HUMAN COMPUTER INTERACTION (HCI) FOR ALERT WARNING AND ATTENTION ALLOCATION SYSTEMS OF THE MULTI-MODAL WATCHSTATION (MMWS)

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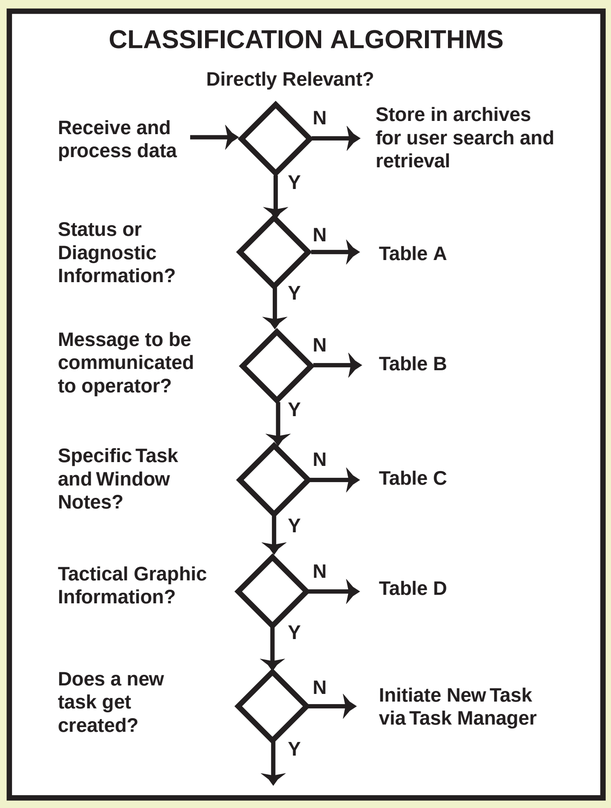
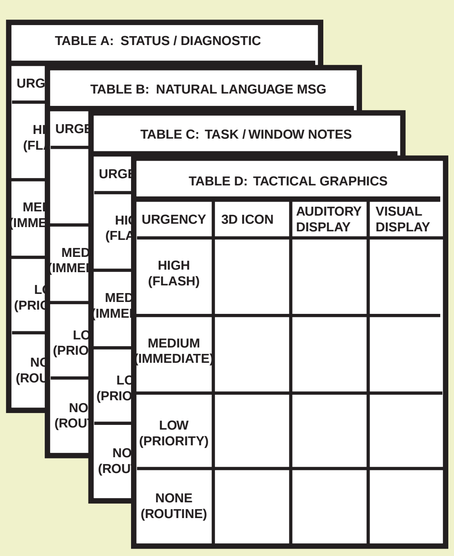


