PROBLEM ANALYSIS

Clear thinking for tough problems
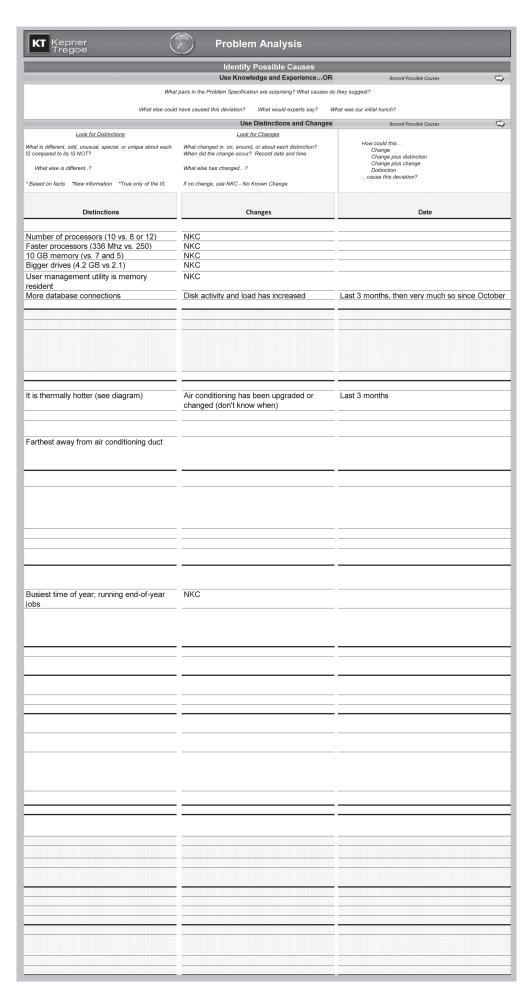
REFERENCE

KT Kepner Tregoe
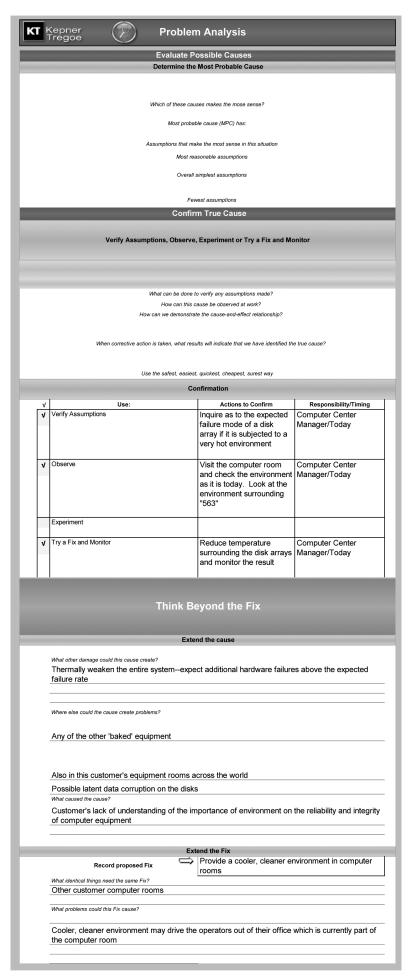
Problem Analysis

Describe Problem

State the Problem (one object, one deviation)

What object (or group of objects) has the deviation?	What deviation does it have?
What do we see, hear, feel, taste, smell, or measure that tells us there is a deviation?	What data tells us that a deviation exists?

Memory Driver stopped working on Series G machine number "563"

Specify the Problem

		IS	IS NOT
WHAT	What object?	Series G machine number "563"	Series G machine "380"; Series G machine "564"
	What deviation?	The Memory Driver had 'hung' (operating system appeared to have stopped working)	System spontaneously powering down; a single application hanging
WHERE	Where geographically?	Within the computer room on-site in the basement. In the computer room. In a cabinet (10-meters long, 1-meter wide and three-meters high) at the far end away from the door	"564" is in an annex to the main computer room in a single 1-meter wide, 1-meter deep, 3-meters high cabinet. "380" is in the main computer room in a recently purchased custom made comms-rack style cabinet
	Where on the object?	NMD--Failure log required but is not available	NMD
WHEN	When first?	9:30 October 6th	Between September 26th and October 6th (NMD on last known time when Memory Drive 563 was working)
	When since?	N/A--563 was removed from production and the year-end job restarted elsewhere	N/A
	What is the Pattern?	Single Instance	Remaining pattern types
	When in the life cycle?	In the last 20 minutes of a 3-hour intensive batch job, read-intensive 150 users on the machine at the time performing ad hoc queries, 3 instances of the database running	Start or middle of the batch job
EXTENT	How many objects?	One machine	2, all 3
	What is the trend?	Stable →	Remaining trend types
	What is the size?	N/A	N/A
	What is the trend?	NMD	NMD
	How many deviations?	First occurrence	Several occurrences
	What is the trend?	NMD	NMD

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Problem Analysis

Identify Possible Causes

Use Knowledge and Experience…OR	Record Possible Causes ⇨

What pairs in the Problem Specification are surprising? What causes do they suggest?

What else could have caused this deviation?   What would experts say?   What was our initial hunch?

Use Distinctions and Changes

Record Possible Causes ⇨

Look for Distinctions

What is different, odd, unusual, special, or unique about each IS compared to its IS NOT?

What else is different..?

* Based on facts   *New information   *True only of the IS

Look for Changes

What changed in, on, around, or about each distinction? When did the change occur? Record date and time.

What else has changed…?

If no change, use NKC - No Known Change

How could this…
  Change
  Change plus distinction
  Change plus change
  Distinction
…cause this deviation?

