VISUAL ANALYTICS

SENSEMAKING & ANALYSIS PROCESSES

LECTURE 4

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informatics mathematics
Inria

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
- usually described as 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
- the situation is unfamiliar and no guiding routines, habits, or rules exist
- projects or routines get interrupted
- action is distributed across multiple actors

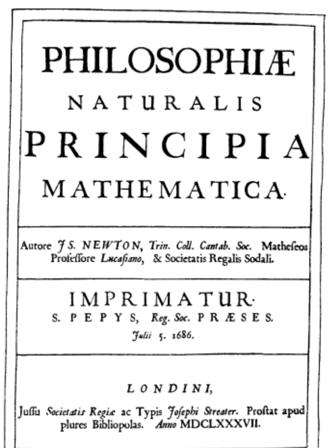
see http://www.slideshare.net/issil2011/ansell-sensemaking-lecture

WHERE DOES SENSEMAKING HAPPEN?

Some examples

IN THE SCIENTIFIC PROCESS

when trying to understand how a system or phenomenon functions

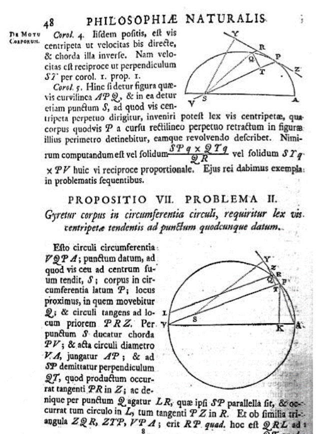


PHILOSOPHIÆ
NATURALIS
PRINCIPIA
MATHEMATICA.

Autore J. S. NEWTON, Trin. Coll. Cantab. Soc. Matheseos Professore Lucasiano, & Societatis Regalis Sodali.

IMPRIMATUR.
S. PEPYS, Reg. Soc. PRÆSES.
Julii 5. 1686.

LONDINI,
Jussu Societatis Regiæ ac Typis Josephi Streater. Prostat apud plures Bibliopolas. Anno MDCLXXXVII.



48 PHILOSOPHIÆ NATURALIS

De Motu Corporum.

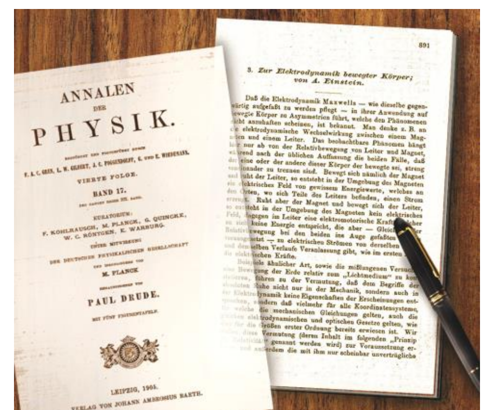
Corol. 4. Iisdem positis, est vis centripeta ut velocitas bis directe, & chorda illa inverse. Nam velocitas est reciproce ut perpendiculum ST per corol. 1. prop. 1.

Corol. 5. Hinc si detur figura quævis curvilinea APQ, & in ea detur etiam punctum S, ad quod vis centripeta perpetuo dirigitur, inveniri potest lex vis centripetæ, qua corpus quodvis P a cursu rectilineo perpetuo retractum in figuræ illius perimetro detinebitur, eamque revolvendo describet. Nimirum computandum est vel solidum $\frac{SPq \times QTq}{QR}$ vel solidum $STq \times PV$ huic vi reciproce proportionale. Ejus rei dabimus exempla in problematis sequentibus.

PROPOSITIO VII. PROBLEMA II.

Gyretur corpus in circumferentia circuli, requiritur lex vis centripetæ tendentis ad punctum quodcunque datum.

Esto circuli circumferentia VQPA; punctum datum, ad quod vis ceu ad centrum suum tendit, S; corpus in circumferentia latum P; locus proximus, in quem movebitur Q; & circuli tangens ad locum priorem PRZ. Per punctum S ducatur chorda PV; & acta circuli diametro VA, jungatur AP; & ad SP demittatur perpendiculum QT, quod productum occurrat tangenti PR in Z; ac denique per punctum Q agatur LR, quæ ipsi SP parallela sit, & occurrat tum circulo in L, tum tangenti PZ in R. Et ob similia triangula ZQR, ZTP, VPA; erit RP quad. hoc est QRL ad QT quad.



ref [4]

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]

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

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]
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)