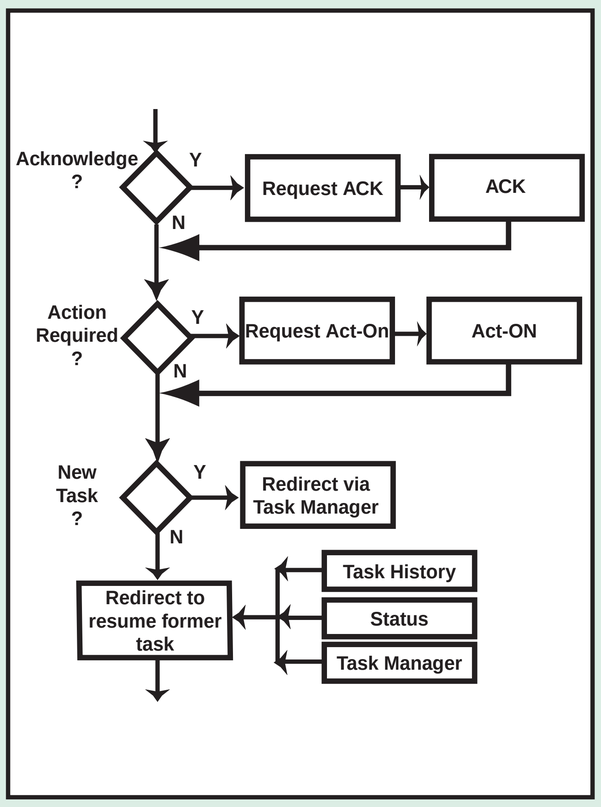
FOUR LEVELS OF URGENCY

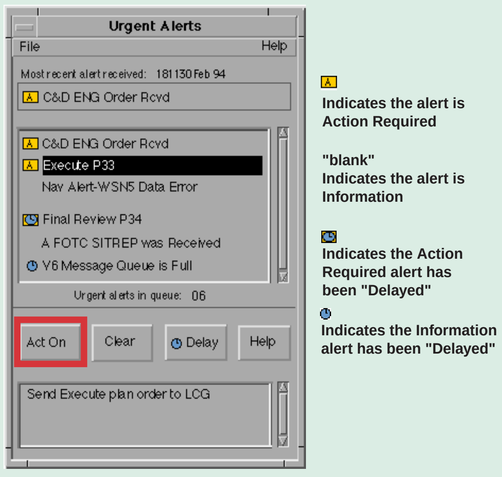
- **High (flash)**: an emergency requiring instantantaneous response;
- **Medium (priority)**: interruption of on-going tasks required;
- **Low (immediate)**: information needed, but do not interrupt initially;
- **None (routine)**: there is no immediate need for the info.



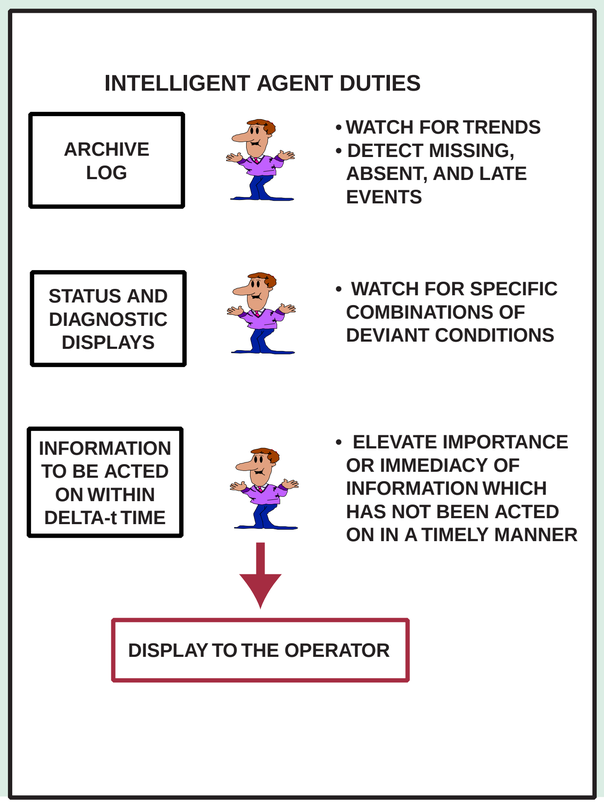
AFTER CAPTURING ATTENTION

After capturing the operator's attention and presenting a message, the system must direct the operator to appropriate information or procedures for responding to the message and then may prompt the operator to begin a new task or the original task.
Note that an alarm or alert is an interruption by definition, and the operator may be prone to error upon returning to the original task.





Where there is action to be taken as a result of a message, the operator should be led to the place where proper action can take place (e.g., the system automatically opens the appropriate response window).



The design of an effective alert/warning and attention management system also includes provisions for intelligent agents to perform helpful activities, thereby unburdening the operator.

In particular, while busy with other tasks, the operator may not notice missing, absent, or late events.

Note that a potential by-product of intelligent agents is the production of additional messages that may interrupt on-going tasks being performed by the operator.

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ABSTRACT

The terms "alert", "warning", and "alarm" are often used interchangeably for systems that (1) involve attention-getting and (2) present information about significant, abnormal, or threatening situations. This poster session addresses both design situations.

