A Predictive Model for Text Quality Analysis: Case Study

Ming-Kai Tse

Quality Engineering Associates (QEA), Inc.
Contact information as of 2010:
755 Middlesex Turnpike, Unit 3
Billerica MA 01821 USA

www.qea.com

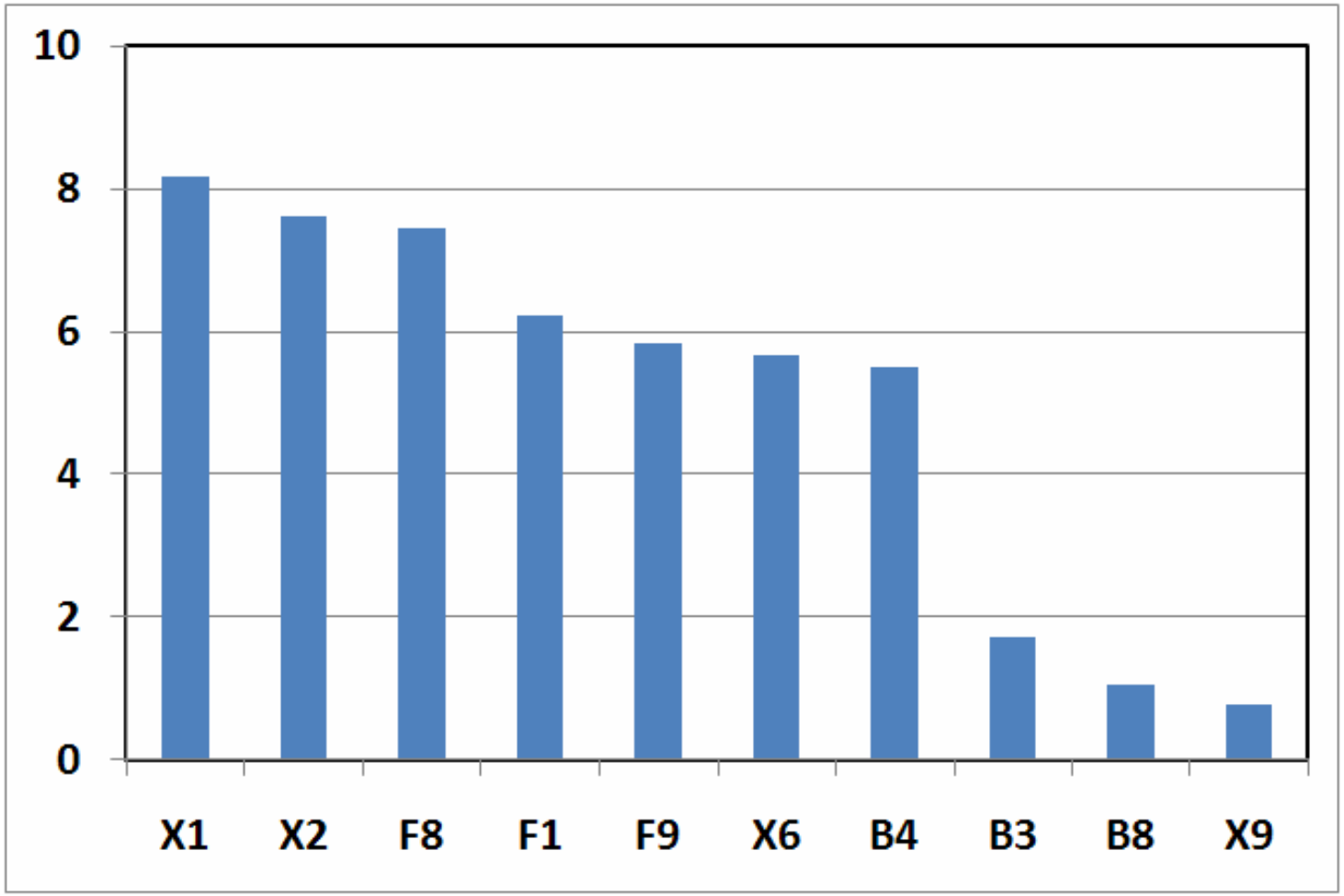
Background

- To explore an instrumented (objective) approach to predict text quality preferences (subjective).
- A challenging (complex) undertaking; many prior efforts & contributions by others.
- A case study *towards* a predictive model – possibilities and challenges?