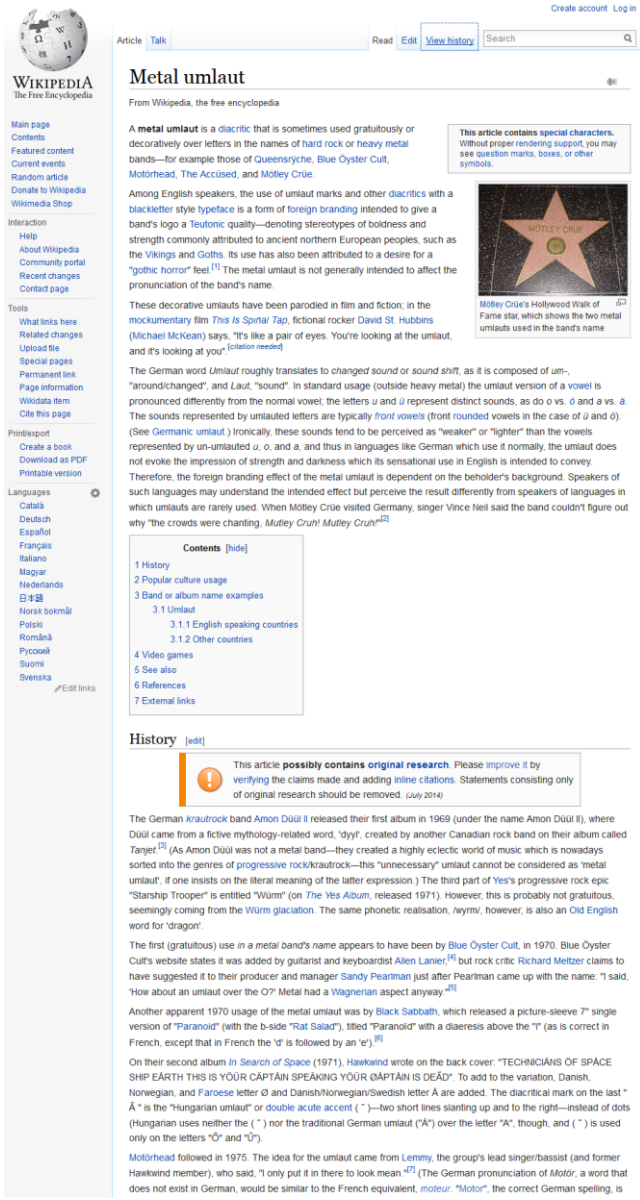
The "heavy metal umlaut" over the ö in the names of Motörhead, and the Blue Öyster Cult has led to the term "spandex and umlaut circuit" being used to describe the heavy metal band touring scene.

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

This article contains special characters. Without proper rendering support, you may see question marks, boxes, or other symbols.

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.

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

The German word *Umlaut* roughly translates to *changed sound* or *sound shift*, as it is composed of *um-*, "around/changed", and *Laut*, "sound". In standard usage (outside heavy metal) the umlaut version of a vowel is pronounced differently from the normal vowel; the letters *u* and *ü* represent distinct sounds, as do *o* vs. *ö* and *a* vs. *ä*. The sounds represented by umlauted letters are typically *front vowels* (front rounded vowels in the case of *ü* and *ö*). (See Germanic umlaut.) Ironically, these sounds tend to be perceived as "weaker" or "lighter" than the vowels represented by un-umlauted *u*, *o*, and *a*, and thus in languages like German which use it normally, the umlaut does not evoke the impression of strength and darkness which its sensational use in English is intended to convey. Therefore, the foreign branding effect of the metal umlaut is dependent on the beholder's background. Speakers of such languages may understand the intended effect but perceive the result differently from speakers of languages in which umlauts are rarely used. When Mötley Crüe visited Germany, singer Vince Neil said the band couldn't figure out why "the crowds were chanting, *Mutley Cruh! Mutley Cruh!*"[2]

Contents [hide]

History [edit]

This article **possibly contains original research**. Please improve it by verifying the claims made and adding inline citations. Statements consisting only of original research should be removed. *(July 2014)*

The German *krautrock* band Amon Düül II released their first album in 1969 (under the name Amon Düül II), where Düül came from a fictive mythology-related word, 'dyyl', created by another Canadian rock band on their album called *Tanjer*.[3] (As Amon Düül was not a metal band—they created a highly eclectic world of music which is nowadays sorted into the genres of progressive rock/krautrock—this "unnecessary" umlaut cannot be considered as 'metal umlaut', if one insists on the literal meaning of the latter expression.) The third part of Yes's progressive rock epic "Starship Trooper" is entitled "Würm" (on *The Yes Album*, released 1971). However, this is probably not gratuitous, seemingly coming from the Würm glaciation. The same phonetic realisation, /wyrm/, however, is also an Old English word for 'dragon'.

