environment (i.e. estimation and prediction of relations among entities). Designing complex and often-distributed decision support systems requires an understanding of both the fusion processes and the decision-making (DM) processes. Important aspects of fusion include timeliness, mitigation of uncertainty, and output quality.

The *recognition primed decision making* model [18] develops the user DM capability based on the current situation and past experience. The *Fusion Situation Awareness Model* [19] highlights user information needs for SA. Other SA models are available [1, 20, 21, 22]

SA has many meanings that could be conveyed from the user's perceptual needs as per spatial awareness, neurophysiological [23], perceptual [24], psychological [25], and cognitive aspects [26]. If the display/delivery of information is not consistent with the user expectations or unexpected situations occur which a machine cannot handle, implications call for (1) incorporating the user in the design process, (2) gathering user needs, and (3) providing the user with available control actions.

Ontological [27] and linguistic [28] issues such as semantics, efficacy, and spatio-temporal queries are important in developing a framework for user refinement (or *interface actions*) that allow the system to coordinate with the user. Such an example is a query system in which the user seeks answers to questions. The reason why the users will do better than a machine is that they are (1) able to reason about culture, (2) assess what are the likely behaviors, and (3) bring in contextual information to reason over the uncertainty.[29]

2.2 Cultural Assessment

One emerging area of cultural analysis is counterdeception [30]. Cultural analysis can be both of the user and the objects being monitored such as harbor security [31]. User's typically utilize experience of the sensors, targets, and environments to make decisions; however, recent applications include intelligent actors [32].

3 User Refinement

User refinement is typically addressed in decision-making through the OODA loop [2]. The OODA loop can be a machine, individual, or organization as well as nested OODA loops within actors or between actors.

3.1 Decision Making Cycle

Intelligent DM employs many knowledge-based information fusion (KBIF) strategies such as neural networks, fuzzy logic, Bayesian networks, evolutionary computing, and expert systems. [33] Each KBIF strategy has different processing durations. Furthermore, each strategy differs in the extent to which it is constrained by the facility with which the user-fusion system may employ it. OODA loops help model a DM user's planned, estimated, or predicted actions. Assessing susceptibilities and vulnerabilities to detected/ estimated/ predicted threat actions, in the context of planned actions, cultural implications, requires a concurrent timeliness assessment.

3.2 User Roles: Reactive, Proactive, Preventive

When tasked with an SA analysis, a user can respond in one of three manners:

- In a ***Reactive mode***, the user makes a rapid detection and minimizes damage or repeat offense. An IF system would gather information from a sensor grid detection of in-situ threats and is ready to act. In this model, the system interprets and alerts users to *immediate threats*.
- ***Proactive mode***, the user utilizes sensor data to anticipate, detect, and capture cultural information prior to an event. For *anticipated threats*, the user would want the predicted locations of the adversary and the range of possible actions.
- ***Preventive Mode***: captures the entire force over a period of time. For the *potential threats*, the user could utilize behavior analysis displays that piece together aggregated information of group affiliations, equipment stores, and previous events to predict actions over time.

Level 5 is intended to address the cognitive SU which includes knowledge representation and reasoning methods. The user defines a fusion system, for without a user, there is no need to provide fusion of multi-sensory data. The user has a defined role with objectives and missions.

Level	Role
0	Determines what and how much data *value* to collect

1 Determines the target *priority* and where to look
2 Understands scenario *context* and user role
3 Defines what is a threat and adversarial *intent*
4 Determines which sensors to deploy and activate
Assesses the *utility* of information
5 Designs user interface controls.

A user is forced to address situational cultural constraints. We define *user refinement* (UR) operations as a function of responsibilities. Once an IF design is ready, the user can act in a variety ways: *monitoring* a situation in an active or passive role or *planning* by either reacting to new data or proactive control over future course of actions. When a user interacts with an IF system, it is important to support knowledge reasoning.

Discovery [34], through culture assessment, is performed by inductive or abductive reasoning, where reasoned conclusions are stronger than the premises (evidence), and the hypothetical inferences produce knowledge. *Induction* is developed by observing a limited set of observations or events and establishing a more general/abstract belief about larger and future populations of instances. *Abduction* is the informal or pragmatic mode of reasoning to describe how we "reason to the best explanation". Evaluating multiple hypotheses for a given set of data, one can arrive at a solution or explanation. Exploratory abduction incorporates both inductive (hypothesis-creating) and deductive (hypothesis-testing) operations to seek alternative frames of discernment for a given set of observations such as deception assessment.

