

## Tradeoff Scenarios (Varying Characteristics)

### 1.) Amount of time spent looking out-the-window/Difficulty of approach/landing

#### Relationship:

- a.) When the desirability of Amount of time spent looking out-the-window *increases*, the desirability of Difficulty of approach/landing *increases* or *decreases*
- b.) When the desirability of Amount of time spent looking out-the-window *decreases*, the desirability of Difficulty of approach/landing *increases* or *decreases*
- c.) When the desirability of Difficulty of approach/landing *increases*, the desirability of Amount of time spent looking out the window *increases* or *decreases*
- d.) When the desirability of Difficulty of approach/landing *decreases*, the desirability of Amount of time spent looking out the window *increases* or *decreases*

Classification: Unstable

#### Explanation of Scenarios:

- a.) Direct Relationship (Tradeoff Possible): If the terrain surrounding the destination airport is not difficult to navigate and the weather is desirable, the PF may be able to spend more time looking out-the-window. However, if the pilot devotes too much head up time, and does not pay attention to his instruments and/or the SVS display, the approach/landing may become more difficult.
- b.) Direct Relationship (Tradeoff Possible): If the PF spends less time viewing the terrain out the window, he/she will have more time to view the SVS and other instruments. This may be especially helpful in poor weather conditions, because the SVS provides an uninterrupted view of terrain. This would make the desirability of the Difficulty of the approach/landing increase. However, looking out-the-window can be used to quickly check the accuracy of the SVS. In this situation, if the PF does not spend any head up time, the desirability of the Difficulty of the approach/landing may decrease (become more difficult).
- c.) Direct Relationship (Tradeoff Possible): If the approach/landing is relatively easy to navigate either because of terrain or weather conditions, then the pilot can spend more time looking out the window, and less time viewing the SVS display. However, since the SVS display may eventually replace the out-the-window view altogether, it may be desirable to have the PF looking primarily at the SVS display during the approach/landing, even if this approach/landing is relatively simple.
- d.) Direct Relationship (Tradeoff Possible): This type of relationship is not easy to imagine. Presumably, if the approach/landing is very difficulty (because of terrain or weather) it would be desirable to have the pilot spend more time viewing the SVS display and less time looking out the window. However, it

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may be somewhat useful for the PF to quickly check the accuracy of the SVS display of terrain by looking out the window, even in difficult approaches.

- 2.) Amount of time spent viewing the SVS display/Amount of time spent looking out-the-window

## Relationship:

- a.) When the desirability of Amount of time spent viewing the SVS display *increases*, the desirability of Amount of time spent looking out-the-window *decreases*
- b.) When the desirability of Amount of time spent viewing the SVS display *decreases*, the desirability of Amount of time spent looking out the window *increases* or *decreases*
- c.) When the desirability of Amount of time spent looking out-the-window *increases*, the desirability of Amount of time spent viewing the SVS display *decreases*
- d.) When the desirability of Amount of time spent looking out-the-window *decreases*, the desirability of Amount of time spent viewing the SVS display *increases* or *decreases*

Classification: Unstable

## Explanation of Scenarios:

- a.) Tradeoff: If a pilot is spending a large amount of time viewing the SVS display, he/she is necessarily spending less time looking out-the-window. This is most likely a desirable situation, since the SVS display should be able to fully support the pilot through all phases of flight.
  - b.) Direct Relationship (Tradeoff Possible): If it is undesirable for the PF to spend a lot of time viewing the SVS display, then he/she can spend more time looking out-the-window. This may be a situation that is not normally desirable. However, the pilot can also spend time looking at instruments other than the SVS, and his/her time spent looking out-the-window and looking at the SVS display will decrease.
  - c.) Tradeoff: If the PF spends a great deal of time looking out the window, then time spent viewing the SVS display will decrease
  - d.) Direct Relationship (Tradeoff Possible): If the PF spends less time looking out-the-window, then it is possible to spend more time viewing the SVS display. However, the PF may also view instruments unrelated to the SVS and time spent looking out-the-window and time spent viewing the SVS display would both decrease.
- 3.) Amount of time spent reading instruments other than the SVS/Amount of time spent looking out-the-window

## Relationship:

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- a.) When the desirability of Amount of time spent reading instruments other than the SVS *increases*, the desirability of Amount of time spent looking out-the-window *decreases*
- b.) When the desirability of Amount of time spent reading instruments other than the SVS *decreases*, the desirability of Amount of time spent looking out-the-window *increases* or *decreases*
- c.) When the desirability of Amount of time spent looking out-the-window *increases*, the desirability of Amount of time spent reading instruments other than the SVS *decreases*
- d.) When the desirability of Amount of time spent looking out-the-window *decreases*, the desirability of Amount of time spent reading instruments other than the SVS *increases* or *decreases*

