VISUAL ANALYTICS
SENSEMAKING & ANALYSIS PROCESSES

Petra Isenberg

SENSEMAKING

A TERM USED IN MANY DISCIPLINES:

- ORGANIZATIONAL SCIENCE
- EDUCATION & LEARNING SCIENCE
- COMMUNICATIONS
- COMMAND AND CONTROL
- HUMAN-COMPUTER INTERACTION (HCI)
- INTELLIGENT SYSTEMS
- INFORMATION SYSTEMS

SENSEMAKING IN GENERAL

= FINDING MEANING / UNDERSTANDING IN A SITUATION

ref [1]

SENSEMAKING IN GENERAL

- SENSEMAKING IS A COGNITIVE ACTIVITY
  - PART OF OTHER MENTAL ACTIVITIES, E.G. DECISION-MAKING, PROBLEM-SOLVING, COMPREHENSION, CREATIVITY, AWARENESS
- PART OF FINDING, UNDERSTANDING, & USING INFORMATION

SENSEMAKING IN VISUAL ANALYTICS

"PROCESS OF COMING TO UNDERSTAND A LARGE/COMPLEX SET OF DATA, CHARACTERIZED BY THE USE OF EXTERNAL REPRESENTATIONS AS MEMORY AND INFERENCE AIDS."

ref [4]

IMPORTANCE

SENSEMAKING IS MOST IMPORTANT WHEN

- UNCERTAINTY AND AMBIGUITY ARE HIGH

- THE SITUATION IS DIFFERENT THAN EXPECTED, UNINTELLIGIBLE, OR CONFUSING

see http://www.slideshare.net/issil2011/ansell-sensemaking-lecture
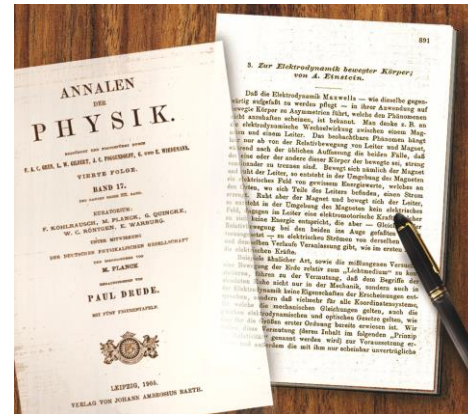
IMPORTANCE

SENSEMAKING IS MOST IMPORTANT WHEN

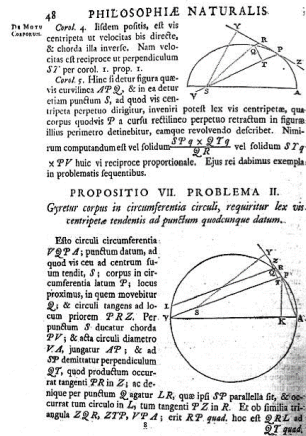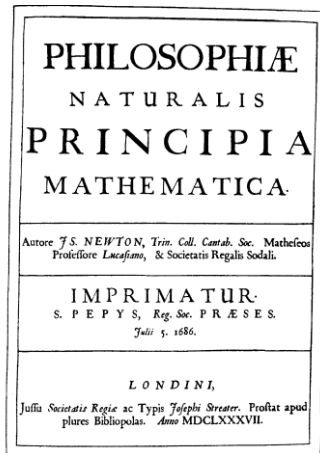- THE SITUATION IS UNFAMILIAR AND NO GUIDING ROUTINES, HABITS, OR RULES EXIST

- PROJECTS OR ROUTINES GET INTERRUPTED

- ACTION IS DISTRIBUTED ACROSS MULTIPLE ACTORS

WHERE DOES SENSEMAKING HAPPEN?

Some examples

IN THE SCIENTIFIC PROCESS

WHEN TRYING TO UNDERSTAND HOW A SYSTEM OR PHENOMENON FUNCTIONS

INTELLIGENCE ANALYSIS

WEAPONS OF MASS DESTRUCTION ANALYSIS

On the brink of war, and in front of the whole world, the United States government asserted that Saddam Hussein had reconstituted his nuclear weapons program, had biological weapons and mobile biological weapon production facilities, and had stockpiled and was producing chemical weapons. All of this was based on the assessments of the U.S. Intelligence Community. And not one bit of it could be confirmed when the war was over.

ref [4,5]

http://fas.org/irp/offdocs/wmd_overview

INTELLIGENCE ANALYSIS

WEAPONS OF MASS DESTRUCTION ANALYSIS

- ONE OF THE MOST DAMAGING INTELLIGENCE FAILURES IN RECENT AMERICAN HISTORY

- LOW QUALITY INFORMATION COLLECTED
(TOO LITTLE, MISLEADING, UNINFORMATIVE)

- COMMUNICATION PROBLEMS WITH POLICY MAKERS. ANALYSTS DIDN'T EXPLAIN HOW MUCH WAS BASED ON ASSUMPTIONS & INFERENCES RATHER THAN CONCRETE EVIDENCE

- BIG TIME PRESSURE

ref [4,5]
http://fas.org/irp/offdocs/wmd_overview.pdf

WIKIPEDIA

COLLECTIVE SENSEMAKING

Metal umlaut

From Wikipedia, the free encyclopedia

This is an old revision of this page, as edited by 81.77.207.173 (talk) at 12:18, 15 April 2003 *(The "heavy metal umlaut" over the ö in the names of Motörhead, and the Blue Öyster Cult has led to the term "spandex and umlaut circuit" being used to describe the heavy metal band touring)*. It may differ significantly from the current revision.

(diff) ← Previous revision | Latest revision (diff) | Newer revision → (diff)

The "heavy metal umlaut" over the ö in the names of Motörhead, and the Blue Öyster Cult has led to the term "spandex and umlaut circuit" being used to describe the heavy metal band touring scene.

http://en.wikipedia.org/wiki/Metal_umlaut

ref [4]

WIKIPEDIA

more info:
http://jonudell.net/udell/gems/umlaut/umlaut.html

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Metal umlaut

From Wikipedia, the free encyclopedia

A **metal umlaut** is a diacritic that is sometimes used gratuitously or decoratively over letters in the names of hard rock or heavy metal bands—for example those of Queensrÿche, Blue Öyster Cult, Motörhead, The Accüsed, and Mötley Crüe.