Applications for multisensor IF require insightful analysis of how these systems will be deployed and utilized. Increasingly complex, dynamically changing scenarios arise, requiring more intelligent and efficient reasoning strategies. Integral to information reasoning is cultural information which requires pragmatic knowledge representation for user interaction.[1]

3.3 DFIG Model

A useful model is one which represents a real world system instantiation. The IF community has rallied behind the *Data Fusion Information Group* (DFIG) process model (that replaces the JDL model) with its revisions and developments, shown in **Figure 2** [35]. Management functions are divided into sensor control, platform placement, and user selection to meet mission objectives. Level 2 (SA) includes tacit functions which are inferred from level 1 explicit representations of object assessment. Since the unobserved aspects of the SA cannot be processed by a computer, user knowledge and reasoning is necessary.

Current definitions, [36], include:

Level 0 – Data Assessment: estimation and prediction of signal/object observable states on the basis of pixel/signal level data association (e.g. information systems collections);

Level 1 – Object Assessment: estimation and prediction of entity states on the basis of data association, continuous state estimation and discrete state estimation (e.g. data processing);

Level 2 – Situation Assessment: estimation and prediction of relations among entities, to include force structure and force relations, communications, etc. (e.g. information processing);

Level 3 – Impact Assessment: estimation and prediction of effects on situations of planned or estimated actions by the participants; to include interactions between action plans of multiple players (e.g. assessing threat actions to planned actions and mission requirements, performance evaluation);

Level 4 – Process Refinement (an element of Resource Management): adaptive data acquisition and processing to support sensing objectives (e.g. sensor management and information systems dissemination, command/control).

Level 5 – User Refinement (an element of Knowledge Management): adaptive determination of who queries information and who has access to information (e.g. information operations) and adaptive data retrieved and displayed to support cognitive decision making and actions (e.g. human computer interface).

Level 6 – Mission Management (an element of Platform Management): adaptive determination of spatial-temporal control of assets (e.g. airspace operations) and route planning and goal determination to support team decision making and actions (e.g. theater operations) over social, economic, and political constraints.

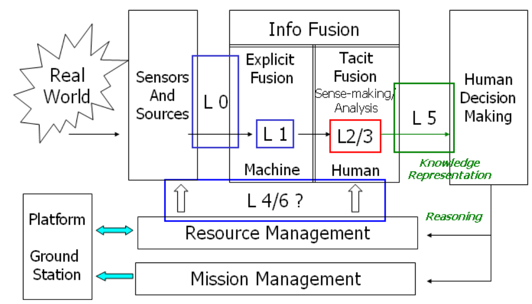

Figure 1. DFIG User-Fusion model [37].

3.4 OODA-TECK Models

In Figure 1, Bradford and Fitzhugh developed a Technology, Emotion, Culture, and Knowledge (TECK) model [37] within the OODA loop. Specifically the role of culture is developed between the decide and act phases. However, one can think of culture as embedded in the entire cycle, yet being represented or instantiated in the D-A process as the *a prior* cultural states are in the A-OB process, the user's culture in the O-O process and extended operational knowledge in the O-D process.

The OODA-TECK model incorporates many ideas that can be instantiated in information fusion models (i.e. the DFIG model). The OODA phases are: [38]

- *Decide*: User engages situational knowledge derived from orientation. The decision consists of evaluating the situational knowledge, projecting process ramifications, focusing on a chosen set of plans, and prioritizing the plans. The priority of the plans is developed through cultural implications, beliefs in the desired outcomes, and affects associated with the plans on society.
- *Act*: The user/organization engages in a process plan that utilizes environmental conditions. Transforming the abstract plan into instrumental behavior forces changes on the society for the environment. The change would be monitored by users with tasking sensors to collect information to asses tactical, operational, and strategic developments for social-political purposes.