Classification: Unstable

**Explanation of Scenarios:**

- a.) Tradeoff: When the PF spends more time viewing instruments unrelated to the SVS, less head up time can be spent viewing terrain.
  - b.) Direct Relationship (Tradeoff Possible): When it is less desirable for the PF to view instruments other than the SVS, more time can be spent looking out-the-window. However, more time can also be spent viewing the SVS display, which would decrease the amount of time spent looking out-the-window.
  - c.) Tradeoff: If it is desirable to have to PF spend time looking out-the-window, less head down time can be spent viewing other instruments in the cockpit.
  - d.) Direct Relationship (Tradeoff Possible): If it is undesirable to have the pilot looking out-the-window, more time can be spent viewing instruments other than the SVS. However, if this additional time is spent viewing the SVS display, less time will be spent viewing instruments other than the SVS.
- 4.) Current level of SA/Amount of time spent looking out-the-window

**Relationship:**

- a.) When the desirability of Current level of SA *increases*, the desirability of Amount of time spent looking out-the-window *increases* or *decreases*
- b.) When the desirability of Current level of SA *decreases*, the desirability of Amount of time spent looking out-the-window *increases* or *decreases*
- c.) When the desirability of Amount of time spent looking-out-window *increases*, the desirability of Current level of SA *increases* or *decreases*
- d.) When the desirability of Amount of time spent looking out-the-window *decreases*, the desirability of Current level of SA *increases* or *decreases*

Classification: Unstable

**Explanation of Scenarios:**

- a.) Direct Relationship (Tradeoff Possible): Situation awareness may become higher because the pilot is spending time looking out-the-window (in desirable

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weather conditions with relatively flat terrain). However, situation awareness may become higher in other situations (such as in poor weather conditions) when the PF is spending less time looking out-the-window (and more time viewing the SVS display).

- b.) Direct Relationship (Tradeoff Possible): If the pilot's current level of SA is low, he/she may spend more time looking out-the-window at the terrain environment in order to try and regain SA. However, he/she may also spend more time looking at the SVS and other instruments (and not out-the-window) in order to try and regain SA.
  - c.) Direct Relationship (Tradeoff Possible): If the PF is spending a great deal of time looking out-the-window, SA may be higher in good weather conditions with flat terrain. However, this may also result in decreased situation awareness if it decreases the amount of time the PF spends viewing the SVS display (in poor weather conditions with complex terrain).
  - d.) Direct Relationship (Tradeoff Possible): When the PF spends less time looking out-the-window, and more time looking at the SVS display, SA will most likely increase. However, there may be some situations in which decreasing time spent looking out-the-window will decrease SA. For example, when there is an inaccuracy in the terrain database, or when hardware/software is otherwise not functioning properly.
- 5.) Level of mental workload/Amount of time spent looking out-the-window

## Relationship:

- a.) When the desirability of Level of mental workload *increases*, the desirability of Amount of time spent looking out-the-window *increases* or *decreases*
- b.) When the desirability of Level of mental workload *decreases*, the desirability of Amount of time spent looking out-the-window *increases* or *decreases*
- c.) When the desirability of Amount of time spent looking out-the-window *increases*, the desirability of Level of mental workload *increases* or *decreases*
- d.) When the desirability of Amount of time spent looking out-the-window *decreases*, the desirability of Level of mental workload *increases* or *decreases*

Classification: Unstable

## Explanation of Scenarios:

- a.) Direct Relationship (Tradeoff Possible): When the desirability of Level of mental workload decreases (mental workload is low) the PF may be able to focus more of their attention on the out-the-window scene. However, the PF may also be able to focus more on the SVS or other displays in this situation.
- b.) Direct Relationship (Tradeoff Possible): When the pilots level of mental workload increases, their time spent looking out-the-window will either

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increase or decrease. If mental workload is high (during landing, for example) the pilot may spend more time making sure the aircraft is at the right altitude/speed and less time looking out-the-window. However, in other phases of flight, the pilot may spend more time looking out-the-window in order to check the accuracy of the SVS display to make certain that an warning from the display is accurate.

- c.) Direct Relationship (Tradeoff Possible): When the PF is spending a great deal of time looking out the window, he/she may have a low level of mental workload if weather conditions are good and the terrain is relatively easy to navigate, or a high level of mental workload because they are not focusing on important information on the SVS display (in poor weather conditions, for example) or from other instruments.
  - d.) Direct Relationship (Tradeoff Possible): If little time is spent looking out-the-window, the pilots level of mental workload may be low because they are instead viewing the SVS display (in poor weather conditions, for example), or high because they are viewing an inaccurate, or improperly aligned display.
- 6.) Amount of time spent reading instruments other than the SVS/Difficulty of approach/landing