PROBLEMS WITH CURRENT DESIGNS

- Alarms may startle, or conversely, go unnoticed;
- False alarms may create a "cry-wolf" effect and thus may be turned off or not listened to;
- Visual and/or auditory alerting mechanisms can be annoying;
- Tactical console operators are often bombarded with too many alerts;
- Multiple alarms and alerts may occur simultaneously;
- Often there are more alerting sounds than can be learned and retained, thus tactical console operators cannot discriminate between them;
- Synthesized or natural speech alarms may not be distinguishable from standard communications;
- The visual information channel can be heavily loaded; and,
- Capturing attention via an alerting mechanism is an interruption and thus may induce errors.

DESIGNING FOR THE 21ST CENTURY

A Multi-Modal Watchstation (MMWS) is being developed for the future land-attack destroyer (DD21) shipbuilding effort. The MMWS features include:

- **Visual**: multiple flat panels, head-worn displays, mobile or seated solutions;
- **Voice**: voice input and synthesized voice output, natural language, 3D audio;
- **Manual**: pointing pen, gesture;
- **Models**: audio management, task management, intelligent aiding, embedded, performance monitoring, alertness monitoring;
- **Other**: virtual functions, collaboration tools.

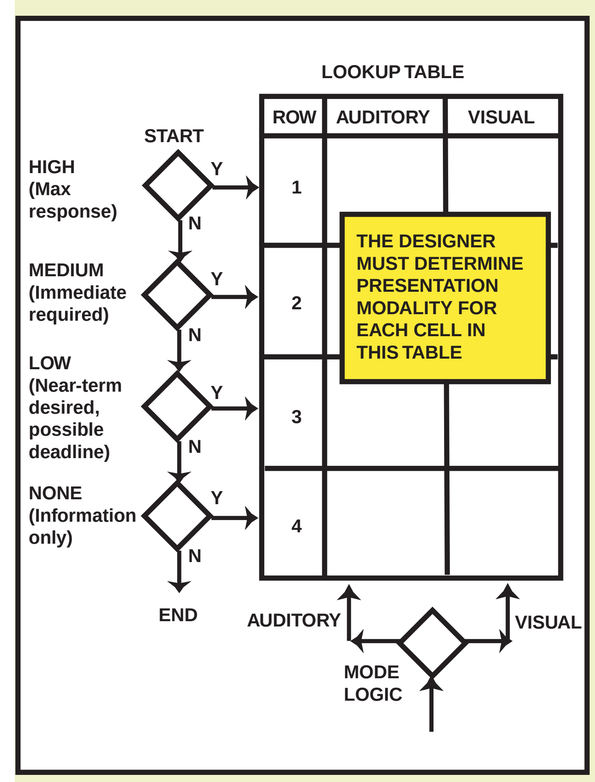
A designer's guide and a literature review have been developed to support design of alert warning and attention management for the MMWS; the initial prototype is being developed at Space and Naval Warfare Systems Center, San Diego.

TO RECEIVE LITERATURE REVIEW AND DESIGN GUIDE DOCUMENTS IN ADOBE ACROBAT (.PDF) FORMAT, LEAVE EMAIL ADDRESS

THE DESIGNER'S TASK

FIVE MESSAGE TYPES:

- **Status or Diagnostic Information**: frequent messages that equipment is up or down;
- **Language Messages**: text or speech messages;
- **Task and Window Notes**: info needed only when doing a specific task;
- **Tactical Graphic Information**: information presented graphically on a map (e.g., range rings);
- **Create New Task**: message resulting in the creation of a new task (via Task Manager).



PRODUCE A SET OF LOOK-UP TABLES FOR EACH MESSAGE TYPE AND URGENCY

Consequently, the designer's task is to develop a set of look-up tables which define the manner in which alerts are presented for each message type and urgency. This involves making choices between visual and auditory (and possibly haptic) modes, and if auditory, consideration of 3D localization.