Subjective Survey

- 10 samples, 3 printing technologies (imagesetter, electrophotography, inkjet); a range of print quality.
- Ten observers, each performed a complete combinatorial pair-wise comparison of all 10 samples (details reported in proceeding).
- Observers provided comments on why preferred one sample over another at end of survey.
- Data tallied, analyzed and reported on scale of 0 (least preferred) to 10 (most preferred).

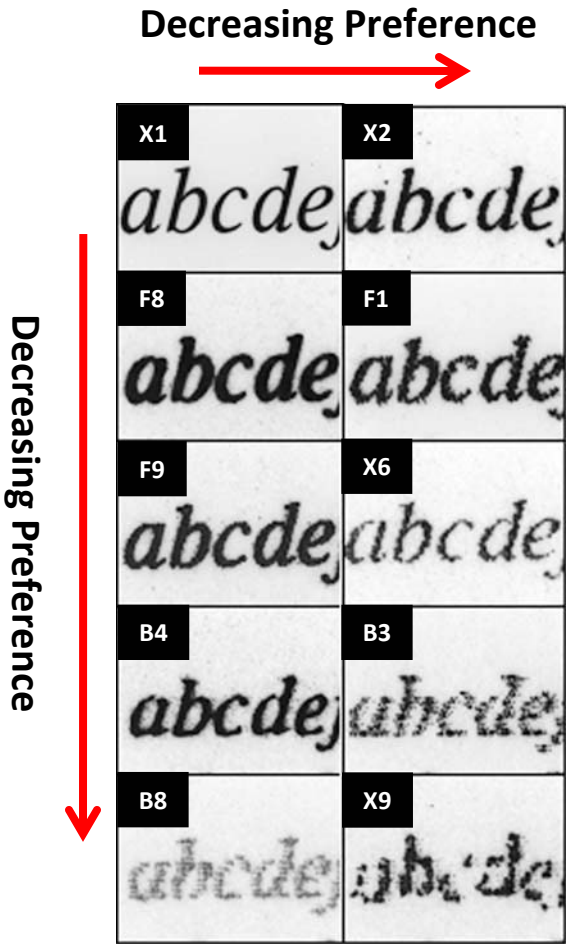
Survey Results



What do the observers really see?

(As they make their preference decisions)

Sample	Score (0 to 10)
X1	8.2
X2	7.6
F8	7.4
F1	6.2
F9	5.8
X6	5.7
B4	5.5
B3	1.7
B8	1.1
X9	0.8