## Relationship:

- a.) When the desirability of Amount of time spent reading instruments other than the SVS *increases*, the desirability of Difficulty of approach/landing *increases* or *decreases*
- b.) When the desirability of Amount of time spent reading instruments other than the SVS *decreases*, the desirability of Difficulty of approach/landing *increases* or *decreases*
- c.) When the desirability of Difficulty of approach/landing *increases*, the desirability of Amount of time spent reading instruments other than the SVS *increases* or *decreases*
- d.) When the desirability of Difficulty of approach/landing *decreases*, the desirability of Amount of time spent reading instruments other than the SVS *increases* or *decreases*

Classification: Unstable

## Explanation of Scenarios:

- a.) Direct Relationship (Tradeoff Possible): If the PF is paying sufficient attention to instruments other than the SVS, the approach/landing may become more difficult because they are paying less attention to the SVS display or less difficult because these instruments are providing information pertinent to the current phase of flight.
- b.) Direct Relationship (Tradeoff Possible): If the PF is paying little attention to instruments other than the SVS, the difficulty of approach/landing may increase because they pilot is not focusing attention on important information.

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However, the difficulty of the approach/landing may decrease because the pilot can spend more time viewing the SVS display.

- c.) Direct Relationship (Tradeoff Possible): When the approach/landing is relatively simple, the pilot has the option of focusing attention on the SVS or on other instruments. Where the pilot focuses his/her attention has fewer consequences in this situation.
  - d.) Direct Relationship: If the approach is extremely difficult, because of weather conditions, terrain, pilot fatigue, etc. it may be essential for the pilot to spend time reading instruments pertinent to that phase of flight. However, in bad weather conditions especially, it may be more important for the pilot to focus on the SVS display which provides a clear view of terrain.
- 7.) Amount of time spent viewing the SVS display/Difficulty of approach/landing

## Relationship:

- a.) When the desirability of Amount of time spent viewing the SVS display *increases*, the desirability of Difficulty of approach/landing *increases* or *decreases*
- b.) When the desirability of Amount of time spent viewing the SVS display *decreases*, the desirability of Difficulty of approach/landing *increases* or *decreases*
- c.) When the desirability of Difficulty of approach/landing *increases*, the desirability of Amount of time spent viewing the SVS display *increases* or *decreases*
- d.) When the desirability of Difficulty of approach/landing *decreases*, the desirability of Amount of time spent viewing the SVS display *increases* or *decreases*

Classification: Unstable

## Explanation of Scenarios:

- a.) Direct Relationship (Tradeoff Possible): Ideally, when the PF is devoting attention to the SVS display, the approach/landing should be less difficult, since the SVS provides a clear view of terrain and other obstacles. However, there may be situations in which the SVS was not functioning correctly, or the terrain database or GPS was inaccurate. In this case, devoting too much time to the SVS could make the approach/landing more difficult.
- b.) Direct Relationship (Tradeoff Possible): When the PF spends little time viewing the SVS display (especially in low visibility conditions) the approach/landing may be more difficult. However, spending little time viewing the SVS display may be necessary as mentioned above, when the system is not functioning properly, and the difficulty of the approach/landing would decrease because the pilot would not have to deal with inaccurate or missing information.
- c.) Direct Relationship (Tradeoff Possible): In an easy approach/landing situation, the pilot may spend more or less time viewing the SVS display. This

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may depend purely on pilot preference, or pilots amount of trust in the SVS, or it may be dependent on the accuracy of the components of the SVS.

- d.) Direct Relationship (Tradeoff Possible): As with an easy approach, with a difficult approach the pilot may spend more or less time viewing the SVS display depending on a variety of factors such as its accuracy, pilot preference, pilot experience, etc.

## 8.) Current level of SA/Difficulty of approach/landing

## Relationship:

- a.) When the desirability of Current level of SA *increases*, the desirability of Difficulty of approach/landing *increases*
- b.) When the desirability of Current level of SA *decreases*, the desirability of Difficulty of approach/landing *decreases*
- c.) When the desirability of Difficulty of approach/landing *increases*, the desirability of Current level of SA *increases*
- d.) When the desirability of Difficulty of approach/landing *decreases*, the desirability of Current level of SA *decreases*

Classification: Direct Relationship

## Explanation of Scenarios:

- a.) Direct Relationship: When the PF has a very high awareness of his surroundings and current situation, this should make the approach/landing easier to carry out regardless of the weather conditions, type of terrain, or other factors.
- b.) Direct Relationship: When the PF has very low situation awareness, the approach/landing would be more difficult regardless of other factors
- c.) Direct Relationship: When the terrain is easy to navigate, or the weather is desirable, for example, the pilots SA will be higher. This may be a result of low mental workload in these conditions.
- d.) Direct Relationship: When the approach/landing is difficult because of any number of factors, the pilots SA will be lower. This may also be a result of high mental workload in these conditions.