Among English speakers, the use of umlaut marks and other diacritics with a blackletter style typeface is a form of foreign branding intended to give a band's logo a Teutonic quality—denoting stereotypes of boldness and strength commonly attributed to ancient northern European peoples, such as the Vikings and Goths. Its use has also been attributed to a desire for a "gothic horror" feel.[1] The metal umlaut is not generally intended to affect the pronunciation of the band's name.

These decorative umlauts have been parodied in film and fiction; in the mockumentary film *This Is Spinal Tap*, fictional rocker David St. Hubbins (Michael McKean) says, "It's like a pair of eyes. You're looking at the umlaut, and it's looking at you".[citation needed]
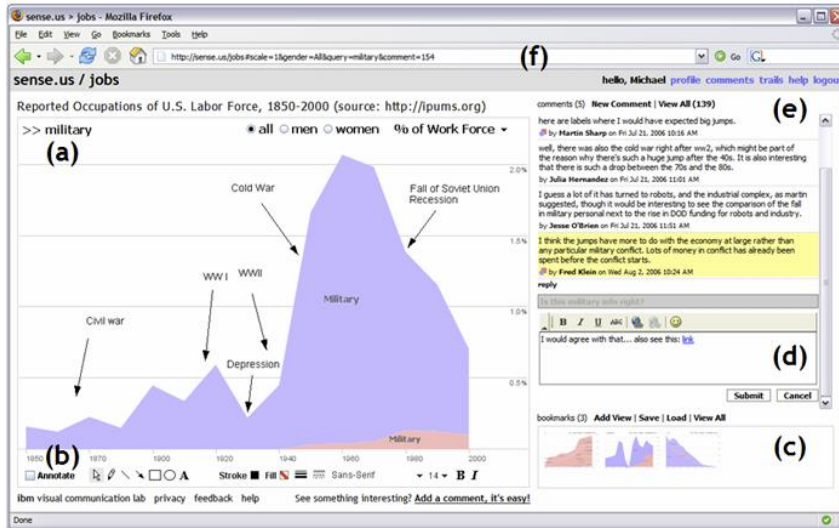
> This article contains special characters. Without proper rendering support, you may see question marks, boxes, or other symbols.

Mötley Crüe's Hollywood Walk of Fame star, which shows the two metal umlauts used in the band's name

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COLLABORATIVE VISUAL ANALYSIS

sense.us [Heer, Viegas, Wattenberg]

- TABLEAU PUBLIC
- IBM MANY EYES
- ...

OTHERS

- BUYING PRODUCTS

- DESIGNING PRODUCTS

THE PROCESS

according to visual analytics literature

THE SENSEMAKING LOOP

THE SENSEMAKING LOOP

The Sense-Making Loop

- (re)represent
- gather information
- develop insight
- produce results
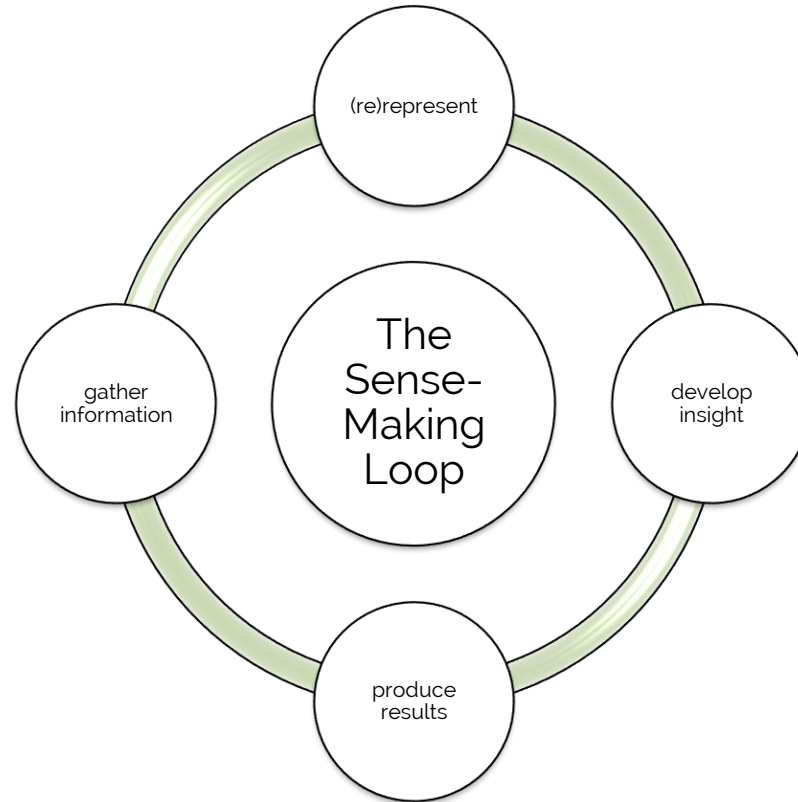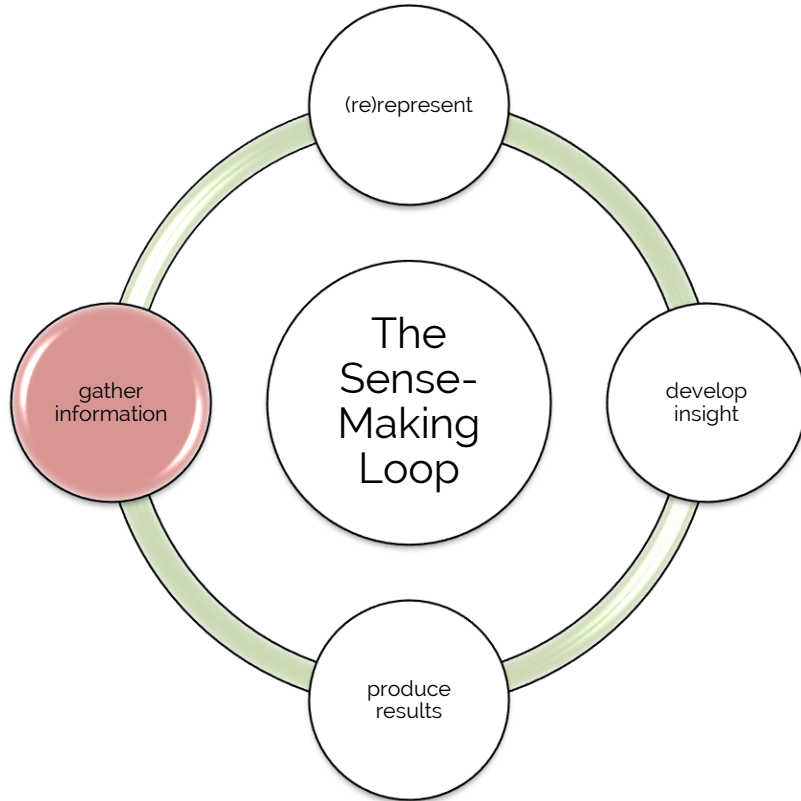
BUYING A CAR:

- ## GATHER INFORMATION:

Statistics - national statistics

Vehicle licensing statistics, Great Britain: Apr to Jun 2014

From:	Department for Transport
First published:	11 September 2014
Part of:	Vehicles statistics, Cars (VEH02), All licensed vehicles and new registrations (VEH01) and Motorcycles (VEH03)

NATIONAL STATISTICS

THE SENSEMAKING LOOP

The Sense-Making Loop:
- (re)represent
- gather information
- develop insight
- produce results
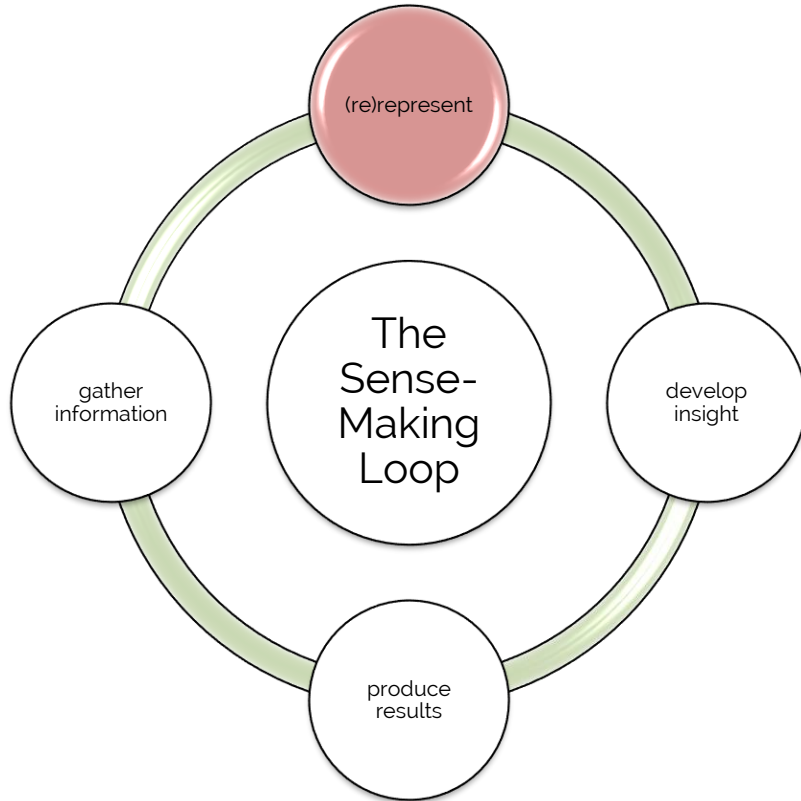
BUYING A CAR:

- ## REPRESENT:

New registrations cars, top 20 models, GB: first half of 2014

Model	Thousands
Ford Fiesta	
Ford Focus	
Vauxhall Corsa	
Volkswagen Golf	
Vauxhall Astra	
Fiat 500	
Nissan Qashqai	
Volkswagen Polo	
Audi A3	
BMW 3 Series	
Nissan Juke	
Toyota Yaris	
Mercedes C Class	
Land Rover Range Rover	
Peugeot 208	
Vauxhall Zafira	
Vauxhall Insignia	
Vauxhall Mokka	
BMW 1 Series	
Mercedes E Class	

0 20 40 60 80
Thousands

THE SENSEMAKING LOOP

The Sense-Making Loop

- (re)represent
- gather information
- develop insight
- produce results

BUYING A CAR:

- **DEVELOP INSIGHT**
  - WHAT IS THE MOST POPULAR CAR?
- **GO BACK TO GATHERING MORE DATA**
  - FIND DATA ON CAR SIZES, PRICES, FEATURES, ...
- **REPRESENT**

THE SENSEMAKING LOOP
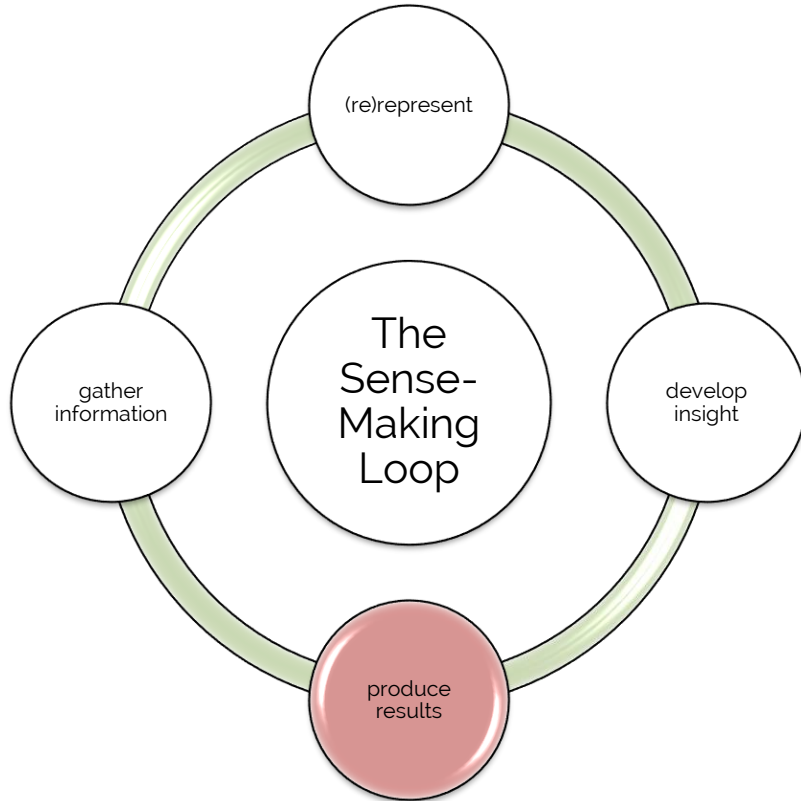
PRODUCE RESULT:

- MAKE A DECISION
- BUY YOUR CAR

THE PROCESS

- THERE IS NOT ONE PROCESS
- PROCESSES DEPEND ON
  - PEOPLE
  - DISCIPLINES
  - QUESTIONS
  - EXTERNAL FACTORS (TIME PRESSURE, MONEY, ...)
  - ...