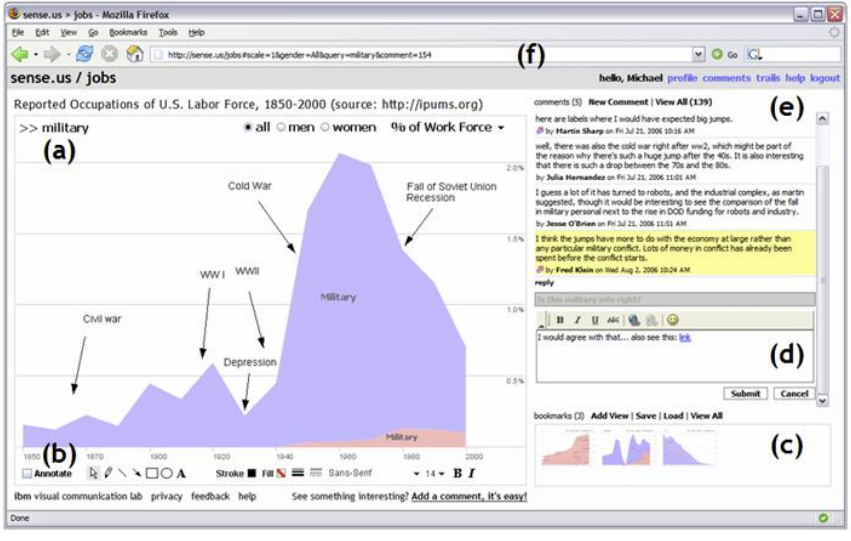
The first (gratuitous) use *in a metal band's name* appears to have been by Blue Öyster Cult, in 1970. Blue Öyster Cult's website states it was added by guitarist and keyboardist Allen Lanier,[4] but rock critic Richard Meltzer claims to have suggested it to their producer and manager Sandy Pearlman just after Pearlman came up with the name: "I said, 'How about an umlaut over the O?' Metal had a Wagnerian aspect anyway."[5]

Another apparent 1970 usage of the metal umlaut was by Black Sabbath, which released a picture-sleeve 7" single version of "Paranoid" (with the b-side "Rat Salad"), titled "Paranoïd" with a diaeresis above the "i" (as is correct in French, except that in French the 'd' is followed by an 'e').[6]

On their second album *In Search of Space* (1971), Hawkwind wrote on the back cover: "TECHNICIÄNS ÖF SPÄCE SHIP EÄRTH THIS IS YÖÜR CÄPTÄIN SPEÄKING YÖÜR ØÄPTÄIN IS DEÄD". To add to the variation, Danish, Norwegian, and Faroese letter Ø and Danish/Norwegian/Swedish letter Å are added. The diacritical mark on the last " Å " is the "Hungarian umlaut" or double acute accent (˝)—two short lines slanting up and to the right—instead of dots (Hungarian uses neither the (¨) nor the traditional German umlaut ("Ä") over the letter "A", though, and (˝) is used only on the letters "Ő" and "Ű").

Motörhead followed in 1975. The idea for the umlaut came from Lemmy, the group's lead singer/bassist (and former Hawkwind member), who said, "I only put it in there to look mean."[7] (The German pronunciation of *Motör*, a word that does not exist in German, would be similar to the French equivalent, *moteur*. "Motor", the correct German spelling, is

COLLABORATIVE VISUAL ANALYSIS



sense.us [Heer, Viegas, Wattenberg]

- Tableau Public
- IBM Many Eyes
- ...

OTHERS

- buying products
- designing products
- ...