## 9.) Level of mental workload/Difficulty of approach/landing

## Relationship:

- a.) When the desirability of Level of mental workload *increases*, the desirability of Difficulty of approach/landing *increases*
- b.) When the desirability of Level of mental workload *decreases*, the desirability of Difficulty of approach/landing *decreases*
- c.) When the desirability of Difficulty of approach/landing *increases*, the desirability of Level of mental work load *increases*
- d.) When the desirability of Difficulty of approach/landing *decreases*, the desirability of Level of mental workload *decreases*

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Classification: Direct Relationship

Explanation of Scenarios:

- a.) Direct Relationship: When the pilot's task is relatively easy, and mental workload is low, the approach/landing will become easier to carry out regardless of other factors such as terrain, weather, or SA.
- b.) Direct Relationship: When the pilot's task is more difficult, and mental workload is high, the approach/landing will become more difficult, regardless of other factors.
- c.) Direct Relationship: When the conditions in which the approach/landing is attempted, or the terrain itself, is easy to carry out, then, assuming the pilot is not fatigued and instruments are functioning correctly, his/her mental workload will be relatively low.
- d.) Direct Relationship: When the approach/landing is very difficult, the pilots mental workload will be higher.

### 10.) Intuitiveness/usability of the SVS/Difficulty of approach/landing

Relationship:

- a.) When the desirability of Intuitiveness/usability of the SVS *increases*, the desirability of Difficulty of approach/landing *increases*
- b.) When the desirability of Intuitiveness/usability of the SVS *decreases*, the desirability of Difficulty of approach/landing *decreases*
- c.) When the desirability of Difficulty of approach/landing *decreases*, the desirability of Intuitiveness/usability of the SVS *decreases*
- d.) When the desirability of Difficulty of approach/landing *increases*, the desirability of Intuitiveness/usability of the SVS *increases*

Classification: Direct Relationship

Explanation of Scenarios:

- a.) Direct Relationship: If the SVS display is very intuitive to the pilot, the approach/landing will be easier to carry out, regardless of other factors. It is important to note that a display may be more or less intuitive depending on the operator's experience, or preference.
- b.) Direct Relationship: If the SVS display is not user friendly, and therefore unintuitive, the approach/landing will be more difficult to carry out regardless of other factors.
- c.) Direct Relationship: If the approach/landing is very difficult because of terrain, weather, pilot fatigue etc., this may require that the SVS display be extremely intuitive, since pilot mental workload may be high in this situation.

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- d.) Direct Relationship: If the approach/landing is very simple, the SVS can be somewhat more difficult to use because mental workload in this situation would be lower and the pilot would have more attention to allocate to the SVS.

## 11.) Current level of SA/Accuracy of pilots mental model of the environment

## Relationship:

- a.) When the desirability of Current level of SA *increases*, the desirability of Accuracy of pilots mental model of the environment *increases*
- b.) When the desirability of Current level of SA *decreases*, the desirability of Accuracy of pilots mental model of the environment *decreases*
- c.) When the desirability of Accuracy of pilots mental model of the environment *increases*, the desirability of Current level of SA *increases*
- d.) When the desirability of Accuracy of pilots mental model of the environment *decreases*, the desirability of Current level of SA *decreases*

Classification: Direct Relationship

## Explanation of Scenarios:

- a.) Direct Relationship: When the PF has a high awareness of their situation and surroundings, they are also likely to have a very accurate mental model of their environment. This may be a result of experience, or a consequence of an easy approach/landing
- b.) Direct Relationship: When the PF has low SA, he/she is less aware of her surroundings and therefore the environment and their mental model may therefore be inaccurate.
- c.) Direct Relationship: The PF may have a great deal of experience with this specific approach/landing and therefore a very accurate mental model of the environment which would result in an increased level of SA
- d.) Direct Relationship: It is also possible that the PF may have little experience with this specific approach, or may have malfunctioning instruments and therefore an inaccurate mental model of the environment which would result in a lower level of SA.

## 12.) Level of mental workload/ Accuracy of pilots mental model of the environment

## Relationship:

- a.) When the desirability of Level of mental workload *increases*, the desirability of Accuracy of pilots mental model of the environment *increases*
- b.) When the desirability of Level of mental workload *decreases*, the desirability of Accuracy of pilots mental model of the environment *decreases*

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- c.) When the desirability of Accuracy of pilots mental model of the environment *increases*, the desirability of Level of mental workload *increases*
- d.) When the desirability of Accuracy of pilots mental model of the environment *decreases*, the desirability of Level of mental workload *decreases*

Classification: Direct Relationship

## Explanation of Scenarios:

- a.) Direct Relationship: If the current task is relatively easy to carry out (low mental workload), then the pilot may have more time to pay attention to his surroundings through instruments or looking out the window, and would have a more accurate mental model of the environment.
  - b.) Direct Relationship: If the current task is very complicated and the pilots mental workload is very high, then he/she would have lower SA, which may create an inaccurate mental model of the environment.
  - c.) Direct Relationship: If the pilot has experience with the approach/landing and has high SA, their mental model of the environment would be very accurate. This could lead to a decrease in mental workload, regardless of other factors.
  - d.) Direct Relationship: If however, the pilot has little experience with the approach and has low SA, their mental model of the environment may be inaccurate, which could lead to increased mental workload even if the approach/landing is relatively easy, or the weather conditions are desirable.
- 13.) Amount of time spent viewing the SVS display/Amount of time spent reading instruments other than the SVS