Distinctions	Changes	Date
Number of processors (10 vs. 8 or 12)	NKC	
Faster processors (336 Mhz vs. 250)	NKC	
10 GB memory (vs. 7 and 5)	NKC	
Bigger drives (4.2 GB vs 2.1)	NKC	
User management utility is memory resident	NKC	
More database connections	Disk activity and load has increased	Last 3 months, then very much so since October
It is thermally hotter (see diagram)	Air conditioning has been upgraded or changed (don't know when)	Last 3 months
Farthest away from air conditioning duct		
Busiest time of year; running end-of-year jobs	NKC	

Problem Analysis

Evaluate Possible Causes — Column 1

Test Possible Causes

For each IS/IS NOT pair, answer the following question:

If (Possible Cause) is the cause of (Problem Statement), then how does it explain both the IS and the IS NOT information?

(Y) YES, explains because…

(N) NO, does not explain because...   (A) Explains ONLY IF (assumption)...

Record supporting data   List all assumptions

MPC ↑ / Y, N, A	Possible Cause — *Explain how the cause creates the deviation*
	Bug in beta version of user management utility which causes the memory driver to hang
N	Does not explain how the utility problem can lead to only a single application failure

Evaluate Possible Causes — Column 2

Test Possible Causes

For each IS/IS NOT pair, answer the following question:

If (Possible Cause) is the cause of (Problem Statement), then how does it explain both the IS and the IS NOT information?

(Y) YES, explains because…

(N) NO, does not explain because...   (A) Explains ONLY IF (assumption)...

Record supporting data   List all assumptions

√ MPC

MPC ↑ / Y, N, A	Possible Cause — *Explain how the cause creates the deviation*
	Due to insufficient cooling for the machine, a threshold has been reached, and the disk arrays have begun to behave unpredictably
A	Machine 563 is the only machine becoming overheated while machines 564 and 380 are at normal operating temperature, assuming that 564 and 380's AC unit has been able to keep them both sufficiently cooled.
A	Insufficient cooling would more likely trigger the operating system to stall or freeze versus shut down, and insufficient cooling would not affect just one application as the entire unit is physically cooled and therefore would be affected as a whole
Y	The basement is thermally hotter than the main computer room, which houses both machines 564 and 380 OR 564 and 380 are at the door end of the rack, nearest to aircon duct.
	NMD
A	Disk arrays were running over temperature on Oct. 6th. When disk arrays are run over temperature,
A	During the last 20 minutes of the batch job machine 563 became overheated because of the volume of activity that was occurring, and the AC unit was ineffective at keeping it under a controlled temperature
A	The other machines are being kept sufficiently cooled by their own AC units
A	Machines 564 and 380 are not overheating and being sufficiently cooled
	N/A
	NMD
A	Disk arrays just recently ran over temperature and then behaved erratically as a one-off instance
	NMD

Evaluate Possible Causes — Column 3

Test Possible Causes

For each IS/IS NOT pair, answer the following question:

If (Possible Cause) is the cause of (Problem Statement), then how does it explain both the IS and the IS NOT information?

(Y) YES, explains because…

(N) NO, does not explain because...   (A) Explains ONLY IF (assumption)...

Record supporting data   List all assumptions

MPC ↑ / Y, N, A	Possible Cause — *Explain how the cause creates the deviation*
	There is some interaction between the operating system, the user management utility, the application and the user data which causes the memory driver to hang
A	The user load uses large data sets using increased input/output load
A	The interaction occurring among the operating system, user management utility, the application, and the user data is affecting the system as a whole, versus individual applications, and is such that it would not result in a total shutdown
Y	Machine 563 is located in the basement.
	NMD
A	The usage of the system peaked on Oct. 6th
A	There is something in the data set to trigger this interaction
A	The other two machines have not yet experienced the same type of interaction
A	The other two machines have not yet experienced the same type of interaction
	N/A
	NMD
A	An interaction of events occurred only when system usage peaked
	NMD

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Evaluate Possible Causes

Determine the Most Probable Cause

Which of these causes makes the mose sense?

Most probable cause (MPC) has:

Assumptions that make the most sense in this situation

Most reasonable assumptions

Overall simplest assumptions

Fewest assumptions

Confirm True Cause

Verify Assumptions, Observe, Experiment or Try a Fix and Monitor

What can be done to verify any assumptions made?
How can this cause be observed at work?
How can we demonstrate the cause-and-effect relationship?

When corrective action is taken, what results will indicate that we have identified the true cause?

Use the safest, easiest, quickest, cheapest, surest way

Confirmation

√	Use:	Actions to Confirm	Responsibility/Timing
√	Verify Assumptions	Inquire as to the expected failure mode of a disk array if it is subjected to a very hot environment	Computer Center Manager/Today
√	Observe	Visit the computer room and check the environment as it is today. Look at the environment surrounding "563"	Computer Center Manager/Today
	Experiment		
√	Try a Fix and Monitor	Reduce temperature surrounding the disk arrays and monitor the result	Computer Center Manager/Today

Think Beyond the Fix

Extend the cause

What other damage could this cause create?

Thermally weaken the entire system--expect additional hardware failures above the expected failure rate

Where else could the cause create problems?

Any of the other 'baked' equipment

Also in this customer's equipment rooms across the world

Possible latent data corruption on the disks

What caused the cause?

Customer's lack of understanding of the importance of environment on the reliability and integrity of computer equipment

Extend the Fix

Record proposed Fix ⇨ Provide a cooler, cleaner environment in computer rooms

What identical things need the same Fix?

Other customer computer rooms

What problems could this Fix cause?

Cooler, cleaner environment may drive the operators out of their office which is currently part of the computer room