	Preis	Motor KW	Diesel Benzin	l/100km	Getriebe	Koffer-raum	Tempo-mat	Klima-anlage	Iso-Fix	Tacho vor Fahrer	Start/ Stopp	Sitz-hei-zung	Ein-park-hilfe	Limiter	Blink-hilfe	digi Radio	3.5 Audi o in	USB	12V	Licht-auto-matik	Re-gen-sen-sor	neuar tige Wisch er	Mittel stopli cht oben	An-haen-ger-kupp-lung	Navi	Bord-com-pu-ter	
uris Touring Sports 1.8 Hybrid Comfort	24,840 €	100	Super	3.7	CVT	530		ja	ja	ja	ja		ja	nein							nein						ADAC-Info
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eat Leon ST	25,590 €	77	Diesel	3.8	7 DSG	587		ja	ja	ja	ja		extra	nein							extra						ADAC-Info
koda Octavia Combi	25,250 €	77	Diesel	4.0	7 DSG	610		ja	ja	ja	ja		ja	nein							extra						ADAC-Info
ord Focus Turnier 1.5 TDCi Start/Stopp Trend Power	25,360 €	88	Diesel	4.2	6 DSG	490		ja	ja	ja	ja		ja	extra							extra				extra		ADAC-Info
ord Grand C-Max 2.0 TDCi Trend Powershift	26,470 €	85	Diesel	5.7	Automat. Schal	439	ja	ja	extra	ja	nein		extra	extra							extra						ADAC-Info
08 SW BlueHDi 150 STOP&START Allure EAT6	29,450 €	110	Diesel	4.2	6 Automat	610		ja	ja	ja	ja		ja	ja							ja						ADAC Info
aguna Grandtour dCi 110 Expression EDC	26,700 €	81	Diesel	4.4	6 DSG	508		ja	ja	ja	nein		ja	ja							ja						ADAC-Info
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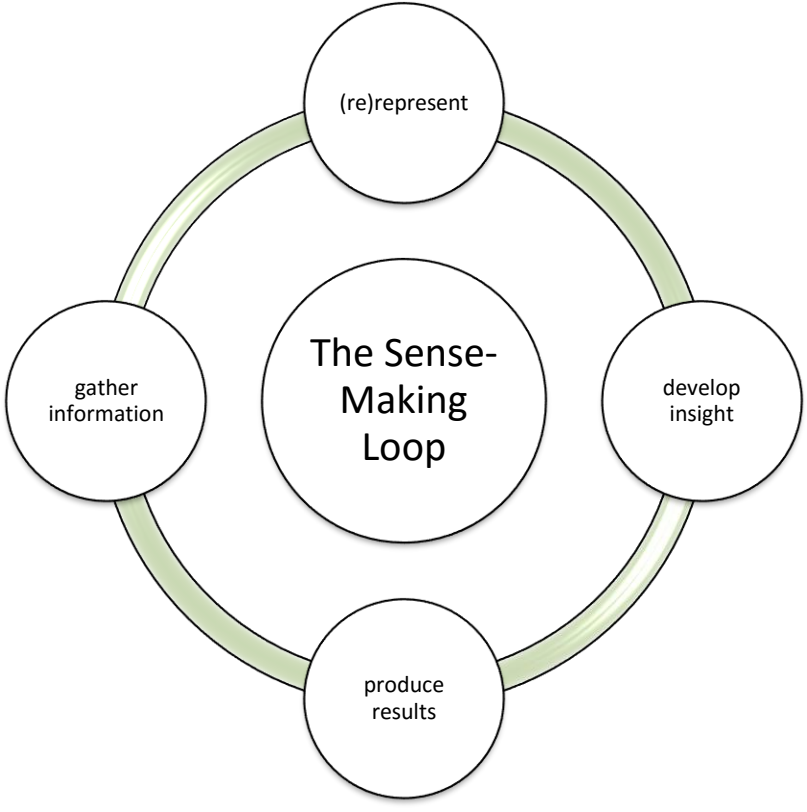
THE PROCESS

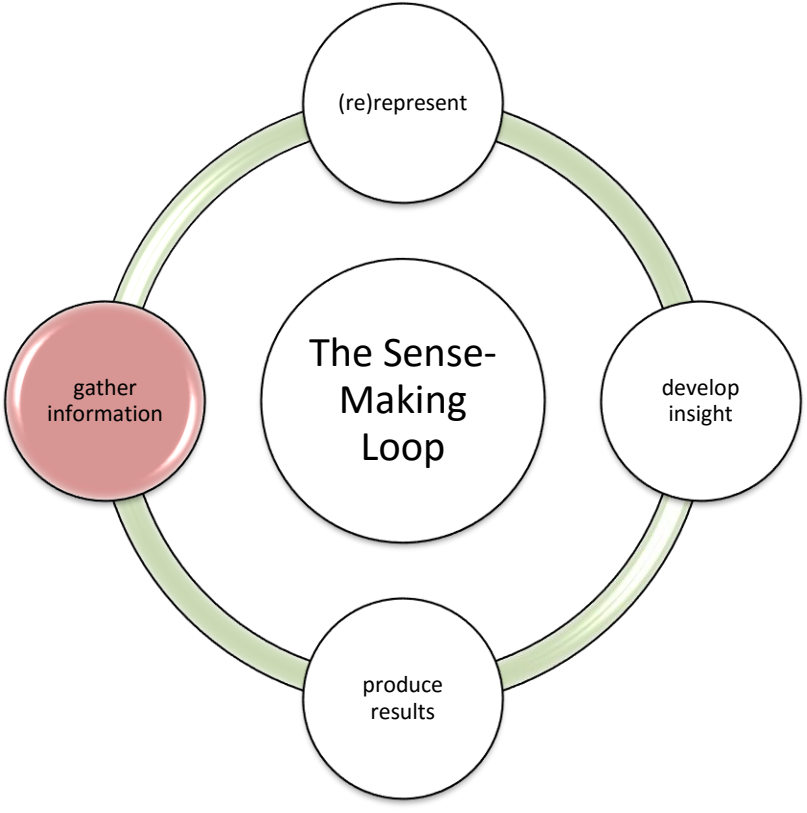
according to visual analytics literature