- *Observe*: A user/organization interacts with the environment, typically by controlling sensors, querying information needs, and assimilating observations from a display. The subject transforms data into a situational awareness through reasoning biased by their beliefs, emotions, and cultural perspectives.
- *Orient*: A user or organization distills information from data to determine situational understanding through assessment of the environment to determine a coherent state of affairs. The information is integrated with knowledge to determine completeness, accuracy, and timeliness of a situation. From here, the cycle repeats itself.

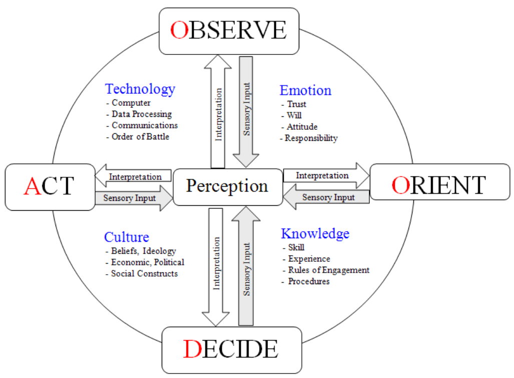

Figure 1. ODDA-TECK model.

From **Figure 1**, the role of culture is highlighted between the D-A phase; however, perception clearly allows for interpretation and sensory inputs for analysis to feed cultural information through to (1) *technology* by way of Level 1 "object refinement" and Level 2 "situational assessment" (SA) information estimation, (2) *emotion* through Level 5 "user refinement" and (3) Level 4 "process refinement" of knowledge weighting and course of action (COA) planning.

Organizations include individuals and teams which requires managing people, processes, and products. Industrial business management includes psychological, organizational, social, and economic effects on the fusion design (shown in **Figure 3**). Likewise IF is managing people, sensors, and cultural data. The ability to develop SA of the PMESII (political, military, economic, social, information, and infrastructure) environment would entail user reasoning about the data to infer information. The current priority control functions include: user, mission, and sensor management. For example, if sensors are deployed, then the highest ranking official coordinating a mission determines who gets control of the assets (which is not under automatic control). Once cultural treaties, air space, insurance policies, and other documentation is in place, the automatic controller (e.g. sensor), can be turned on.

4 Cultural Understanding

Cultural understanding developments of IF designs can be aided by other research fields such as psychology, anthropology, and sociology that affects the individual, organization, or machine processing. For purposes of this paper, we are interested in the definition of culture from both implementation and observation.

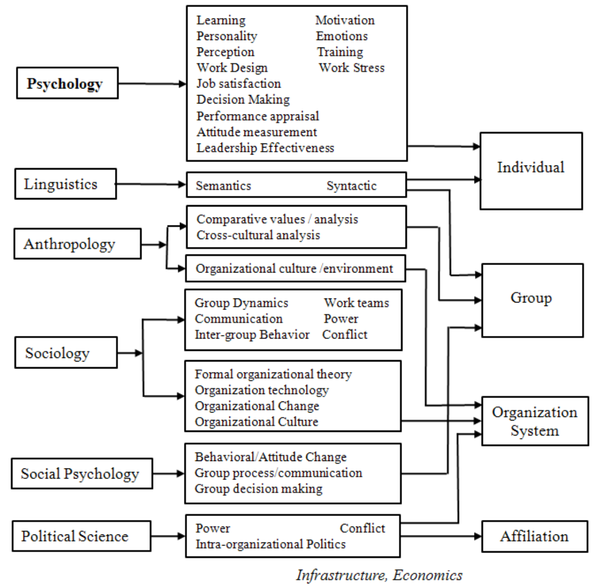

Figure 2. Human-Social Science Studies.

Culture is a feature of terrain that has been *constructed by man* [39] including roads, building, and canals, boundary lines as well internal thoughts and processes of man.. The more complete definitions of culture are usually found in nonmilitary writings. Merriam-Webster's Online Dictionary defines *culture* as:

a. the integrated pattern of human knowledge, belief, and behavior that depends upon man's capacity for learning / transmitting knowledge to generations
b. the customary beliefs, social forms, and material traits of a racial, religious, or social group
c. the set of shared attitudes, values, goals, and practices that characterizes a company or corporation.
d. the set of values, conventions, or social practices associated with a particular field, activity, or societal characteristic

Culture refers to social capital of the values, beliefs, attitudes, goals, habits, and preferred ways of behavior of a social group [38]. Culture primarily involves values, attitudes, beliefs, assumptions, preconceptions, goals, assumptions, and expectations which are displayed in some form of religion, behavior, and customs.