INTELLIGENCE ANALYSIS
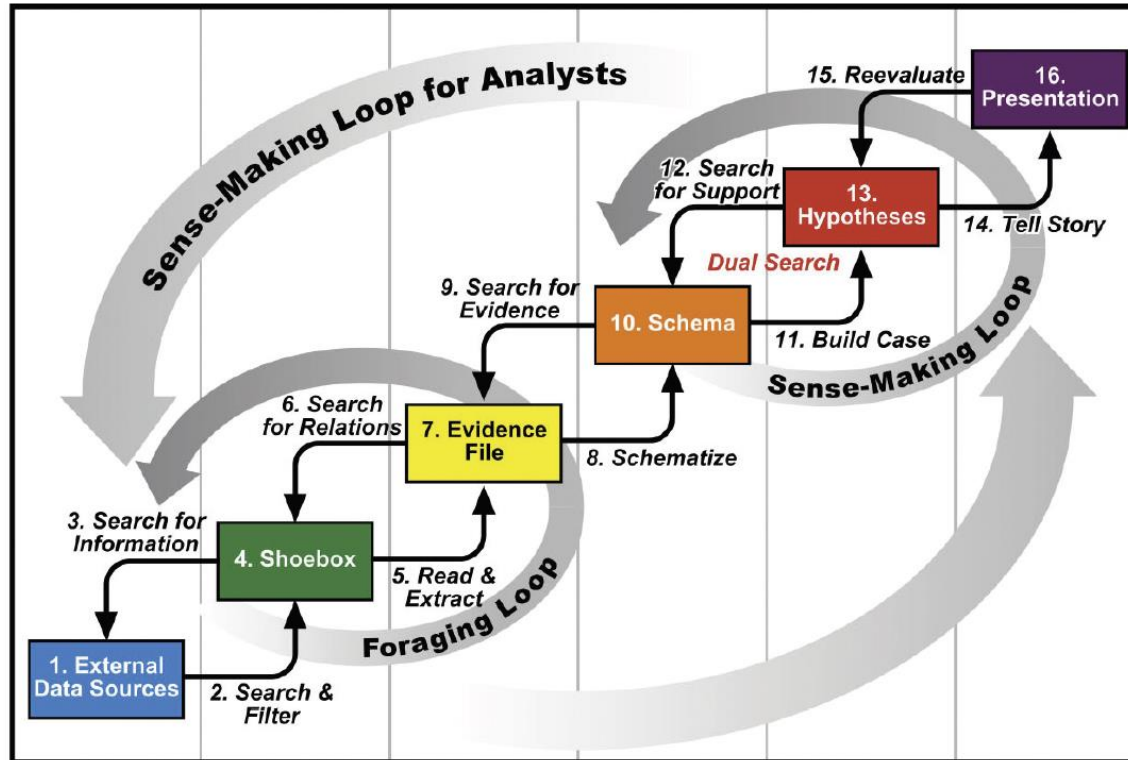
proposed for some types of intelligence analysis

ref [3]

BUT...

- THE DESCRIPTION OF THIS MODEL IS SCARCE IN DETAILS

- MORE IN-DEPTH STUDIES NEEDED TO UNDERSTAND HOW ANALYSTS MAKE SENSE OF INFORMATION

EXAMPLE

Youn-ah Kang and John Stasko

- FIELD STUDY AT
  - A VERY PRESTIGIOUS PROGRAM IN INTELLIGENCE STUDIES
  - 300+ FUTURE INTELLIGENCE ANALYSTS

ref [5]

EXAMPLE

Georgia Tech | College of Computing

Youn-ah Kang and John Stasko

- FIELD STUDY AT

  Mercyhurst COLLEGE
  Institute for Intelligence Studies

  - A VERY PRESTIGIOUS PROGRAM IN INTELLIGENCE STUDIES

  - 300+ FUTURE INTELLIGENCE ANALYSTS

- 3 TEAMS, 10 WEEKS INTELLIGENCE PROJECT

ONE TEAM'S TASK:

Who are the key people, technologies and organizations that likely currently have or will develop the potential to disrupt or replace traditional US national security Intelligence Community (IC) analytic work flows and products with commercially available products available over the next 24 months?

PROCESS COMPONENTS

CONSTRUCTING A
CONCEPTUAL MODEL

– MAP OF ISSUES AND
CONCEPTS TO
INVESTIGATE
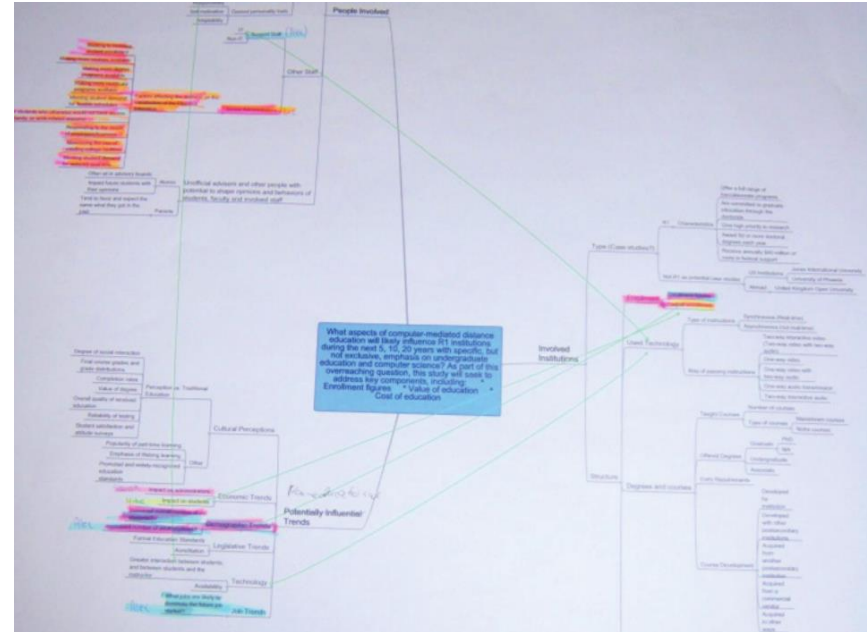
PROCESS COMPONENTS

COLLECTION

- COLLECT DATA FROM VARIOUS SOURCES
- OFTEN SHARED IN COLLAB DATA COLLECTION SOFTWARE (ZOTERO, RSS FEEDS, …)