THE SENSEMAKING LOOP



ref [3]

THE SENSEMAKING LOOP



Buying a car:

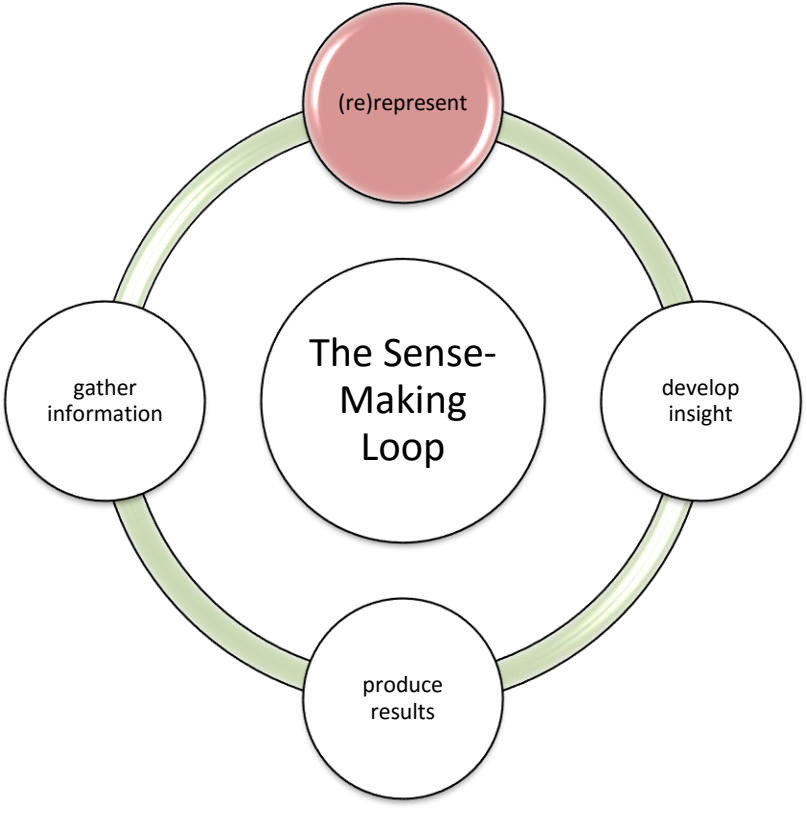
- Gather information:

Statistics - national statistics

Vehicle licensing statistics, Great Britain: Apr to Jun 2014

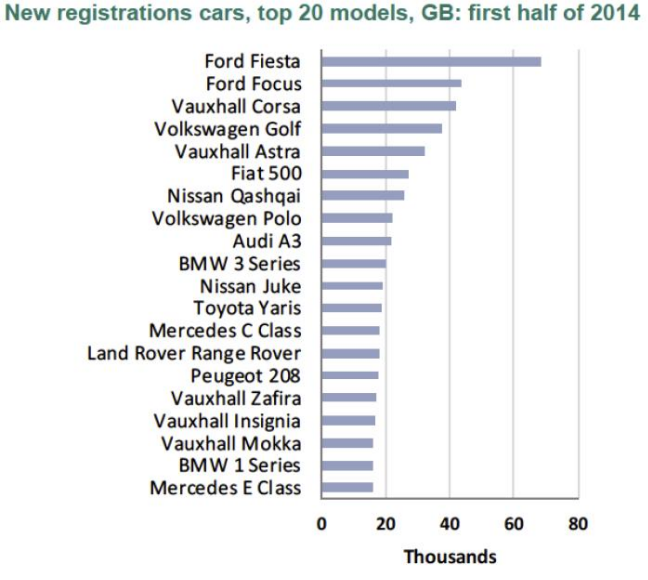
From: Department for Transport
First published: 11 September 2014
Part of: Vehicles statistics, Cars (VEH02), All licensed vehicles and new registrations (VEH01) and Motorcycles (VEH03)