- *Values* are the social principles or standards held or accepted by an individual, class or society.
- *Attitudes* are the dispositions, opinions, or mental sets held by individuals or groups of people.
- *Belief* is the mental acceptance of something as true especially a doctrine, creed, or tenet.
- *Goals* are objects or ends that a person or group strives to obtain—an aim or aspiration.

These four cultural factors—values, attitudes, beliefs, and goals—are prevalent and common in most civilizations and cultures which determine what data collection is performed, by whom, and what analysis is done.

4.1 IF-Cultural Example

The use of cultural information for an IF system can directly affect data collection and output estimation. An example is information warfare (IW) [**40**] but could easily be seen in any game-theoretic or multi-actor decision system.

Information Warfare consists of six phases: [**41**]

- *Psychological operations*: Use of information to affect the opponent's reasoning
- *Military Deception*: Mislead opponent about capabilities and intentions
- *Electronic Warfare*: Deny accurate information to the opponent
- *Physical Destruction*: Affect information system elements through conversion of stored energy to destructive power.
- *Security measures*: Seek to keep opponent from learning about capabilities and intentions.
- *Information attack*: Directly corrupt information without visibly changing the physical entity on which it resides.

Of the six phases, there are three categories (1) actors, (2) sensors, and (3) information.

- *Actors:* Psychological Operations (PSYOP) [**42**] involve actions taken to change the perceptions and behavior of individuals. PSYOP requires an accurate understanding of the targeted audience, means of influence in terms of specific goals and objectives, and access to **cultural**, sociopolitical, and current-event/situation data. Information needs to be accurate, updated as close to real-time as possible, and culturally validated.
- *Sensors*: Implications for sensors systems results in **cultural** factors in collecting and disseminating the data. For example, if an organizational **culture** relies heavily on a certain sensor for data collection, then it becomes a point of operation. For example, GPS is used in a wide variety of sensors for registration accuracy. Affecting the registration of sensors would indeed affect IF by way of sensor alignment, data estimations, and sensor control.
- *Information*: attacks would also be cultural dependent on deception, denial, and destruction of systems that display, disseminate, and deploy information. An example is the cultural use of wireless systems.

As shown through the example of IW, cultural understanding can be used as a way to improve the focus of attention as well as be node for attack. The key is in the user perceptions which can be addressed from studies of psychology and sociology.

5 DM Fusion through TECK

The users have many roles that they can play in gathering, controlling, filtering and assessing data. They can be passive in monitoring the display or active in altering the display information (i.e. change weights). The user can interpret the data based on context and be proactive to collect date to confirm hypothesis or rule out anomalies. Additionally, it would be good to mathematically model emotion as a parameter, that could be sensed from bio-feedback, but it would be hard to measure its validity.

Bayes' rule offers a way to interpret information in a sequential way by accumulating evidence $P(Y|X)$ (likelihood) of events relating to the outcome

$$P(Y|X)\,P(X) = P(X|Y)\,P(Y) \qquad (1)$$

where $P(X)$ is the diagnosis (cause), $P(Y)$ the effect (symptoms), and $P(X|Y)$ is the prediction back in time.

Using Bayes' Rule:

$$P(X|Y) = \frac{P(Y \mid X)\,P(X)}{P(Y \mid X)\,P(X) + P(Y \mid \neg X)\,P(\neg X)}$$

Many contextual factors can lead to an understanding of cultural issues through a cause and effect relation. The key is to expedite decision making through the use of contextual/cultural information and or enhanced cultural understanding. For instance, we can look at the cultural effects within the OODA loop as it affects knowledge for decision making. The Bayesian instantiation would occur at each phase by utilizing the calculations/ processing within each loop. For instance:

D-A: Platform routing and system management

A-OB: Sensor exploitation algorithms to determine the probability of detection

OB-OR: Users emotion, bias, and weighting of evidence

OR-D: Incorporation of context and terrain information in targeting

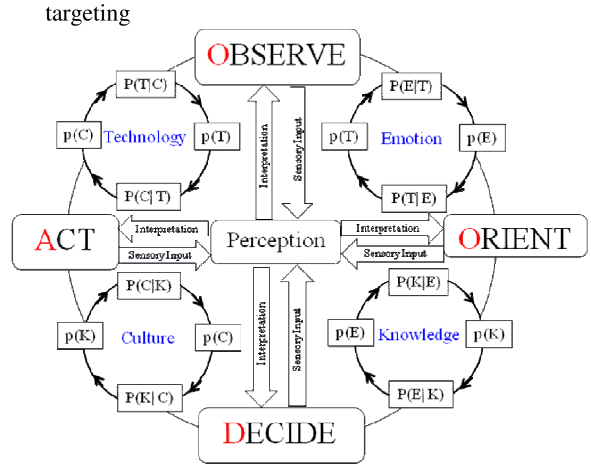

Figure 3. Actor-Subject Relations in PSYOPS.

If we let technology, T, be the IF system, then the probability of technology understanding is affected by the user's emotions and cultural bias $P(T \mid E, C)$ which can be determined from

$$P(T \mid E, C) = \frac{P(C \mid T, E)\,P(E \mid T)\,P(T)}{P(C \mid E)\,P(E)} \qquad (2)$$

which is a function of the a prior capability of the fusion system to provide answers $P(T)$, the user's use of the technology $P(E \mid T)$, and cultural issues surrounding the organization's operational use of the technology and individual emotions $P(C \mid T, E)$. Furthermore, the result is normalized by the user's emotional attitude $P(E)$ and their role within the cultural organization $P(C|E)$. Note that the *a priori* assessment of the users could be their tendencies to conservative or risk-taking/aggressive behavior. Users could view the technology results as pessimistic or optimistic about the display.

The important development of cultural implications resides in decision making (as planning for action would require plan assessment over the implications of actions). To determine the knowledge gained (for effective decision-making) we need to look for $P(K \mid T, E, C)$ which is the knowledge of the IF system over the *machine* (T), *user* (E), and *organization* (C). All are included in the assessment of feasible alternatives.

Since we are interested in how culture affects system performance, two possible ways to address system analysis include (a) culture affects (or influences) knowledge decisions based a user's emotions $P(C \mid E)$ and (b) the cultural effect (or casual result) of the organization given the people and equipment $P(C \mid T, E)$. To determine the cultural influences for the system, we could use a likelihood ratio test to determine affects and effects of cultural changes.

For **cultural affects** on an IF system, we can solve for different user's influence on the process (whether they interact well with the IF technology solution) :

$$P(K \mid T, E, C) = \frac{P(T \mid E, C)\, P(C \mid E)\, P(E)}{P(TECK)} \quad (3)$$

$$P(C \mid E) = \frac{P(TECK)\, P(K \mid T, E, C)}{P(T \mid E, C)\, P(E)} \quad (4)$$

The discussion is confounded with the system and would require testing in a work domain setting. However, using a cognitive work assessment (CWA)[43], evaluation could be completed for the user and the technology:

$$P(T \mid E, C) = \frac{P(C \mid T, E)\, P(E \mid T)\, P(T)}{P(C \mid E)\, P(E)} \quad (5)$$

where the user's role in the organization $P(C \mid E)$ and emotions $P(E)$ could be determined from the work environment. The IF capability would also be fixed for a given scenario.

For **cultural effects** of a IF system we can just invert the analysis and assess a different likelihood value.

$$P(K \mid T, E, C) = \frac{P(C \mid T, E)\, P(E \mid T)\, P(T)}{P(TECK)} \quad (6)$$

$$P(C \mid T, E) = \frac{P(K \mid T, E, C)\, \mathrm{P}(TECK)}{P(E \mid T)\, P(T)} \quad (7)$$

The distinction between culture influences (affects) and results (effects) can be understood from a scenario.

6 Cultural Example

The cultural example involves an actor (user) who wishes to accumulate evidence on the behavior of a subject (object). The standard approach might be to conduct object assessment through sensor exploitation using belief filters, finite-set statistics, or DSmT methods for tracking and identifying the person. However, tracking objects with intelligent users requires careful assessment of cultural knowledge. A subject contains behaviors and reasoning to explicitly minimize their signature through appearance changes (camouflage), detection avoidance (concealment), and induce deception techniques. The last is the concern as deception techniques come from cultural influences and knowledge about tactics, behaviors, and procedures that the subject uses to deceive.

