

# Structured Analysis of Competing Hypotheses

## Improving a Tested Intelligence Methodology

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One of the best general purpose methodologies for intelligence analysis is Richards Heuer's analysis of competing hypotheses (ACH). First developed by Heuer between 1978 and 1986 while he was an analyst at the Central Intelligence Agency (CIA), ACH draws on the scientific method, cognitive psychology, and decision analysis. This method became widely available for the first time when the CIA published online Heuer's now-classic book, *The Psychology of Intelligence Analysis*.

The ACH methodology helps analysts overcome cognitive biases common to analysis in national security, law enforcement, and competitive intelligence. Using ACH forces analysts to set aside their preconceptions and look for inconsistencies in the data that may indicate a flaw in their reasoning or deception by the target. This method forces analysts to *disprove* hypotheses rather than let their minds jump to conclusions and permit biases and mindsets to determine the outcome before they properly evaluate the evidence.

### THE EIGHT-STEP METHOD

Analysis of competing hypotheses is a very logical process consisting of eight fairly straightforward steps. A synopsis of the method follows. More complete details can be found in chapter 8 of Heuer's book (Heuer 1999).

#### 1. Hypotheses generation

This step requires divergent thinking to ensure that all hypotheses are considered, and convergent thinking to ensure that redundant and irrational hypotheses are eliminated from the final set of hypotheses. Obviously, where to draw this line is more art than science.

#### 2. List evidence and arguments

Heuer recommends that "evidence" be interpreted broadly to include all factors (assumptions or logical deductions, goals, and standard procedures regarding the target) that might have an impact on judgments about the hypotheses (see sidebar 1).

#### 3. Create a matrix

Take the hypotheses from step 1 and the evidence from step 2, and put them into a matrix, with the hypotheses listed across the rows and the evidence down the first column (see table 1). Move *across* the rows, one piece of evidence at a time, and decide whether the evidence is consistent (+), inconsistent (-), or irrelevant (N/A) to the hypothesis being tested. This will help you determine if the evidence supports or refutes the hypotheses.

Perform this process for each remaining piece of evidence, keeping in mind that the purpose of this step is to determine how each piece of evidence relates to each hypothesis. In our demonstration example, consider a matrix where there are a few additional pieces of evidence such as, "The doctor has advised the boss to limit his fat intake" or "The boss is thrifty."

#### 4. Refine the matrix

In this step, reassess the hypotheses in light of the evidence. Reconsider or reword hypotheses to reflect all significant alternatives. Some hypotheses may need to be combined with others or separated into two. Cross out, but do not remove from view, evidence from the matrix that is consistent with all hypotheses (i.e., has no diagnostic value). Do not delete evidence that is not useful in simple ACH as it may be critical in structured ACH.

In this case, the fact that the boss always buys his lunch, that he is thrifty, and that there are only two restaurants nearby do not help the office worker disprove either of the hypotheses. These facts have no real adjudicative value in this analysis.

## 5. Tentative conclusions

Working *down* the columns of the matrix in table 1, review each hypothesis to draw tentative conclusions about the relative likelihood of each one. In this case, it seems likely that the boss is not going to Burger Barn. Furthermore, of all the facts gathered so far, only the fact that the boss's wife is monitoring his diet and the fact that the boss's doctor has recommended a low-fat diet have any relevance here. These are the linchpins around which the analysis revolves.

## 6. Reevaluate weight of critical evidence

Re-examine key assumptions and pieces of evidence that seem to drive the analysis in a particular direction. Now that the office worker understands the logic – what counts and what doesn't – in his analysis, he should go back and examine each piece of it in detail for flaws. Does it make sense in whole and in part?

Heuer says, "When analysis turns out to be wrong, it is often because of key assumptions that went unchallenged and proved invalid." (Heuer 1999 p.106) This step is designed explicitly to challenge those assumptions.

## 7. Report conclusions

One of the real strengths of ACH is that it makes the logic behind the analysis transparent to the decision-maker. In Heuer's method, report both the conclusions and the other hypotheses that were tested and rejected.

## 8. Milestones for future observation

Because events are dynamic and subject to a variety of influences, analytic conclusions are always tentative. Therefore, specify in advance that certain occurrences, if observed, could cause significant changes in the probability of the accepted or alternative hypotheses. Collection of additional information can also suggest possibilities that may occur in the future.