PROCESS COMPONENTS

ANALYSIS

- PROCESS DATA TO CONVERT "DATA INTO KNOWLEDGE"

- DIFFERENT METHODS USED

- CLOSE CONNECTION TO COLLECTION & PRODUCTION PHASE

PROCESS COMPONENTS

PRODUCTION

- SYNTHESIS OF INDIVIDUAL FINDINGS
- PREPARE PRESENTATION FOR DECISION MAKERS
- CHECKING AND VALIDATION COMMON

GENERAL PROCESS FINDINGS

1. THE ANALYSIS PROCESS WAS NOT SEQUENTIAL BUT MORE PARALLEL AND ORGANIC
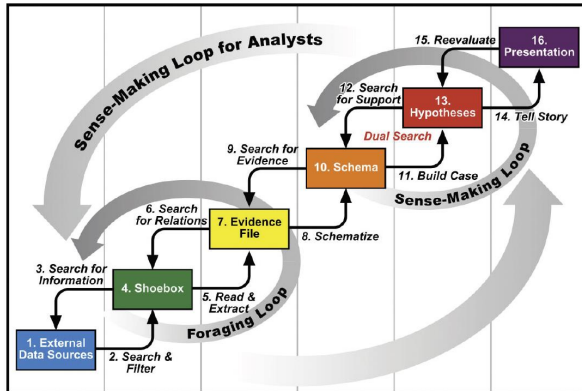
has loops but suggests an ordering

Wheaton's model of the intelligence process [6]
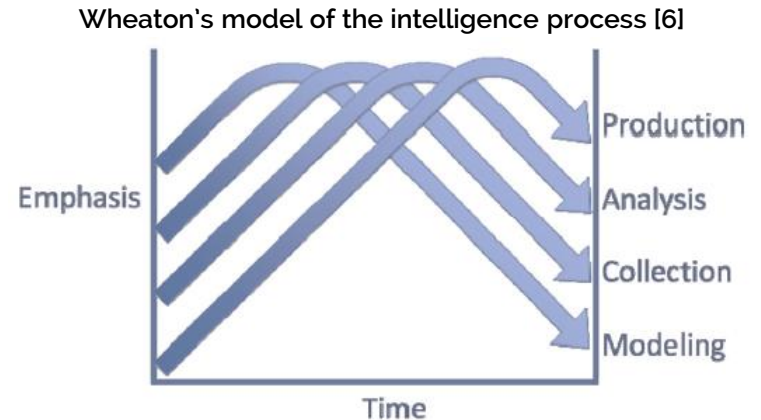
reflects parallelism observed

GENERAL PROCESS FINDINGS

2. ANALYSIS DOES NOT ONLY INVOLVE LOOKING AT DATA. A PART OF ANALYSIS JUST AS IMPORTANT (OR EVEN MORE) IS:

– FINDING OUT HOW TO ANSWER A QUESTION

– WHAT TO RESEARCH

– WHAT TO COLLECT

– WHAT CRITERIA TO USE

GENERAL PROCESS FINDINGS

→ SUCCESSFUL VA SYSTEMS NEED TO SUPPORT A TIGHT INTEGRATION OF COLLECTION & ANALYSIS

GENERAL PROCESS FINDINGS

3. ANALYSIS IS ALMOST ALWAYS A COLLABORATIVE ACTIVITY

GENERAL PROCESS FINDINGS

4. TOOLS MUST SUPPORT A VARIETY OF WORK STYLES AND ANALYSIS METHODS

THE ROLE OF VA IN INTELLIGENCE

VA CAN HELP TO IMPROVE INTELLIGENCE WORK BY

- EXTERNALIZING THE THINKING PROCESS
- SUPPORTING SOURCE MANAGEMENT

THE ROLE OF VA IN INTELLIGENCE

VA CAN HELP TO IMPROVE INTELLIGENCE WORK BY

- SUPPORT ANALYSIS WITH CONSTANTLY CHANGING INFORMATION

- HELP CREATE CONVINCING PRODUCTION

- SUPPORT (ASYNCHRONOUS) COLLABORATION

THE ROLE OF VA IN SENSEMAKING

VA CAN HELP TO IMPROVE SENSEMAKING THROUGH

- ACCELERATED SEARCH
- FASTER READING
- FASTER RECOGNITION OF RELATIONSHIPS

THE ROLE OF VA IN SENSEMAKING

VA CAN HELP TO IMPROVE SENSEMAKING THROUGH

- HYPOTHESIS MANAGEMENT

- STRUCTURED PRESENTATION / ARGUMENTATION

- INTERACTIVE ANALYSIS & PRESENTATION

CAN WE AID SENSEMAKING?

By using specific methods or tools?

METHODS: HOW TO ANSWER A QUESTION

- AT LEAST 50 DIFFERENT METHODS EXIST IN THE INTELLIGENCE COMMUNITY ALONE
  - ANALYSIS OF COMPETING HYPOTHESES
  - SOCIAL NETWORK ANALYSIS
  - GEOSPATIAL MAPPING
  - DECISION MATRIX
  - ...

METHODS

DETECT THE EXPECTED
DISCOVER THE UNEXPECTED

ANALYTIC DISCOURSE

PEOPLE CANNOT EFFECTIVELY REASON ABOUT HYPOTHESES AND SCENARIOS UNAVAILABLE TO THEM

ANALYTIC DISCOURSE

HOW DO YOU KNOW WHAT YOU DON'T KNOW?

HOW DO YOU KNOW IF YOU HAVE GENERATED ALL POSSIBLE HYPOTHESES?

HOW TO GENERATE HYPOTHESES?

FOUR PRINCIPLE STRATEGIES:

- SITUATIONAL LOGIC

- APPLYING THEORY

- COMPARISON WITH HISTORICAL CASES

- "NON-STRATEGY" – DATA IMMERSION

SITUATIONAL LOGIC

MOST COMMON OPERATING MODE FOR INTELLIGENCE ANALYSTS.