## Relationship:

- a.) When the desirability of Amount of time spent viewing the SVS display *increases*, the desirability of Amount of time spent reading instruments other than the SVS *decreases*
- b.) When the desirability of Amount of time spent viewing the SVS display *decreases*, the desirability of Amount of time spent reading instruments other than the SVS *increases*
- c.) When the desirability of Amount of time spent reading instruments other than the SVS *increases*, the desirability of Amount of time spent viewing the SVS *decreases*
- d.) When the desirability of Amount of time spent reading instruments other than the SVS *decreases*, the desirability of Amount of time spent viewing the SVS *increases*

Classification: Tradeoff

### Tradeoff Scenarios (Varying Characteristics)

#### Explanation of Scenarios:

- a.) Tradeoff: The relationship between these two variables is rather obvious. When the PF devotes a great deal of attention to the SVS display, his/her time spent viewing instruments other than the SVS will necessarily decrease. Since the SVS can be used exclusively for viewing terrain, especially in poor visibility conditions, this may be the ideal situation
- b.) Tradeoff: When the PF spends little time viewing the SVS display, he/she will spend more time viewing instruments other than the SVS. This may result from lack of trust in the SVS, lack of experience with the SVS, some malfunction of the SVS, or a variety of other factors.
- c.) Tradeoff: If the PF devotes more time to viewing instruments other than the SVS, less time will be available to devote to viewing the SVS.
- d.) Tradeoff: If the PF devotes less time to viewing instruments other than the SVS, more time will be available to devote to viewing the SVS.

#### 14.) Current level of SA/Amount of time spent reading instruments other than the SVS

#### Relationship:

- a.) When the desirability of Current level of SA *increases*, the desirability of Amount of time spent reading instruments other than the SVS *increases* or *decreases*
- b.) When the desirability of Current level of SA *decreases*, the desirability of Amount of time spent reading instruments other than the SVS *increases* or *decreases*
- c.) When the desirability of Amount of time spent reading instruments other than the SVS *increases*, the desirability of Current level of SA *increases* or *decreases*
- d.) When the desirability of Amount of time spent reading instruments other than the SVS *decreases*, the desirability of Current level of SA *increases* or *decreases*

Classification: Unstable

#### Explanation of Scenarios:

- a.) Direct Relationship (Tradeoff Possible): A high level of SA can result from a variety of factors. The PF may need to devote a significant amount of attention to instruments other than the SVS if, for example, they contain information pertinent to the current phase of flight, the SVS is inaccurate, in order to cross-check between displays, etc. However, increased SA should also come from viewing the SVS display, especially in very low visibility conditions, in which the out-the-window view is insufficient.
- b.) Direct Relationship (Tradeoff Possible): Low SA can also result from choosing to spend time viewing instruments other than the SVS, or from viewing the SVS display itself, depending on the circumstance. Ideally, when

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the SVS is functioning properly, it should encourage high SA. However, if the SVS display is inaccurate, if the pilot has an inaccurate machine model, or the pilot does not trust the SVS display, viewing the display may actually result in decreased SA.

- c.) Direct Relationship (Tradeoff Possible): As mentioned above, devoting a significant amount of attention to instruments other than the SVS can result in an increased or decreased level of SA, depending on the circumstances.
  - d.) Direct Relationship (Tradeoff Possible): As mentioned above, viewing the SVS display or looking out-the-window, and not devoting attention to instruments other than the SVS can also result in an increased or decreased level of SA depending on the situation.
- 15.) Level of mental workload/Amount of time spent reading instruments other than the SVS

## Relationship:

- a.) When the desirability of Level of mental workload *increases*, the desirability of Amount of time spent reading instruments other than the SVS *increases or decreases*
- b.) When the desirability of Level of mental workload *decreases*, the desirability of Amount of time spent reading instruments other than the SVS *decreases*
- c.) When the desirability of Amount of time spent reading instruments other than the SVS *increases*, the desirability of Level of mental workload *increases or decreases*
- d.) When the desirability of Amount of time spent reading instruments other than the SVS *decreases*, the desirability of Level of mental workload *increases or decreases*

Classification: Unstable

## Explanation of Scenarios:

- a.) Direct Relationship (Tradeoff Possible): When the PF is experiencing a low level of mental workload, presumably because the task is relatively simple (i.e. weather conditions are ideal), then he/she has the option of devoting more/less attention to instruments other than the SVS.
- b.) Direct Relationship: If the desirability of the amount of mental workload decreases (high mental workload), then the PF will have less attention to devote to viewing instruments other than the SVS. In very low visibility conditions, the PF may need to devote much of his/her attention to the SVS display in order to carry out the approach/landing.
- c.) Direct Relationship (Tradeoff Possible): Spending a significant amount of time viewing instruments other than the SVS can result in high or low levels of mental workload depending on a variety of factors. For example, if the PF should be looking at the SVS display and is not, mental workload may increase. However, if these other instruments are providing pertinent

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information to the current phase of flight, this may result in decreased mental workload.