## STRENGTHS AND WEAKNESSES

Analysis of competing hypotheses, like all analytic methods, has a variety of strengths and weaknesses. The strengths of the method include the following:

- **Audit Trail.** By listing the evidence, weighing its relevance and importance, and applying it to the hypotheses in the matrix, ACH illustrates the analytic processes and creates a clear evidence trail. This helps us both explain our findings to decision-makers and conduct after-action reviews of their analyses to see what went right (or wrong).
- **Overcome Cognitive Biases.** Using ACH forces us to look at alternative hypotheses in a systematic way.

### SIDEBAR 1: WHERE IS THE BOSS GOING TO LUNCH?

As a simple demonstration of the ACH process, imagine an office worker is about to go out to lunch but does not want to go to the same place his boss goes for lunch. Furthermore, there are only two real options for lunch in the area, Burger Barn or Sub Road. Thus, there are two possible hypotheses to test in order to avoid his boss:

- The boss will eat lunch at Burger Barn.
- The boss will eat lunch at Sub Road.

Disproving hypotheses provides a more effective method for avoiding established mental roadblocks and showing us how dependent we may be on a single piece of evidence that may lead to the wrong conclusion.

If analysis of competing hypotheses is such a good method, why is it not used more often? Certainly, Heuer's work has had enough time to penetrate the collective consciousness of the analytic community. In fact, several weaknesses keep this method from being used.

- **Dependent on evidence validity.** Analysis is only as good as the evidence that goes into the process. Unreliable evidence or disinformation can undermine even the most thoughtful process execution. While this is a problem with all analytic methods and is, therefore, a weak criticism of the method, it often calls into question the seemingly "scientific" results of the ACH method.
- **Time consuming.** Performing the ACH process manually can be long and arduous, especially when there are numerous hypotheses and a large body of evidence. Analysts often feel they do not have the time to follow this more formal process.

## THE NEED FOR STRUCTURE

Heuer's method is generally accepted as one of the best available for intelligence analysis. However, some improvements are required to get the most out of it and, more important, to persuade analysts to actually use it. Specifically, we suggest that ACH needs structure and automation.

Adding structure to ACH allows us to take our analysis further and deeper—to go beyond the first estimate and discover not only what we do not know, but also what we *can* know with a reasonable degree of certainty. Automating the process facilitates the analysis and encourages more analysts to actually use the method.

## SIDEBAR 2: TOOLS FOR AUTOMATING SACH

- ACH 2.0.3 (download this tool for free at <http://www2.parc.com/istl/projects/ach/ach.html>)
- Decide (for more information see <http://www.sss-research.com/products.aspx>)
- DecisionBreakthrough (for additional information contact Willard Zangwill at [Willard.zangwill@chicagogsb.edu](mailto:Willard.zangwill@chicagogsb.edu))

## WHAT DO WE MEAN BY “STRUCTURE” ?

Consider the following statement:

### *DO GEESE SEE GOD*

If you were putting together a team to analyze this phrase, who would you choose? A theologian? An ornithologist? Maybe a philosopher? How about a ninth-grade English teacher – the person who first teaches us about palindromes, words or phrases that are spelled the same backward and forward.

If you didn't consider your ninth-grade English teacher as an appropriate member for your team, maybe it was because you jumped to some early conclusions. Perhaps you assumed the most important thing about the phrase was that it was an English-language question (even though there was no question mark). Perhaps you focused on the meaning of that English-language question first. Clearly it is both in English and apparently a question, but making those leaps early in your analysis caused you to miss something important about the phrase.

To overcome such cognitive biases, structured analysis of competing hypotheses (SACH) asks you to begin with the simplest possible hypotheses and then to drill down, becoming increasingly specific, expanding and deepening the estimative conclusion.

## THE VALUE OF STRUCTURE: AN EXAMPLE

To begin, imagine that you have been asked to look at a new entrant into your firm's existing market in widgets. The first step in ACH and in SACH is to determine appropriate hypotheses. In SACH, however, you are required to ask the simple questions first. One of the simplest questions you could ask is, “Will this new entrant compete with us?” which, in turn, leads to two simple hypotheses to test:

- The new entrant will compete with us.
- The new entrant will not compete with us.

Already you can see the value of structuring the ACH process. For example, it would be a simple mistake to assume that because you had been told to examine the firm, it was a competitor. Without questioning, however briefly, this

implicit assumption up front, you could spend a considerable amount of time investigating a firm that might have little or no impact on your company's operations.

Working through the available evidence using the standard eight-step ACH methodology on this simple set of hypotheses assures you that you are working on something of value for your company. Alternatively, it gives you the evidence to go back to your boss and argue that there are better things to spend your time on.

Assuming the evidence collected so far suggests that the new firm is a legitimate competitor, you are now in a position to take the second step in the structured process. Here you build off the hypothesis most consistent with the evidence available from the first level and ask a second question that broadens your understanding of the issue.