4 pt Times Roman

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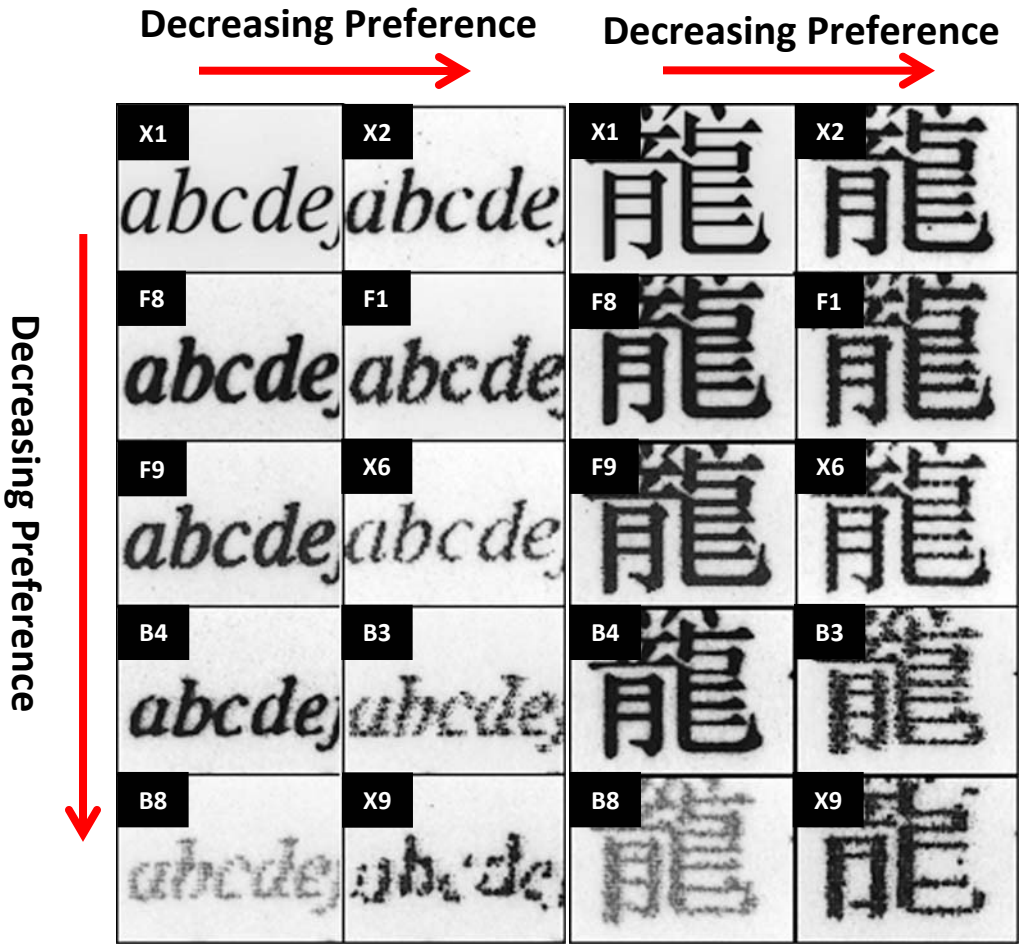


Observer Comments

(Obtained 8 out of 10; abbreviated to fit into slide)

- Contrast is important; clarity of lines leaves good impression.
- Like dark and sharp text.
- Looked at sharpness of 4 pt fonts. Overall darkness & edge smoothness.
- Strokes should be sharp, distinct without voids.
- First looked at large letters & then judge if text is easy to read.
- B8 is too light; X6 and B3 seem “grainier” than others.
- Attributes in order: sharpness, contrast, density & stroke width.
- Decided based on darkness of print, clarity of fonts and whether thin lines showed clearly.