- d.) Direct Relationship (Tradeoff Possible): As mentioned above, devoting a great deal of attention to instruments other than the SVS display can result in an increased or decreased level of mental workload depending on the situation.

## 16.) Current level of SA/Amount of time spent viewing the SVS display

## Relationship:

- a.) When the desirability of Current level of SA *increases*, the desirability of Amount of time spent viewing the SVS display *increases*
- b.) When the desirability of Current level of SA *decreases*, the desirability of Amount of time spent viewing the SVS display *decreases*
- c.) When the desirability of Amount of time spent viewing the SVS display *increases*, the desirability of Current level of SA *increases*
- d.) When the desirability of Amount of time spent viewing the SVS display *decreases*, the desirability of Current level of SA *decreases*

Classification: Unstable

## Explanation of Scenarios:

- a.) Direct Relationship: The SVS is designed to promote high situation awareness because it allows the pilot to have a clear view of terrain and other obstacles regardless of current weather conditions. Therefore, in an ideal situation, high SA should result from spending a significant amount of time viewing the SVS display.
- b.) Direct Relationship: Similar to the situation mentioned above, if the PF spends little time viewing the SVS display, this will most likely result in decreased SA.
- c.) Direct Relationship: As mentioned above, viewing the SVS display for a significant amount of time should result in increased SA
- d.) Direct Relationship: Not devoting a great deal of attention to the SVS display should result in decreased SA.

## 17.) Level of mental workload/Amount of time spent viewing the SVS display

## Relationship:

- a.) When the desirability of Level of mental workload *increases*, the desirability of Amount of time spent viewing the SVS display *increases* or *decreases*
- b.) When the desirability of Level of mental workload *decreases*, the desirability of Amount of time spent viewing the SVS display *increases* or *decreases*
- c.) When the desirability of Amount of time spent viewing the SVS display *increases*, the desirability of Level of mental workload *increases* or *decreases*

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- d.) When the desirability of Amount of time spent viewing the SVS display *decreases*, the desirability of Level of mental workload *increases* or *decreases*

Classification: Unstable

## Explanation of Scenarios:

- a.) Direct Relationship (Tradeoff Possible): If the mental workload of the PF is low then he/she has the option of allocating more or less attention to the SVS display.
- b.) Direct Relationship (Tradeoff Possible): If, however, the mental workload of the PF is very high because the weather conditions are very poor, he/she may need to spend a significant amount of time focusing on the SVS display, which is designed for use in this type of situation. However, under conditions of high mental workload, he/she may have less time to view one instrument for any extended period of time, and will most likely need to cross-check frequently between instruments.
- c.) Direct Relationship (Tradeoff Possible): If the PF is spending most of their time viewing the SVS display, this can result in low or high mental workload. Mental workload may decrease if weather conditions or other factors warrant the pilot paying attention exclusively to the SVS display. However, if the SVS is inaccurate, not functioning correctly, or the pilot has an inaccurate machine model, mental workload may increase as a result.
- d.) Direct Relationship (Tradeoff Possible): If the pilot spends little time viewing the SVS display, this can result in low or high levels of mental workload depending on the above-mentioned factors.

## 18.) Intuitiveness/usability of the SVS display/Level of mental workload

## Relationship:

- a.) When the desirability of Intuitiveness/usability of the SVS display *increases*, the desirability of Level of mental workload *increases*
- b.) When the desirability of Intuitiveness/usability of the SVS display *decreases*, the desirability of Level of mental workload *decreases*
- c.) When the desirability of Level of mental workload *increases*, the desirability of Intuitiveness/usability of the SVS display *decreases*
- d.) When the desirability of Level of mental workload *decreases*, the desirability of Intuitiveness/usability of the SVS display *increases*

Classification: Unstable

## Explanation of Scenarios:

- a.) Direct Relationship: If the SVS display is highly intuitive to the pilot, then this should result in a lower level of mental workload, regardless of other factors. This may depend on the experience of the pilot, his amount of trust in the SVS, his machine model, as well as other factors.

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- b.) Direct Relationship: If the SVS display is not intuitive to the pilot, then this should result in a higher level of mental workload, regardless of other factors.
- c.) Tradeoff: If the PF mental workload is very low, then it is not as critical that the SVS display be extremely intuitive to him/her. Although a user-friendly interface is always desirable, it is less important under conditions of low mental workload since the pilot would presumably have more attention to devote to the display.
- d.) Tradeoff: If the PF mental workload is very high, then it is extremely critical that the SVS be intuitive to that individual, since he/she will not have a great deal of time or attention to devote to the display.