Culture also includes the user's bias. The user utilizes machines to aggregate information for decision-making. However, the machine is trained to detection and ID known things, not the unknown or cases of deception. The user must reason over cultural knowledge to determine if the machine instances are correct.

The distinction between the actor and the subject being observed creates a scenario of bilateral cultural assessment. **Figure 5** shows the case where the actor observes the subject for normal detection. If there is no action (open) then the user expects no information. Two cultural cases have to be explored (a) subject is there but evades or conceals detection and (b) the subject creates deception that causes the actor to question the results (e.g. false alarm of detections of others, instrumentation attack by spoofing, or anomalies in cultural norms).

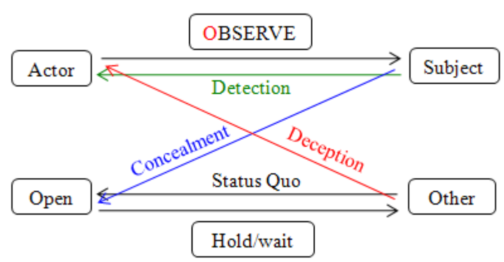

Figure 4. Actor-Subject Relations in PSYOPS.

6.1 Cultural Scenario

To simulate the ideas in an example, we utilize the OODA-TECK model for Bayesian analysis. Since the process is cyclic, *a priori* information has been collected over time. For the simulation, the processing begins with the IF processing from the machine. Assuming that the data collected is equivalent between the distinction between the person identity (1) and the incorrect person identity (0) each is equivalent p = [0.5 0.5]. After analysis, the likelihood of the analysis determines the regions of the correct analysis as well as the regions of error. The choice of depiction of the results is two-fold, to show the correct regions typical of analysis $P(1|1) + P(0|0)$ and then separate errors from ***deception*** $P(1|0)$ and ***concealment***

P(0|1). Cultural differences are required to solve the problem for situational understanding. For concealment, the user must query other information sources to ascertain the location and ID of the subject (Technology). For deception, the user must address the ideological implications of the subject (Culture). Together the user must address the emotional issues associated with finding, requiring, and searching for the subject. From Figure 5, deception is $P(R1|S0)$ – for receive 1 but sent nothing – and concealment is:

$$P(S1|R0) = \frac{P(R0 \mid S1)\, P(S1)}{P(R0 \mid S1)\, P(S1) + P(R0 \mid S0)\, P(S0)}$$

6.2 Case 1: Accumulating Evidence

A cycle repeats itself with the evidence supporting the cultural analysis of a person's actions. Since technology is ***working properly*** (i.e. detecting a subject in the open), $P(1|1)$, the evidence supports the known location of the subject and their actions – large blue area in Figure 6.

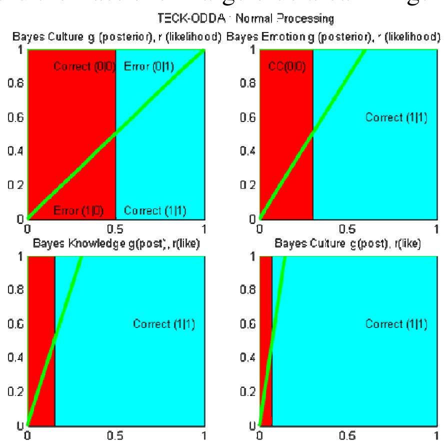

Figure 5. Accumulating Evidence.

6.3 Case 2: Deception (i.e. PSYOPS)

In this case, the actor being detected is sending ***cultural deceptive responses*** (magenta block). The user must investigate, scrutinize, probe, inspect the deception and act, refrain, abstain from the information. If ***no action*** is taken, the accumulated evidence errs on the side of the subject location and identification (the red area below the green likelihood line in Figure 7).