Comments Summary

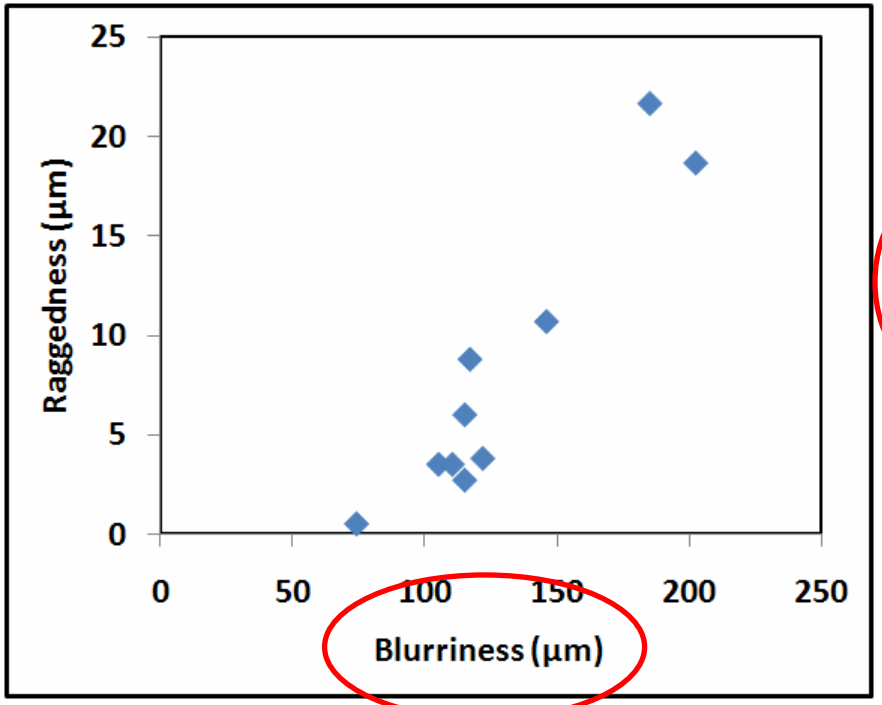
- Clarity, sharpness, distinctness (goodness measures)
- Contrast, darkness, density (goodness measures)
- Discontinuities, voids, graininess (defect measures)

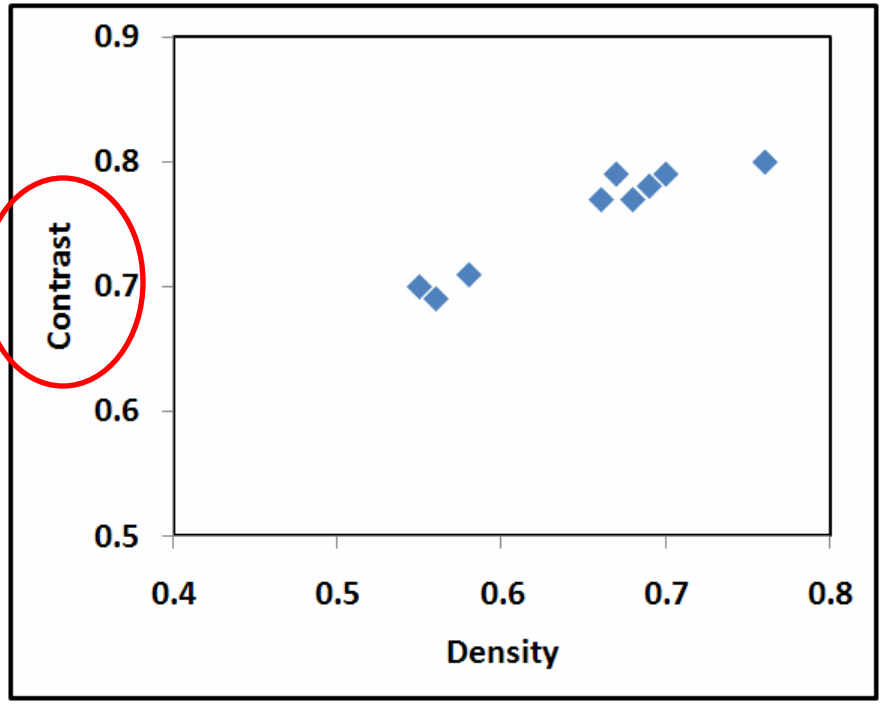
$\Rightarrow$ **Objective stroke properties analysis?**

Objective Stroke Quality Analysis

- Instrumented analysis (portable image analysis system – QEA PIAS-II), ISO13660 based line quality tools.
- Analyze vertical strokes in characters “I”, “L”, and “T” in the 12 pt. Arial font set.
- Stroke properties: width, blurriness, raggedness, density and contrast.

