

# Auditory Displays

DEA 3250/6510

## Auditory Displays

- Auditory information displays are commonplace in daily life:
  - The speech we generate and hear.
  - The radios/music we listen to.
  - The TV's we watch, etc.
  - Alarm clocks, bells
  - Phone rings
  - Sirens, horns

## Auditory vs. Visual Displays

- When the origin of a signal itself is a sound.
- When the message is short.
- When the message need not be referred to at a later date.
- When the message deals with events in the time, e.g. cassette player in a museum to guide you through.
- When the message calls for immediate action, e.g. starter gun at a race.
- When the visual system is on overload, e.g. a pilot with a warning sounds from instruments.
- When illumination limits vision.
- When the position of the receiver varies.
- When a verbal response is required.

## General Principles

- **Compatibility** - Make use of pre-existing stimulus-response relationships which may be natural, learned, or population stereotypes.
  - **Orienting reflex** - is a basic reflex to turn to the source of a sound (stimulus), e.g. If you want an auditory sound as a warning for a pilot, don't put the speaker behind the person!
  - **Learned** - Examples are sirens which are learned to be associated with an emergency; higher frequency = high value like a tea kettle whistle.

## General Principles

- Approximation - Complex messages should be presented in two stage signals:
  - Attention Demanding Signal - to capture attention.
  - Designation Signal - with precise message information.

## General Principles

- Dissociability - Auditory signal must be discernible from other noise, especially multiple auditory signals, e.g. when several phones ring in an office it's difficult to tell which is ringing.

## General Principles

- Parsimony - Messages should be as short as possible.

## General Principles

- Invariance - Same signal or message should designate the same information in all situations to avoid confusion like that between "priority" and "emergency" information.

## Auditory Presentation

- Avoid extreme auditory dimensions - if sound is too loud or there will be a "startle response".
- Signal/noise ratio - establish intensity relative to ambient noise levels to avoid masking.
- Variable Signal - an interrupted or variable signal works best to attract attention by minimizing perceptual adaptation to monotonous and increasing the detectability of the signal, e.g. Beep! Beep! Beep! is better than "Beeeeeeep"!
- Don't overload the auditory channel - you need to know something about the situation and consider the effect of the auditory information on the whole system.

## Auditory Warnings

- **Warning Signals** - Auditory displays are especially useful for signaling alarms partially because noise will go around corners. "Yeows" and "Beeps" get a faster response time.

## Effective Auditory Displays

- Use frequencies between 200 - 5 KHz. Preferred range is between 500 and 3 KHz the most sensitive range for hearing.
- Use frequencies below 1000 Hz when the signal has to travel more than 1000 feet.
- Use frequencies below 500 Hz when the signal has to pass through partitions or "bend around" obstacles.
- Use modulated signal (1-8 beeps/ sec, warble 1-3/sec)

## Effective Auditory Displays

- Use signals with frequencies different from background noise to avoid masking.
- For choice situations, use moderate intensity easily discriminable frequency or amplitude signals (but not too many).
- Where possible use separate auditory warning system, which is different from other auditory signals.