THE SENSEMAKING LOOP

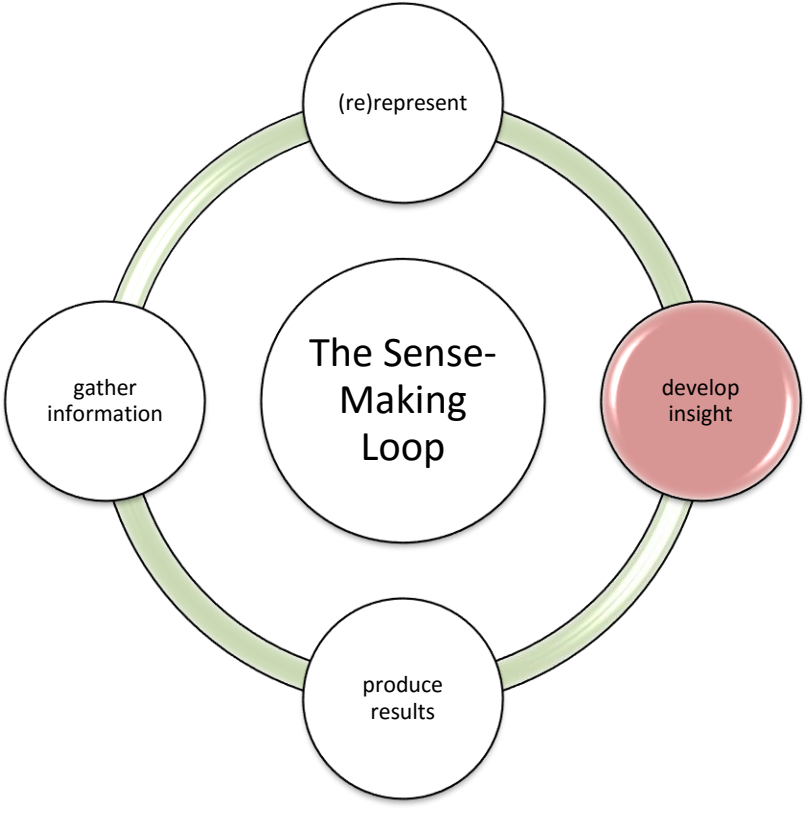


Buying a car:

- Represent:



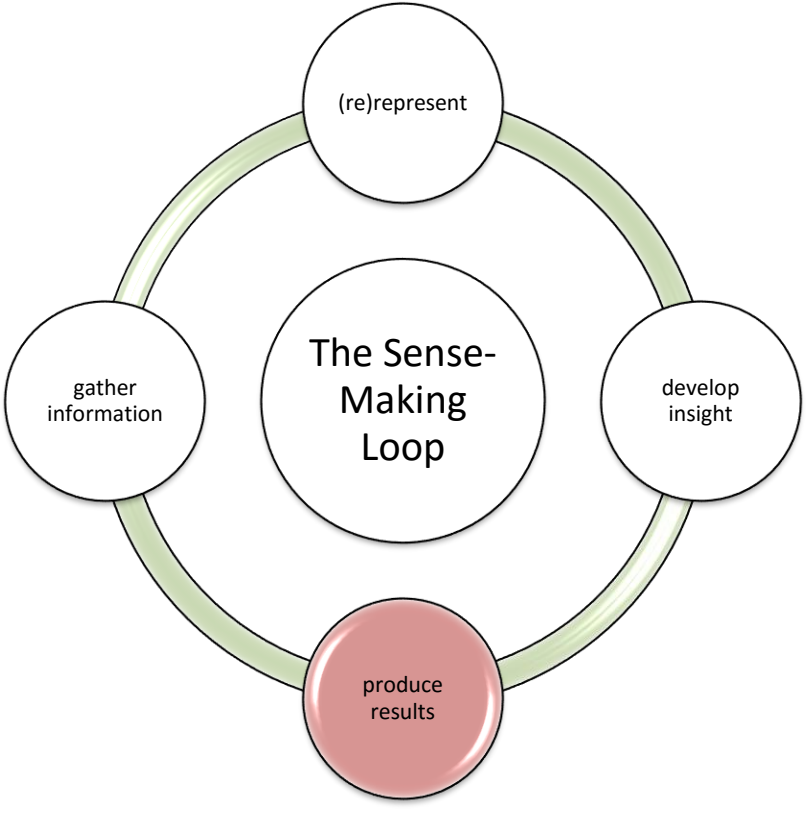
THE SENSEMAKING LOOP



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



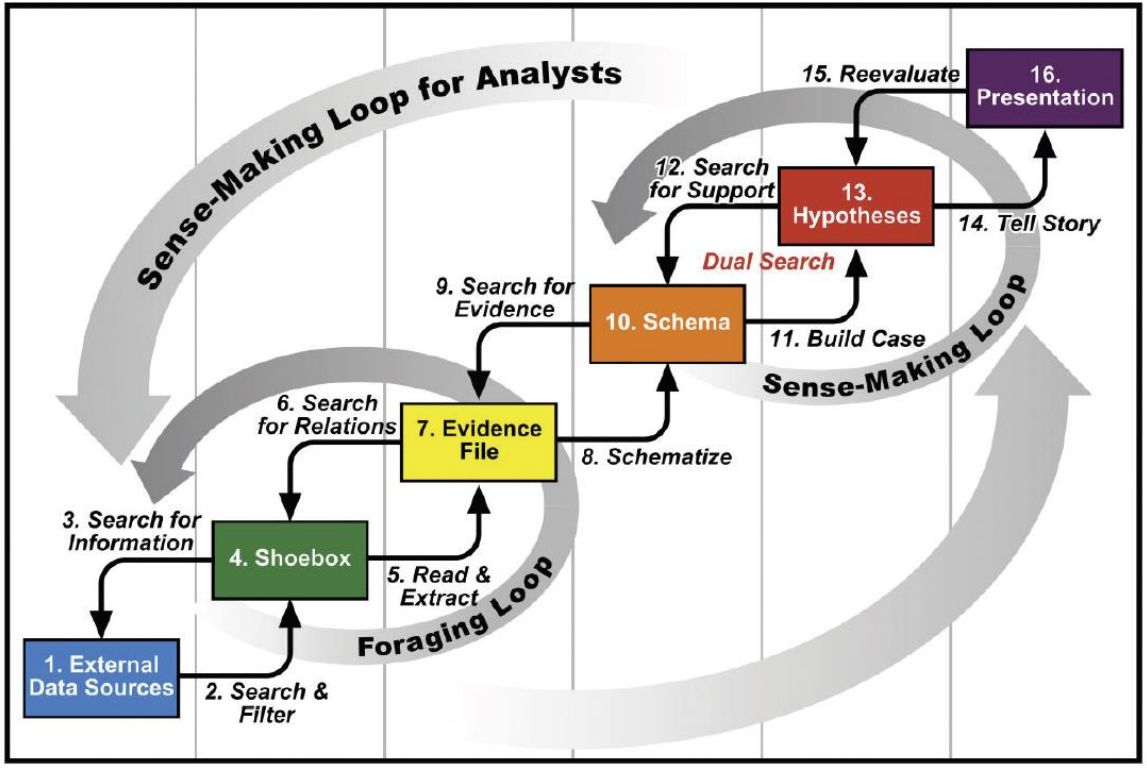
Produce result:

- 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 

  - 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?:
Criteria that will be used to identify these key players are:
- Those that are not beholden to the IC or US Government as primary sources of funding.
- Those that are looking at future based events or actions that are outside the control of the forecaster/predictor.

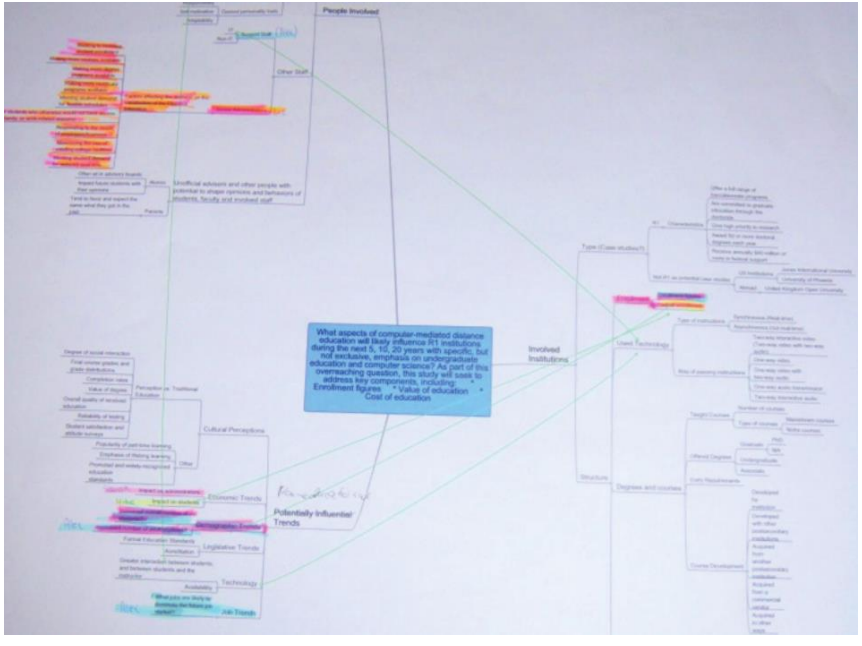
EXAMPLE

Georgia Tech College of Computing
Youn-ah Kang and John Stasko

Why?

