U-SIT And Think News Letter - 09

Updates and Commentary

Unified **S**tructured **I**nventive **T**hinking is a problem-solving methodology for creating unconventional perspectives of a problem, and discovering innovative solution concepts, when conventional methodology has waned.

Dear Readers:

- Today's mini-lecture became a bit long in its draft form so I have divided it into two parts. The second will appear in the next edition. This has the advantage that you can practice what you have learned so far by completing the QC graph from where we end in this newsletter.

1. USIT – How to Invent: the USIT textbook.

2. USIT – an Overview

3. Mini USIT Lecture – 09

A Qualitative-Change Graph for Messy Newsprint

Continuation of the publisher's problem – "Ink on newsprint is messy. Fix it!"

Recap: In Mini-Lecture_08 the qualitative-change graph was defined and you were encouraged to aply it to the messy newsprint problem.

ML_09: The qualitative-change graph is used to identify trends in causal attributes that worsen the unwanted effect. This tool analyzes a problem. The closed-world diagram analyzes the same system as it was designed to function – i.e., assuming there is no problem.

The common ordinate of the two qualitative-change graphs (see figure) can be labeled "probability of smeared ink" as the unwanted effect, which becomes increasingly worse in the upward direction. This choice of direction towards things getting worse might seem a little strange, but it is used to introduce another unconventional viewpoint. The objects, paper, ink, and air, are added in three boxes on each abscissa of the graphs. Causal attributes, to be listed under each object, were found in NL_04 and NL_05. They included 12 for paper, 7 for ink not bonding to paper, 7 for ink not bonding to itself, and 3 for air. Two of the attributes for ink, temperature and viscosity, are the same for ink bonding to paper and to itself. They may or may not have the same trends concerning the probability of smearing ink. We'll look into this as we go along. We will examine each previously identified causal attribute and test it to determine which trend graph it belongs to.

What we are preparing to do is a repeat process of the original thinking that went into identifying the causal attributes. Is this a waste of time? I think not. In the first pass we simply identify attributes, while in the second we look for the affects of their trends. Practice shows that this type of repetition clarifies original thinking, allows corrections, and deepens understanding as overlooked ideas come to mind, producing additional causal attributes. (You will see my errors, rethinking, and new ideas.)

Phenomenology and models: Identification of attributes, and especially identification of attribute trends, requires development of mental models to guide one's thinking. These are personal inventions that are compatible with one's training, experience, and technical intuition. They are windows to fundamental phenomenology and you are encouraged to press the limits of your capabilities in building your models. An initial model can be constructed from one's undergraduate level of college training. Iterations of a model's usage may bring to mind further improvements; thus, a model grows with use. Area experts can help you improve your model; but they may not be readily accessible so one must resort to personal ability to get started. My first attempt at a model was laid out in the second paragraph of Mini Lecture-04. No one has taken issue with assumptions listed there.

However, I feel the need to enlarge my model to allow interpretation of interface effects: insoluble ink particle to liquid-phase ink interface, insoluble ink particle to air interface, and liquid-phase ink to air interface. Ink particles, whether in dry or wet ink, are always covered with at least a monolayer of molecules from the liquid-phase ink – most likely water molecules, assuming the particulate to be hydrophilic. This is a presumed necessity for particle wetting in a colloidal suspension. A monolayer of water molecules adsorbed on ink particulate would be sufficient to support particle-to-particle bonding. When separated further by liquid-phase ink the particles would experience lubricity as a result of a liquid's inability to support shear – it undergoes viscous flow instead. I'll use this expanded model as I try to identify attribute trends.

Attributes of paper: Smoothness of paper was seen as a deterrent to lock-and-key type of physical bonding – the more smoothness, the shallower, and consequently weaker, will be any lock-and-key bonding and the greater the probability of smearing ink. Thus, smoothness is listed under the left-hand graph (L). Inadequate absorption of ink into paper was seen as removing too little of the liquid phase ink leaving the remaining ink particulate unable to make contact and bond to other ink particules or to the paper.

Thus, the smaller the degree of absorption by paper the greater will be the probability of smearing ink (assigned to the right hand graph, R). This raises two more fundamental phenomena: affinity of ink to paper and affinity of ink to ink. An idea comes to mind:

> Solution concept [11]: Design ink as a two-component colloidal suspension consisting of colored particulate and *absorbing* liquid. Until ink is applied to paper, the liquid enables transport of the particulate as a colloidal fluid. Once ink has been applied to paper, the liquid is readily absorbed, by design, into the paper leaving dry ink particulate on the surface. The dry ink, lacking lubricity of its transporting liquid, is less apt be smeared. Note that this concept involves a different model from concept [3] in NL_06.