BEGINS WITH CONSIDERATION OF CONCRETE ELEMENTS OF THE CURRENT SITUATION

BROAD, GLOBAL GENERALIZATIONS ARE AVOIDED

SITUATIONAL LOGIC

THE SITUATION IS REGARDED AS "ONE-OF-A-KIND" SO THAT IT MUST BE UNDERSTOOD USING ITS OWN UNIQUE LOGIC

E.G. A SINGLE COUNTRY IS LOOKED AT ON MULTIPLE RELATED ISSUES

BEST FOR ANALYZING SHORT-TERM DEVELOPMENTS

SITUATIONAL LOGIC

ADVANTAGES:

BROAD APPLICABILITY (CAN ANALYZE ANY SITUATION)

ABILITY TO INTEGRATE LARGE AMOUNT OF RELEVANT DETAILS

SITUATIONAL LOGIC

PROBLEMS:

PERSONAL BIAS – PROJECTING YOUR OWN PERSONAL INTERPRETATION ONTO THE SUBJECT OF ANALYSIS.
E.G. IF YOU ARE ANALYZING A PERSON, YOU MAY NOT KNOW HIS/HER BELIEFS, VALUES, MISPERCEPTIONS, ETC.

DOES NOT UTILIZE WHAT'S ALREADY KNOWN

THEORY

A GENERALIZATION BASED ON THE STUDY OF MANY EXAMPLES OF SIMILAR PHENOMENON.

ADVANTAGE IS THAT "THEORY ECONOMIZES THOUGHT"

- IT HELPS TO IDENTIFY THE KEY ELEMENTS (FACTORS) IN A GIVEN SITUATION
- ALLOWS THE ANALYST TO IGNORE THE NOISE

THEORY

PROBLEM:

ASSUMES THAT THE CURRENT SITUATION
FALLS INTO A KNOWN PATTERN

- ARE TWO SITUATIONS EVER EXACTLY THE SAME?

- HOW DOES ONE GENERALIZE ONE INTO ANOTHER?

- WHAT ASSUMPTIONS ARE BEING MADE BECAUSE
  OF ONE'S MENTAL BIAS?

SITUATION LOGIC VS. THEORY

Situation Logic

	Country	Country	Country	Country
Issue	Evidence	Evidence	Evidence	Evidence
Issue	Evidence	Evidence	Evidence	Evidence
Issue	Evidence	Evidence	Evidence	Evidence
Issue	Evidence	Evidence	Evidence	Evidence

Theory

Situational Logic Vs. Theory

COMPARISON WITH HISTORICAL CASES

DIFFERS FROM SITUATIONAL LOGIC IN THAT PRESENT SITUATION IS INTERPRETED IN THE LIGHT OF A MORE OR LESS EXPLICIT CONCEPTUAL MODEL BASED ON SIMILAR SITUATIONS IN THE PAST

DIFFERS FROM THEORY IN THAT THERE ARE NOT ENOUGH CASES TO FORM UNIVERSALLY ACCEPTED SET OF RULES.

COMPARISON WITH HISTORICAL CASES

TYPICALLY USED AS A SHORTCUT, WHEN NO DATA OR THEORY AVAILABLE

WHEN TIME PRESSURE IS HIGH

COMPARISON WITH HISTORICAL CASES

PROBLEMS:

VIVID HISTORICAL PRECEDENTS OFTEN FORCE THEMSELVES TO THE FOREFRONT OF CONSIDERATION

(TOO) EASY AND CONVENIENT TO ASSUME THAT THE CURRENT AND PAST SITUATION ARE EQUIVALENT BASED ON KNOWN SIMILARITIES

COMPARISON WITH HISTORICAL CASES

PROBLEMS:

IN US FOREIGN POLICY, FOR EXAMPLE:

- In 1930s, policy makers adopted an isolation policy that would have worked well for preventing American involvement in WWI, but failed for WWII.

- Communist aggression were seen as analogous to Nazi aggression, leading to a policy of containment that would have prevented WWII.

- Vietnam was used as an argument against US preparations in the Gulf War – flawed because a difference in terrain

DATA IMMERSION

SOME ANALYSTS DESCRIBE THEIR WORK PROCEDURE AS IMMERSING IN DATA WITHOUT FITTING DATA INTO ANY PRECONCEIVED PATTERN.

WHEN PATTERN (ANSWER/EXPLANATION) EMERGES → GOING BACK TO DATA TO CHECK FOR SUPPORT

DATA IMMERSION

PROBLEM:

"INFORMATION CANNOT SPEAK FOR ITSELF"

IT REQUIRES A CONTEXT (OR A PERSON'S MENTAL MODEL)

DATA IMMERSION

DATA IMMERSION IS OFTEN UNAVOIDABLE AS THE SITUATION IS OFTEN TOO VAGUE, TOO NEW, AND TOO MESSY.

HOWEVER, KEEP IN MIND THAT THIS IS "ABSORBING INFORMATION", NOT "ANALYZING INFORMATION"

OBJECTIVITY CANNOT BE GAINED BY "NOT HAVING ANY ASSUMPTIONS".

IT IS ONLY POSSIBLE BY MAKING MULTIPLE ASSUMPTIONS EXPLICIT SO THAT THEY CAN BE EXAMINED AND CHALLENGED

CREATIVITY

BE CREATIVE. THINK OUT OF THE BOX. SEE ALL DIFFERENT PERSPECTIVES.

WORK WITH COLLEAGUES WHO CAN CHALLENGE YOUR THOUGHTS

EXPOSE YOURSELF TO ALTERNATIVE IDEAS AND CONCEPTS

WORK IN AN ENVIRONMENT WITH CREATIVE THINKING IS ENCOURAGED

LOTS OF HYPOTHESES, NOW WHAT?

BAD STRATEGIES FOR CHOOSING A HYPOTHESIS

"SATISFICING"

SELECT THE FIRST IDENTIFIED ALTERNATIVE THAT'S GOOD ENOUGH

INCREMENTALISM

FOCUSING ON A NARROW RANGE OF ALTERNATIVES WITHOUT LARGE DEVIATION FROM EXISTING POSITION

LOTS OF HYPOTHESES, NOW WHAT?

BAD STRATEGIES FOR CHOOSING A HYPOTHESIS

"CONSENSUS

AGREEMENT AMONG COLLABORATORS

REASONING BY ANALOGY

CHOOSING THE ALTERNATIVE THAT APPEARS TO AVOID PREVIOUS ERROR (OR TO DUPLICATE PREVIOUS SUCCESS)

RELY ON PRINCIPLES THAT DISCRIMINATE BAD FROM GOOD

DETERMINE A SET OF PRINCIPLES AND JUDGE THE HYPOTHESES USING THESE PRINCIPLES

BIASES

"MANY FUNCTIONS ASSOCIATED WITH PERCEPTION, MEMORY, AND INFORMATION PROCESSING ARE CONDUCTED PRIOR TO AND INDEPENDENTLY OF ANY CONSCIOUS DIRECTION."