## 19.) Difficulty of approach/landing/Amount of display cross-checking

## Relationship:

- a.) When the desirability of Difficulty of approach/landing *increases*, the desirability of amount of display cross-checking *decreases*
- b.) When the desirability of Difficulty of approach/landing *decreases*, the desirability of amount of display cross-checking *increases* or *decreases*
- c.) When the desirability of Amount of display cross-checking *increases*, the desirability of Difficulty of approach/landing *increases* or *decreases*
- d.) When the desirability of Amount of display cross-checking *decreases*, the desirability of Difficulty of approach/landing *increases* or *decreases*

Classification: Unstable

## Explanation of Scenarios:

- a.) Tradeoff: If the approach/landing situation is relatively easy because of terrain, weather conditions, or other factors such as experience of the pilot, the amount of time the pilot spends cross-checking will decrease. If the pilot is overly confident, he/she may not cross-check between displays enough, which could result in an error.
- b.) Direct Relationship (Tradeoff Possible): If the approach/landing situation is very difficult, the PF may need to cross-check information between displays frequently in order to avoid a potential error and to increase his situation awareness, and the accuracy of his mental model of the environment. However, there may also be situations in which the approach/landing causes an increase in mental workload, and the pilot does not have the attention to devote to cross-checking between displays. In this situation it may be more desirable to have the pilot focused primarily on one instrument such as the SVS.
- c.) Direct Relationship (Tradeoff Possible): If the PF is spending a significant amount of time cross-checking information, this could make the approach easier for him/her because they will have increased SA. However, if too much time is spent cross-checking information, the pilot may not be allocating enough attention to pertinent displays (such as the SVS) which

**Tradeoff Scenarios (Varying Characteristics)**

would assist in the approach/landing, and the difficulty of the approach/landing would therefore increase.

- d.) Direct Relationship (Tradeoff Possible): If the PF is spending little time cross-checking information between displays, this could also make the current approach/landing more or less difficult depending on the above mentioned factors.

20.) Difficulty of approach/landing/Degree of display clutter/degree of overlay with PFD data

## Relationships:

- a.) When the desirability of Difficulty of approach/landing *increases*, the desirability of Degree of display clutter/degree of overlay with PFD data *decreases*
- b.) When the desirability of Difficulty of approach/landing *decreases*, the desirability of Degree of display clutter/degree of overlay with PFD data *increases*
- c.) When the desirability of Degree of display clutter/degree of overlay with PFD data *increases*, the desirability of Difficulty of approach/landing *increases* or *decreases*
- d.) When the desirability of Degree of display clutter/degree of overlay with PFD data *decreases*, the desirability of Difficulty of approach/landing *increases* or *decreases*

Classification: Unstable

## Explanation of Scenarios:

- a.) Tradeoff: If the approach/landing situation is relatively simple, then the desirability of the Degree of clutter will increase (low clutter level). In other words, it will be less essential for the display to be uncluttered, since mental workload will presumably be lower.
- b.) Tradeoff: If the approach/landing is very difficult, for whatever reason, then it is essential that the degree of display clutter be relatively low in order to decrease mental workload for the PF and provide an intuitive, easy to read display.
- c.) Direct Relationship (Tradeoff Possible): If the SVS is uncluttered, and therefore easy to read and intuitive to the PF, the approach/landing will most likely be easier for the PF to carry out since the display is more intuitive. However, the approach/landing could become more difficult if the display has so little information that information the pilot currently needs is not displayed, and he/she has to search through the menu in order to obtain this information.
- d.) Direct Relationship (Tradeoff Possible): If the SVS is very cluttered, the approach landing may be more or less difficult for the above mentioned reasons.

**Tradeoff Scenarios (Varying Characteristics)**

## 21.) Amount of display cross-checking/Current level of SA

## Relationships:

- a.) When the desirability of the Amount of display cross-checking *increases*, the Current level of SA *increases*.
- b.) When the desirability of the Amount of display cross-checking *decreases*, the Current level of SA *decreases*
- c.) When the desirability of the Current level of SA *increases*, the desirability of Amount of display cross-checking *decreases*
- d.) When the desirability of the Current level of SA *decreases*, the desirability of Amount of display cross-checking *increases*.

Classification: Unstable

## Explanation of Scenarios:

- a.) Direct Relationship: If the PF is spending a lot of time cross-checking information between displays, then his/her SA should increase.
- b.) Direct Relationship: If the PF is spending little time cross-checking between displays, his/her SA should decrease since they are getting information primarily from one source which could be inaccurate.
- c.) Tradeoff: If the PF has a high SA because he/she is very experienced with the current terrain surroundings, or has a high amount of general experience, they will not need to cross-check information between displays as frequently.
- d.) Tradeoff: If the PF has very low SA, he/she may need to cross-check information between displays in order to increase their awareness of the current situation.