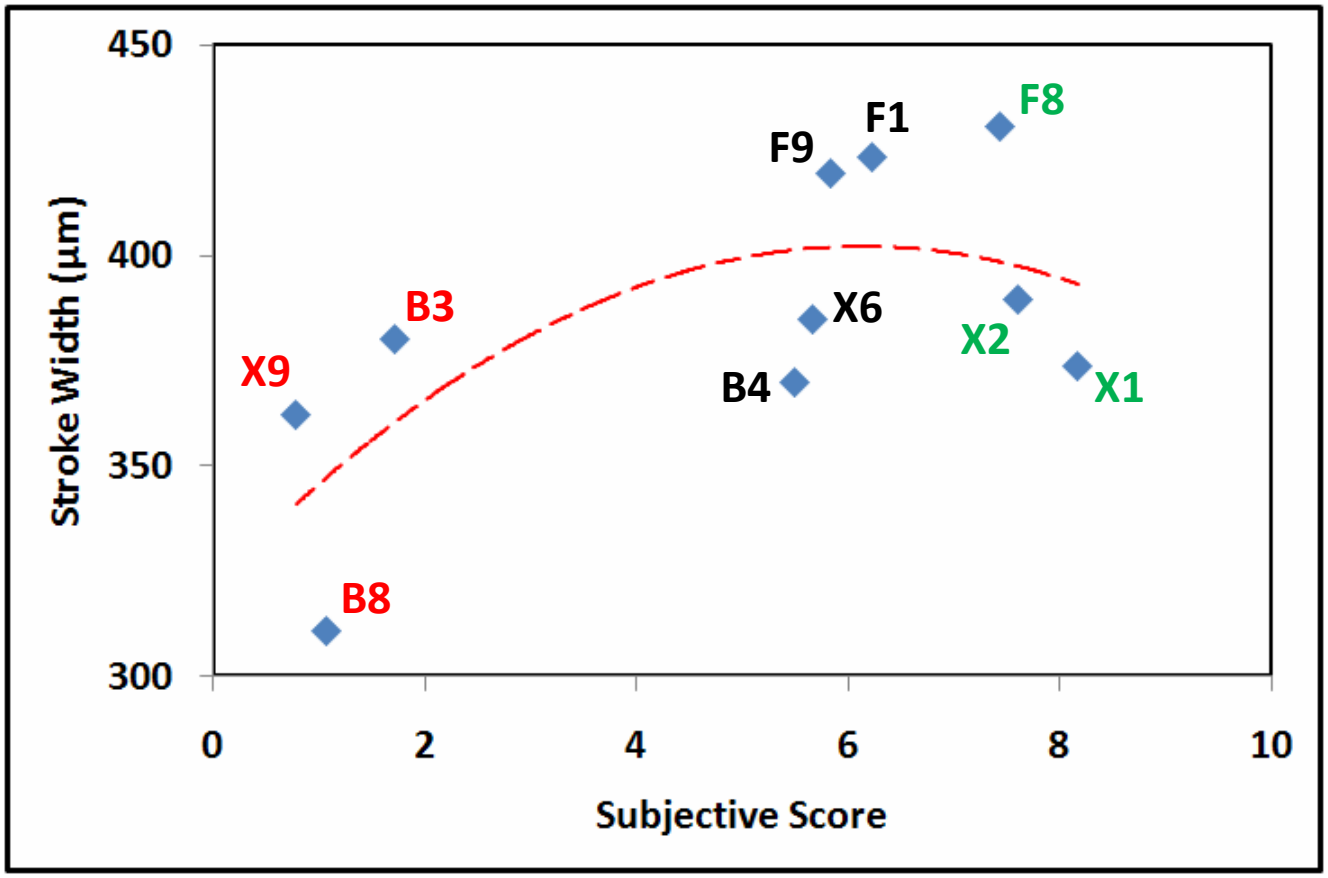
Objective Analysis Results (1)