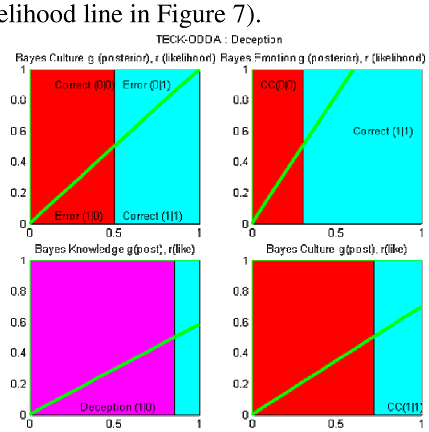

Figure 6. Deception.

6.4 Case 3: Deception with Cultural Assessment

In this case, the ***cultural information discounts the deceptive signals*** (magenta block). The ***user*** utilizes its own organizational cultural knowledge, constrained emotions relative to the risk, and the anomaly associated with the behaviors that are culturally inconsistent. The information in this OODA cycle is discounted, preserving the knowledge assessment for decision-making (again the large blue area to the right in Figure 8).

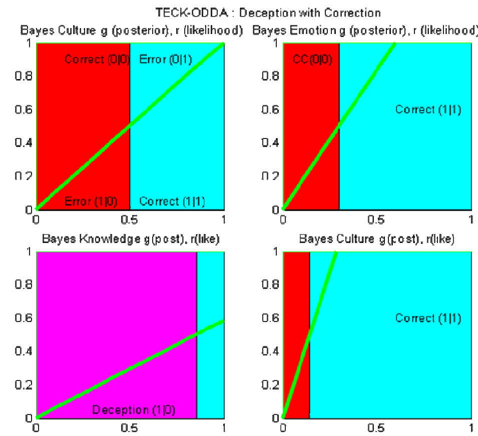

Figure 7. Deception with Correction.

From the plots in Figures 6-8, it is easy to see the impact of "culture" by the ***user's recognition of deception***.

7 Implications for Command/ Control

The paper's purpose is to demonstrate the importance of "cultural awareness" in IF processing. Techniques associated with game theory, dynamic programming, and learning include multi-player games. These techniques characterize a known set of behaviors (e.g. winning a chess game); however, real-world SU of targeting requires *cultural acknowledgement* related to the organization deploying the sensors, the user exploiting the data, and the target's varying cultural features. Together, emotions and deception can lead to erroneous (false alarms) from which traditional methods require user involvement. Implementation of this method requires (1) fusion reasoning over data, (2) user control to adapt to changing conditions, and (3) enhanced processing for timeliness.

Situational understanding requires more than data overlay, historical data regression, and context. Utilizing techniques of IF in SA can reduce false alarms, maintain track histories, and incorporate context such as terrain information. Nyquist *sampling* based on the behavioral operating conditions of variations in sensors, objects, and the environment is needed to detect *impact cues* of the emerging situations.

Interactive control from the user can include pointing sensors, extracting portions of the data (pulling out a section of the image simultaneously with other users), and combing various perspectives for enhanced understanding.

The user would like mechanisms of IF to mine, filter, and predict data for salient cueing of future threats.

Technical advances afford faster data delivery, higher throughput, and low-cost solutions to complement cultural decision-making. Cultural DM requires: (1) SU, (2) dynamic responsiveness to changing conditions, and (3) evaluation to meet throughput and latency requirements. These factors afford sensor management replanning.[44] To afford interactions between future IF designs and users' *information needs*, metrics are required. The metrics chosen include timeliness, accuracy, throughput, confidence, and cost, [45], which are culturally sensitive.

Table 1: Metrics for various Disciplines [45].

COMM	User	Info Fusion	ATR/ID	TRACK
Delay	Reaction Time	**Timeliness**	Acquisition /Run Time	Update Rate
Probability of Error	Confidence	**Confidence**	Prob. (Hit), Prob. (FA)	Prob. of Detection
Delay Variation	Attention	**Accuracy**	Positional Accuracy	Covariance
Throughput	Workload	**Throughput**	No. Images	No. Targets
Cost	Cost	**Cost**	No. platforms	No. Assets

8 Summary

The purpose of this paper was to provide some insight into user *cultural issues* for user refinement and situational understanding. The DFIG requires user needs presentation to support effective and efficient proactive decision making. This paper discussed important cultural issues for (1) establishing *a priori* cultural data for machine processing, (2) involving user refinement over abductive cultural reasoning, and (3) addressing organizational planning over cultural analysis impacts of actions.

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