Absorption of ink into paper brings up the question of what do *adsorption* and *absorption* mean? My dictionary is not adequately clear on this to suit my taste. So I'll give you my interpretation. (You can take it or leave it – as they say.) When, for example, a paper towel is used to remove spilled water, two effects are present: dissolution and capillarity. *Dissolution*: Water partially dissolves the binder holding paper particles together forming a paste-like liquid clinging to the remaining dry paper. Thus, water and insoluble paper particulate become commingled with water molecules distributed throughout the penetrated region of paper towel. In fact, too much water, for the quantity of paper used, allows the water to dissolve the binder completely leaving a paste-like liquid (where the spill was). *Capillarity*: Adsorption, by comparison, only holds liquid onto the surface of paper with physical bonds – involving no liquid dissolution of the binder. However, open porosity of the paper provides pores into which liquid can be wicked and there adsorb on the walls of the pores according to paper's wettability and water's surface tension (interdependent attributes). High paper density would reduce pore size and density and lessen ink adsorption (L).

Inadequate physical bonding of ink by paper brings up too little lock-and-key type bonding, the simple engagement of irregularities in the shape of two objects (discussed above), and too few van der Waals' bonds (low surface-density of bonds), the forces holding molecules together. Weak van der Waals' bonding would allow slipping, or shear between molecules, permitting ink smearing (R).

I noticed that in NL_04 I listed chemical bonding also for paper, although it was dropped in NL_05. Chemical bonds hold atoms together in molecules – requiring stronger bonds than needed for molecule-to-molecule bonding. "Water content of paper may not provide any chemical activity for bonding (?)" – was also mentioned in NL_04 and retained in NL_05. I am dropping this also to avoid confusing chemical and physical bonds.

Paper's affinity for water allows physical bonding with, at least, the water component of ink: less affinity for water would allow more smearing (R). High transfer speed of paper shortens the time for ink drying before reaching storage (L). High storage and packing pressure (L), and low permeability (R), can reduce escape of volatile components of ink, thus slowing drying and supporting smearing.

Your turn: As an exercise to complete before the next edition of this news letter, try completing the QC-graphs with attribute trends for ink and paper. These will include the following:

Attributes of ink bonding to paper:

Attributes of ink bonding to ink:

Attributes of air for drying ink:

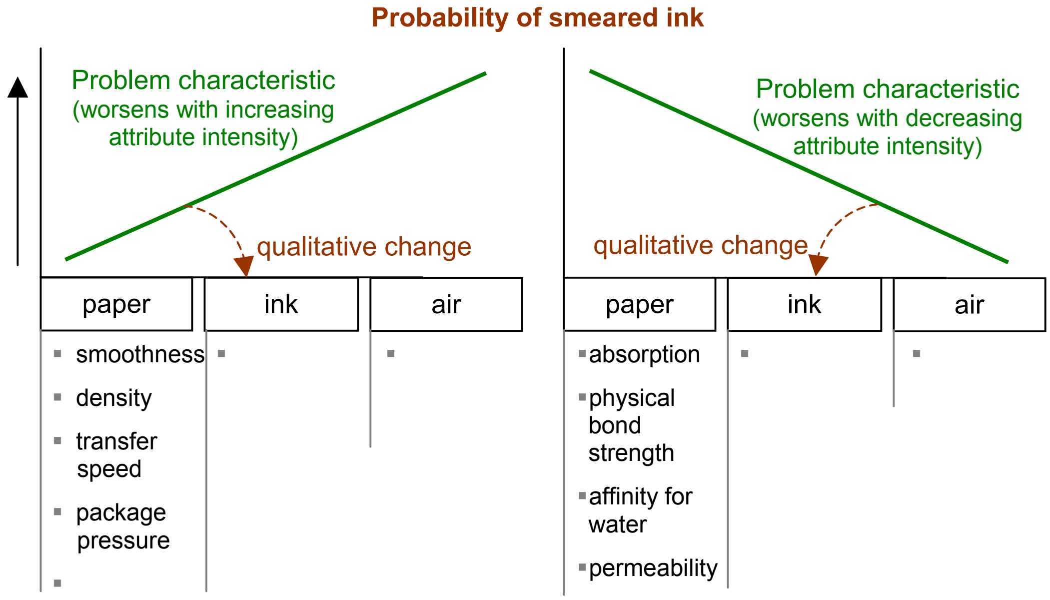

Figure: Two QC-graphs showing attribute trends supporting the probability of ink being smeared.

4. Classroom Commentary

I assume you are aware that the reason for these exercises is not for you to demonstrate what you understand, but for you to find out what you do not understand.

I liken this to the observer of a prestidigitator's performance – that is, of the observer who quickly claims, "Oh, I understand how that trick is done." Of course the proof lies not in the claim but in the reproduction of the trick. To understand juggling is nice. To be able to juggle is nicer.

But do not worry, there will be no test on QC graphs.

To be creative, U-SIT and think.

5. Problem-Solving Tricks and Related Miscellany

6. Feedback

7. Q&A

8. Other Interests

Please send your feedback and suggestions to Ntelleck@u-sit.net

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