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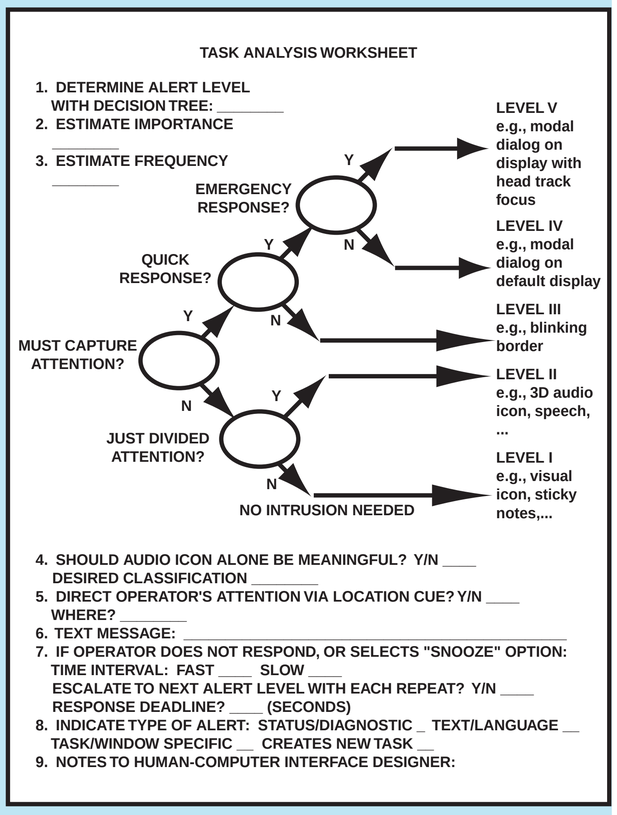
LEVELS OF URGENCY TRANSLATED INTO LEVELS OF ATTENTION CAPTURE/DISRUPTION

In terms of the degree of attention capture, the four levels of urgency may be translated as:

- **High Urgency = Emergency**: design for maximum and unequivocal attention capture;
- **Medium Urgency = Interrupt and require immediate action**: design for shift of focused attention (while attempting to maintain an acceptable annoyance level;
- **Low Urgency = Minimal disruption**: design for divided attention and assume the task will permit attending to the information in a timely fashion (must elevate to next level of urgency if deadline is exceeded);
- **No Urgency = No disruption**: design for selective attention so information can be easily found when the operator wants it.

TASK ANALYSIS IS NEEDED TO PROVIDE INFORMATION FOR ALERT SYSTEM DESIGN

The figure on the right shows an example worksheet which may be modified for specific applications. The decision tree focuses analysis on the degree of disruption which is appropriate for each alert message.



THE LITERATURE REVIEW AND DESIGN GUIDE DOCUMENTS PROVIDE AVAILABLE INFORMATION FOR THE DESIGN OF THE ALERT MESSAGE SYSTEM

DESIGN GOAL	AUDITORY		VISUAL	HAPTIC
	ICONS	SPEECH		
MAX. ATTENTION CAPTURE	YES	YES	YES	TBD
FOCUSED ATTENTION CAPTURE	YES	YES	YES	TBD
MODERATE DISRUPTION, DIVIDED ATTENTION	YES	YES	YES	TBD
NO URGENCY (ROUTINE)	CONVENTIONAL HCI DESIGN			

DESIGN GUIDELINES

SELECTED GENERAL SYSTEM GUIDELINES (partial list)

- Filter-out inappropriate messages;
- Vary presentation depending on the urgency;
- Consider use of 3D auditory icons to gain attention, identify category, and cue where to look;
- Support "pre-attentive" processing by providing priority/category in aural alerts;
- Ensure that the performance penalty for the interruption does not exceed the value of the info;
- Redirect the operator's attention through responding and returning to the original task;
- Inhibit lower priority alerts during time-critical situations;
- Attempt to design the human-computer interface to be "interrupt-resistant."
- Permit the operator to have a degree of control over task interruptions.

SPECIFIC GUIDELINES

For specific guidelines, submit request. Leave email address (business card, or enter on tablet). Documents will be emailed in Adobe Acrobat (.pdf) format.

RESEARCH NEEDS

- The designer will not find all of the information needed to design the human-computer interface;
- One option is to conduct ad hoc empirical studies;
- Additional research needed:
  - Effects on selective, focused, and divided attention;
  - Ranking attention-capturing capability;
  - Use of intelligent agents;
  - Interrupt-resistant HCI;
  - General-purpose rapid prototyping and performance measurement tools.

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