For example, knowing that the new firm is a competitor, the second natural question might be, “In what product lines will this new firm attempt to compete with us?” The hypotheses generated by this question might include the following:

- The new firm will attempt to compete with us in our large widget product line.
- The new firm will attempt to compete with us in our small widget product line.
- The new firm will attempt to compete with us in both product lines.

Note that the hypotheses “compete” with each other. They are mutually exclusive; only one can be true. Once you generate the hypotheses, take the exact same evidence compiled for the first set of hypotheses and go through the eight-step ACH process again. Much of the evidence that was relevant to the first set of hypotheses might now be irrelevant. Evidence that was very useful in evaluating the first set of hypotheses might now be consistent with both hypotheses and thus have no adjudicative value.

Alternatively, when the evidence already collected is viewed in light of these new hypotheses, it might still prove definitive. In this case, no additional evidence needs to be collected, and you can take the analysis to yet another level of complexity. (You might ask, “How will the new entrant compete with our large widget product line?” assuming that the evidence clearly showed that the large widget line was where the competition is likely to focus.)

Oftentimes, however, the evidence is not clear. None of the hypotheses seem more likely than the others. In this case, additional collection is clearly warranted. Furthermore, the questions that need to be answered to resolve the inconsistencies become the basis for the collection plan.

The flowchart in figure 1 illustrates this process. Note that this process is a never-ending loop. Theoretically, at least, there is no specific end to the process. An analyst can carry it out as long as there are questions and useful evidence.

**TABLE 1: EXAMPLE OF SIMPLE ACH MATRIX**

Where is the boss going to lunch?		
	Burger Barn	Sub Road
Boss always buys his lunch	+	+
Wife is monitoring his diet	-	+
Boss is thrifty	+	+
Doctor advised boss to limit fat	-	+
Only two restaurants nearby	+	+

Practically, the process usually exhausts itself after three to four iterations or until significant new evidence comes to light.

This process is far more time consuming than simple ACH and cries out for automation. Fortunately, a number of products are currently available or in the works to help analysts use either ACH or SACH (see sidebar 2).

**IMPROVING THE DECISION-MAKING PROCESS**

Using SACH eases the process for analysts from start to finish by closing evidence gaps and creating a tighter finished product. Documenting every step in SACH later helps you easily follow the estimative process. Because SACH provides a trail of auditable information, should you provide an incorrect estimate, it is easier to evaluate what went wrong.

In addition to helping analysts, SACH helps at least three other groups in the decision-making process better

understand the analysis and the analytic process. SACH:

- Assists managers in supervising and monitoring analysts' progress.
- Provides decision-makers with higher-quality products while making it easier for them to see exactly how the analyst arrived at the final estimate.
- Improves oversight as products are more easily defensible by clearly tracing all thought processes back to the simplest hypotheses.

The intelligence community uses numerous well-known and practical methodologies. Few, however, rival the power and analytic precision of Heuer's analysis of competing hypotheses. Flexible yet authoritative, comprehensive yet realistic, adding structure and automation to ACH can only improve it, not replace it.

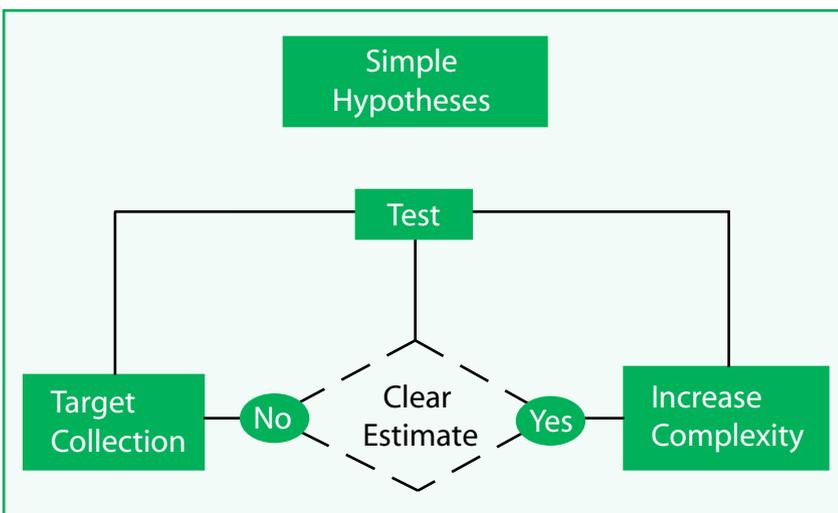
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**Figure 1: SACH process flowchart**