## 22.) Amount of display cross-checking/Level of mental workload

## Relationships:

- a.) When the desirability of Amount of display cross-checking *increases*, the desirability of the Level of mental workload *decreases*
- b.) When the desirability of Amount of display cross-checking *decreases*, the desirability of the Level of mental workload *increases*
- c.) When the desirability of the Level of mental workload *increases*, the desirability of Amount of display cross-checking *increases*
- d.) When the desirability of the Level of mental workload *decreases*, the desirability of Amount of display cross-checking *decreases*

Classification: Unstable

## Explanation of Scenarios:

- a.) Tradeoff: If the PF is constantly cross-checking information between displays, his/her Level of mental workload will increase simply because they are performing more mental tasks. It is important to note

**Tradeoff Scenarios (Varying Characteristics)**

that a high degree of display cross-checking may be desirable even though mental workload may increase in these circumstances.

- b.) Tradeoff: If the PF is spending little time cross-checking information between displays, his/her Level of mental workload will decrease because they are performing fewer mental tasks. Again, this may not be a desirable situation regardless of the level of mental workload.
- c.) Direct Relationship: If the PF currently has a high level of mental workload, he/she will have less time to devote to cross-checking information between displays, and may need to devote their attention to one primary display (such as the SVS)
- d.) Direct Relationship: If the PF currently has a low level of mental workload because of the terrain situation, weather, confidence, etc., he/she will have more attention to allocate to cross-checking information between displays.

23.) Level of mental workload/Degree of display clutter/Degree of overlay with PFD data

Relationship:

- a.) When the desirability of Level of mental workload *increases*, the desirability of Degree of display clutter/Degree of overlay with PFD data *increases*
- b.) When the desirability of Level of mental workload *decreases*, the desirability of Degree of display clutter/Degree of overlay with PFD data *decreases*
- c.) When the desirability of Degree of display clutter/Degree of overlay with PFD data *increases*, the desirability of Level of mental workload *increases*
- d.) When the desirability of Degree of display clutter/Degree of overlay with PFD data *decreases*, the desirability of Level of mental workload *decreases*

Classification: Direct Relationship

Explanation of Scenarios:

- a.) Direct Relationship: When the PF is experiencing a low level of mental workload it is less important that the display maintain a low degree of clutter, because he/she presumably has more attention to allocate to the display.
- b.) Direct Relationship: When the PF is experiencing a high level of mental workload it is critical that the display be easy to interpret, which may mean a low degree of display clutter. It is important however, that pertinent information still be readily available, and not buried in the menu structure in an attempt to have an uncluttered display.

**Tradeoff Scenarios (Varying Characteristics)**

- c.) Direct Relationship: When display clutter is kept to a minimum, then mental workload should decrease because the display should be more intuitive and therefore easier for the pilot to interpret.
- d.) Direct Relationship: When there is a high degree of display clutter, mental workload will increase because it will be more difficult for the pilot to quickly obtain needed information from the display. It is important to not however that pertinent information not be removed from the display in an effort to oversimplify the SVS because this may result in a high level of mental workload which is the opposite of what it is intended to produce.

24.) Degree of display clutter/Degree of overlay with PFD data/  
Intuitiveness/usability of the SVS

Relationship:

- a.) When the desirability of Degree of display clutter/Degree of overlay with PFD data *increases*, the desirability of the Intuitiveness/usability of the SVS *increases*
- b.) When the desirability of Degree of display clutter/Degree of overlay with PFD data *decreases*, the desirability of the Intuitiveness/usability of the SVS *decreases*
- c.) When the desirability of the Intuitiveness/usability of the SVS *increases*, the desirability of Degree of display clutter/Degree of overlay with PFD data *decreases*
- d.) When the desirability of the Intuitiveness/usability of the SVS *decreases*, the desirability of Degree of display clutter/Degree of overlay with PFD data *increases*

Classification: Unstable

Explanation of Scenarios:

- a.) Direct Relationship: If the SVS is uncluttered (but still displays pertinent information when needed) and is therefore easy to read and interpret it will be more intuitive and usable to the PF.
- b.) Direct Relationship: If the SVS is extremely cluttered with PFD data, and it is therefore difficult to read and interpret, it will be less intuitive and usable to the PF.
- c.) Tradeoff: If the SVS display is highly intuitive for reasons besides the degree of display clutter such as coloring, menu structure, etc., then it will be less critical that the display maintain a low level of clutter.
- d.) Tradeoff: If the SVS display is not intuitive to the PF for reasons other than the degree of display clutter, then it will be extremely critical the SVS display maintain a low degree of clutter (while still displaying pertinent information) because this measure will help to make the display more intuitive and usable to the pilot.