[ref 7]

PARIS
IN THE
THE SPRING

ONCE
IN A
A LIFETIME

BIRD
IN THE
THE HAND

WHAT DID YOU SEE?

YOU TEND TO SEE WHAT YOU EXPECT TO SEE

→ IT TAKES MORE (UNAMBIGUOUS) INFORMATION TO SEE SOMETHING UNEXPECTED THAN SOMETHING EXPECTED

Decision-making, belief, and behavioral biases [edit]

Many of these biases affect belief formation, business and economic decisions, and human behavior in general. They arise as a replicable result to a specific condition: when confronted with a specific situation, the deviation from what is normally expected can be characterized by:

Name	Description
Ambiguity effect	The tendency to avoid options for which missing information makes the probability seem "unknown."[8]
Anchoring or **focalism**	The tendency to rely too heavily, or "anchor," on one trait or piece of information when making decisions (usually the first piece of information that we acquire on that subject)[9][10]
Attentional bias	The tendency of our perception to be affected by our recurring thoughts.[11]
Availability heuristic	The tendency to overestimate the likelihood of events with greater "availability" in memory, which can be influenced by how recent the memories are or how unusual or emotionally charged they may be.[12]
Availability cascade	A self-reinforcing process in which a collective belief gains more and more plausibility through its increasing repetition in public discourse (or "repeat something long enough and it will become true").[13]
Backfire effect	When people react to disconfirming evidence by strengthening their beliefs.[14]
	The tendency to do (or believe) things because many other people do (or believe) the same.

WHAT TO DO?

OBJECTIVITY IS ACHIEVED BY MAKING BASIC ASSUMPTIONS AND REASONING AS EXPLICIT AS POSSIBLE

LET THEM BE CHALLENGED BY OTHERS, AND SELF-EVALUATED FOR VALIDITY

PITFALLS

SELECTIVE PERCEPTION

- BIASED BY PREDISPOSITIONS OR MIND SETS
- LOOKING FOR DATA THAT FITS A HYPOTHESIS

FAILURE TO GENERATE APPROPRIATE HYPOTHESES

- IGNORE IMPORTANT INFORMATION OR DATA

PITFALLS

FAILURE TO CONSIDER DIAGNOSTICITY OF EVIDENCE

A PIECE OF EVIDENCE CAN BE USED TO SUPPORT DIFFERENT ARGUMENTS
(E.G. A PATIENT WITH HIGH TEMPERATURE IS CLEARLY ILL BUT TEMPERATURE HAS LITTLE DIAGNOSTICITY TO TELL FROM WHICH DISEASE)

EXPERIMENT HYPOTHESES GENERATION & REJECTION

- GIVEN THREE NUMBERS: 2, 4, 6
- DISCOVER THE RULE BEHIND THIS SEQUENCE
- YOU ARE ALLOWED TO GENERATE ANY 3 NUMBER SEQUENCE AS MANY TIMES AS YOU'D LIKE, AND I WILL TELL YOU IF THE SEQUENCE CONFORMS TO THE RULE

PITFALLS

FAILURE TO REJECT HYPOTHESES

PEOPLE GENERALLY SEEK CONFIRMING RATHER THAN DISCONFIRMING EVIDENCE

OPTIMAL STRATEGY:

TRY TO DISPROVE YOUR FAVORITE HYPOTHESIS

THINKING AIDS

structuring analytical problems

EXTERNALIZATIONS

DEPEND ON THE TYPE OF ANALYSIS PROBLEM AND ITS STRUCTURE

- LISTS
- OUTLINES
- TABLES
- DIAGRAMS
- TREES
- MATRICES

...

MULTI-ATTRIBUTE UTILITY ANALYSIS (DECISION MATRIX)

ANALYSIS OF COMPETING HYPOTHESES

DECISION MATRIX

DIVIDE AND CONQUER

E.G. BUYING A CAR

    WHAT ATTRIBUTES ARE IMPORTANT

    HOW IMPORTANT IS EACH ATTRIBUTE

    COLLECT DATA

DECISION MATRIX

Price

Maintenance Cost

Styling

Gas Mileage

Comfort

Handling

DECISION MATRIX

Price	30%
Operating Cost	10%
Styling	20%
Comfort	20%
Handling	15%
Safety	5%
Total	100%

DECISION MATRIX

	% Value	Car 1	Car 2	Car 3
Price	30%	3.5%	3.0%	3.5%
Operating Cost	10%	3.5%	2.0%	4.5%
Styling	20%	2.5%	4.5%	3.0%
Comfort	20%	4.0%	2.5%	3.5%
Handling	15%	3.0%	4.0%	3.0%
Safety	5%	3.5%	2.5%	4%

DECISION MATRIX

	% Value	Car 1	Car 2	Car 3
Price	30%	105	90	105
Operating Cost	10%	35	20	45
Styling	20%	50	90	60
Comfort	20%	80	50	70
Handling	15%	45	60	45
Safety	5%	17.5	12.5	20
Totals		332.5	322.5	345

THIS WAS A MULTI-ATTRIBUTE UTILITY ANALYSIS

ANALYSIS OF COMPETING HYPOTHESES

- THOROUGH
- PARTICULARLY APPROPRIATE FOR CONTROVERSIAL ISSUES
- AUTOMATICALLY LEAVES A TRAIL

Step-by-Step Outline of Analysis of Competing Hypotheses

1. Identify the possible hypotheses to be considered. Use a group of analysts with different perspectives to brainstorm the possibilities.

2. Make a list of significant evidence and arguments for and against each hypothesis.

3. Prepare a matrix with hypotheses across the top and evidence down the side. Analyze the "diagnosticity" of the evidence and arguments—that is, identify which items are most helpful in judging the relative likelihood of the hypotheses.

4. Refine the matrix. Reconsider the hypotheses and delete evidence and arguments that have no diagnostic value.

5. Draw tentative conclusions about the relative likelihood of each hypothesis. Proceed by trying to disprove the hypotheses rather than prove them.

6. Analyze how sensitive your conclusion is to a few critical items of evidence. Consider the consequences for your analysis if that evidence were wrong, misleading, or subject to a different interpretation.