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

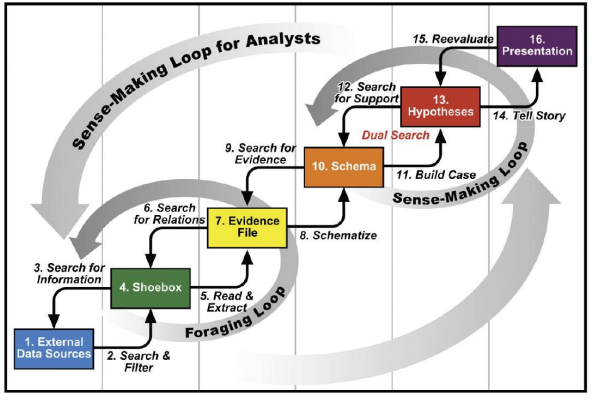
- Analysis
  - process data to convert “data into knowledge”
  - different methods used
  - close connection to collection & production phase

PROCESS COMPONENTS

- Production
  - synthesis of individual findings
  - prepare presentation for decision makers
  - checking and validation common

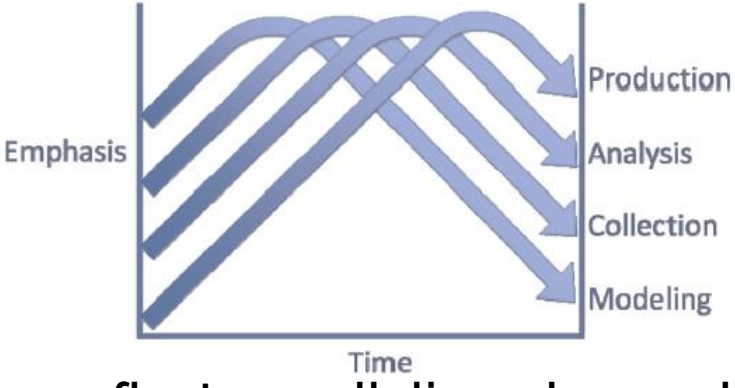
GENERAL PROCESS FINDINGS

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

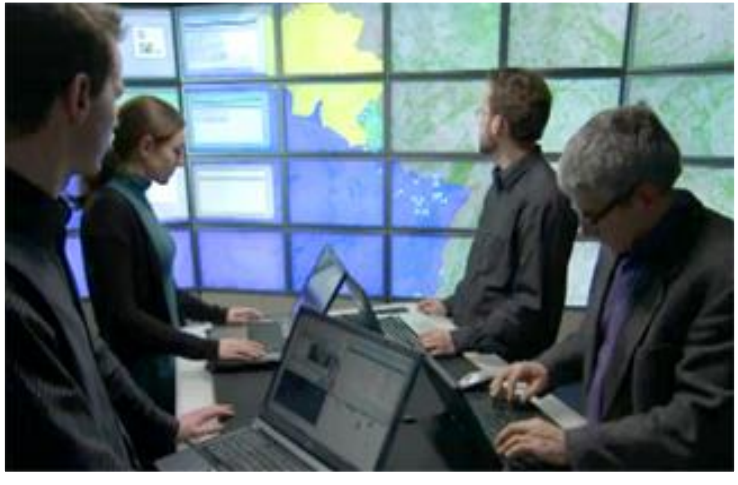
GENERAL PROCESS FINDINGS

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

→ 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
- 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
- hypothesis management
- structured presentation / argumentation
- interactive analysis & presentation

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

- how do you know what you don't know?
  - how do you know if you have generated all possible hypotheses?

Ackn. Remco Chang

HOW TO GENERATE HYPOTHESES?

Four principle strategies:

- Situational Logic
- Applying Theory
- Comparison with Historical Cases
- “Non-strategy” – data immersion

Ackn. Remco Chang

SITUATIONAL LOGIC

- Most common operating mode for intelligence analysts.
- Begins with consideration of concrete elements of the current situation.
- The situation is regarded as "one-of-a-kind" so that it must be understood using its own unique logic
- 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

Ackn. Remco Chang

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

Ackn. Remco Chang

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?

Ackn. Remco Chang

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

Ackn. Remco Chang

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.

Ackn. Remco Chang

COMPARISON WITH HISTORICAL CASES

- Typically used as a shortcut, when no data or theory available
- When time pressure is high

Ackn. Remco Chang

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

Ackn. Remco Chang

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

Ackn. Remco Chang

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

Ackn. Remco Chang

DATA IMMERSION

- Problem:
  - “Information cannot speak for itself”
  - It requires a context (or a person’s mental model)

Ackn. Remco Chang

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

Ackn. Remco Chang

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

Ackn. Remco Chang

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
  - 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

Ackn. Remco Chang

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
- 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)

Ackn. Remco Chang

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
  - …

THINKING AIDS

- 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.

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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

no diagnostic value →

diagnostic value →

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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:
  - Note the absence of evidence as well as its presence! (In a Sherlock Holmes story, "the dog did not bark" was a vital clue)
- Step 4:
  - Need to add new evidence? Combine hypotheses?
- Step 5:
  - All "+"s do not indicate a proven hypothesis, but the fewest "-"s are more likely to be true.
  - Finding all supporting evidences for a hypothesis is too easy. 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:
  - 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?
- Step 7:
  - Need to report confidence level!
  - Discuss findings in step 6.
- Step 8:
  - 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

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