7. Report conclusions. Discuss the relative likelihood of all the hypotheses, not just the most likely one.

8. Identify milestones for future observation that may indicate events are taking a different course than expected.

Step-by-Step Outline of Analysis of Competing Hypotheses

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Step 3

COMBINES
STEP 1 + 2
INTO AN
EXTERNALIZATION

WORK OUT HOW
CONSISTENT ONE E
IS WITH ONE H
→ WORK ACROSS
ROWS

→ DO NO WORK OUT
HOW CONSISTENT
ONE H IS WITH
ONE E (THIS IS
STEP 5)

Question: Will Iraq Retaliate for US Bombing of Its Intelligence Headquarters?

Hypotheses:
H1 - Iraq will not retaliate.
H2 - It will sponsor some minor terrorist actions.
H3 - Iraq is planning a major terrorist attack, perhaps against one or more CIA installations.

	H1	H2	H3
E1. Saddam public statement of intent not to retaliate.	+	+	+
E2. Absence of terrorist offensive during the 1991 Gulf War.	+	+	−
E3. Assumption that Iraq would not want to provoke another US attack.	+	+	−
E4. Increase in frequency/length of monitored Iraqi agent radio broadcasts.	−	+	+
E5. Iraqi embassies instructed to take increased security precautions.	−	+	+
E6. Assumption that failure to retaliate would be unacceptable loss of face for Saddam.	− −	+	+

Step 3

Question: Will Iraq Retaliate for US Bombing of Its Intelligence Headquarters?

Hypotheses:
H1 - Iraq will not retaliate.
H2 - It will sponsor some minor terrorist actions.
H3 - Iraq is planning a major terrorist attack, perhaps against one or more CIA installations.

	H1	H2	H3
NO DIAGNOSTIC VALUE → **E1.** Saddam public statement of intent not to retaliate.	+	+	+
E2. Absence of terrorist offensive during the 1991 Gulf War.	+	+	−
E3. Assumption that Iraq would not want to provoke another US attack.	+	+	−
DIAGNOSTIC VALUE → **E4.** Increase in frequency/length of monitored Iraqi agent radio broadcasts.	−	+	+
E5. Iraqi embassies instructed to take increased security precautions.	−	+	+
E6. Assumption that failure to retaliate would be unacceptable loss of face for Saddam.	− −	+	+

IMPORTANT NOTES

STEP 2 - MAKING EVIDENCE LIST:

NOTE THE ABSENCE OF EVIDENCE AS WELL AS ITS PRESENCE! (IN A SHERLOCK HOLMES STORY, "THE DOG DID NOT BARK" WAS A VITAL CLUE)

E2. Absence of terrorist offensive during the 1991 Gulf War.

+	+	−

STEP 4 – REFINING MATRIX:

NEED TO ADD NEW EVIDENCE? COMBINE HYPOTHESES?

Question: Will Iraq Retaliate for US Bombing of Its Intelligence Headquarters?

Hypotheses:
H1 - **Iraq will not retaliate.**
H2 - It will sponsor some minor terrorist actions.
H3 - Iraq is planning a major terrorist attack, perhaps against one or more CIA installations.

	H1	H2	H3
E1. Saddam public statement of intent not to retaliate.	+	+	+
E2. Absence of terrorist offensive during the 1991 Gulf War.	+	+	−

IMPORTANT NOTES

STEP 5 –TENTATIVE CONCLUSIONS:

ALL "+"S DO NOT INDICATE A PROVEN HYPOTHESIS, BUT THE FEWEST "-"S ARE MORE LIKELY TO BE TRUE.

FINDING A SINGLE EVIDENCE TO DISPROVE A HYPOTHESIS IS HARD (BUT THE MOST SIGNIFICANT).

ANALYSTS OFTEN NOTICE THAT THEIR JUDGMENTS ARE BASED ON A FEW FACTORS AS OPPOSED TO THE MASS OF INFORMATION THAT THEY INITIALLY THOUGHT THAT THEY HAD GATHERED.

THE MATRIX DOES NOT OFFER A SOLUTION!!

IMPORTANT NOTES

STEP 6 – ANALYZING CONCLUSIONS:

HOW FLIMSY IS YOUR CONCLUSION?

IF THE KEY EVIDENCE TURNS OUT TO BE WRONG, DOES THAT COMPLETELY CHANGE YOUR JUDGMENT?

WHAT IS THAT KEY EVIDENCE?

IMPORTANT NOTES

STEP 7 – REPORTING CONCLUSIONS:

NEED TO REPORT CONFIDENCE LEVEL!

DISCUSS FINDINGS IN STEP 6.

IMPORTANT NOTES

STEP 8 – DISCUSS THE FUTURE:

WHAT SCENARIO COULD HAPPEN IN THE FUTURE THAT WILL CHANGE THE OUTCOME OF YOUR ANALYSIS?

SUMMARY

KEY ASPECTS OF ACH

START WITH A FULL SET OF ALTERNATIVE POSSIBILITIES

IDENTIFY AND EMPHASIZE EVIDENCE WITH HIGHEST DIAGNOSTIC VALUES

LOOK FOR EVIDENCE AGAINST RATHER THAN FOR A HYPOTHESIS

LECTURE SUMMARY

YOU LEARNED TODAY:

- SENSEMAKING AS A GENERAL PROCESS OF MAKING MEANING

- ANALYSIS METHODS TO HELP "MAKE SENSE" OF A SITUATION

READINGS

1. Sharoda Paul: UNDERSTANDING TOGETHER: SENSEMAKING IN COLLABORATIVE INFORMATION SEEKING, PhD Thesis, 2010

2. Russell, D. M., Stefik, M. J., Pirolli, P., & Card, S. K. (1993). The cost structure of sensemaking. In Proceedings of the ACM Conference on Human factors in Computing Systems (CHI '93), 269-276, ACM Press

3. Illuminating the Path: The Research and Development Agenda for Visual Analytics Paperback – January 1, 2005 by James J. Thomas (Editor), Kristin A. Cook (Editor)

4. http://theopenacademy.com/content/lecture-15-sensemaking-iii-searching-and-organizing-information

5. http://www.theguardian.com/world/2004/feb/08/iraq.iraq

6. Characterizing the intelligence analysis process: Informing visual analytics design through a longitudinal field studyY Kang, J Stasko Visual Analytics Science and Technology (VAST), 2011 IEEE Conference on, 21-30

7. K. Wheaton. Wikis in intelligence. Unpublished manuscript, 2011.

8. Heuer. The psychology of intelligence analysis