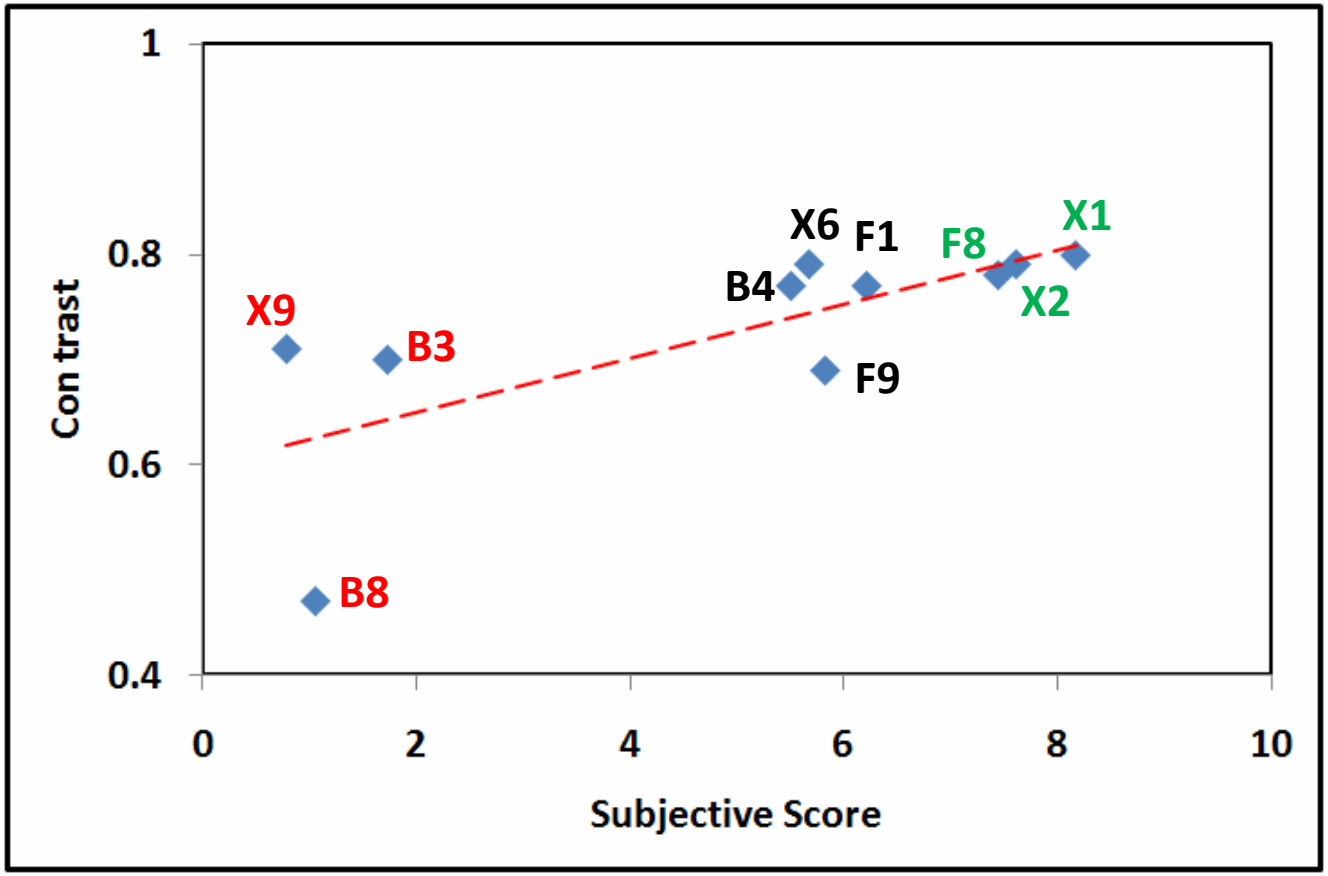
Empirically: Blurriness & Raggedness are correlated, so are Density & Contrast ∴ simplify by using only Blurriness, contrast, and stroke width in subsequent analyses

Objective Analysis Results (2)



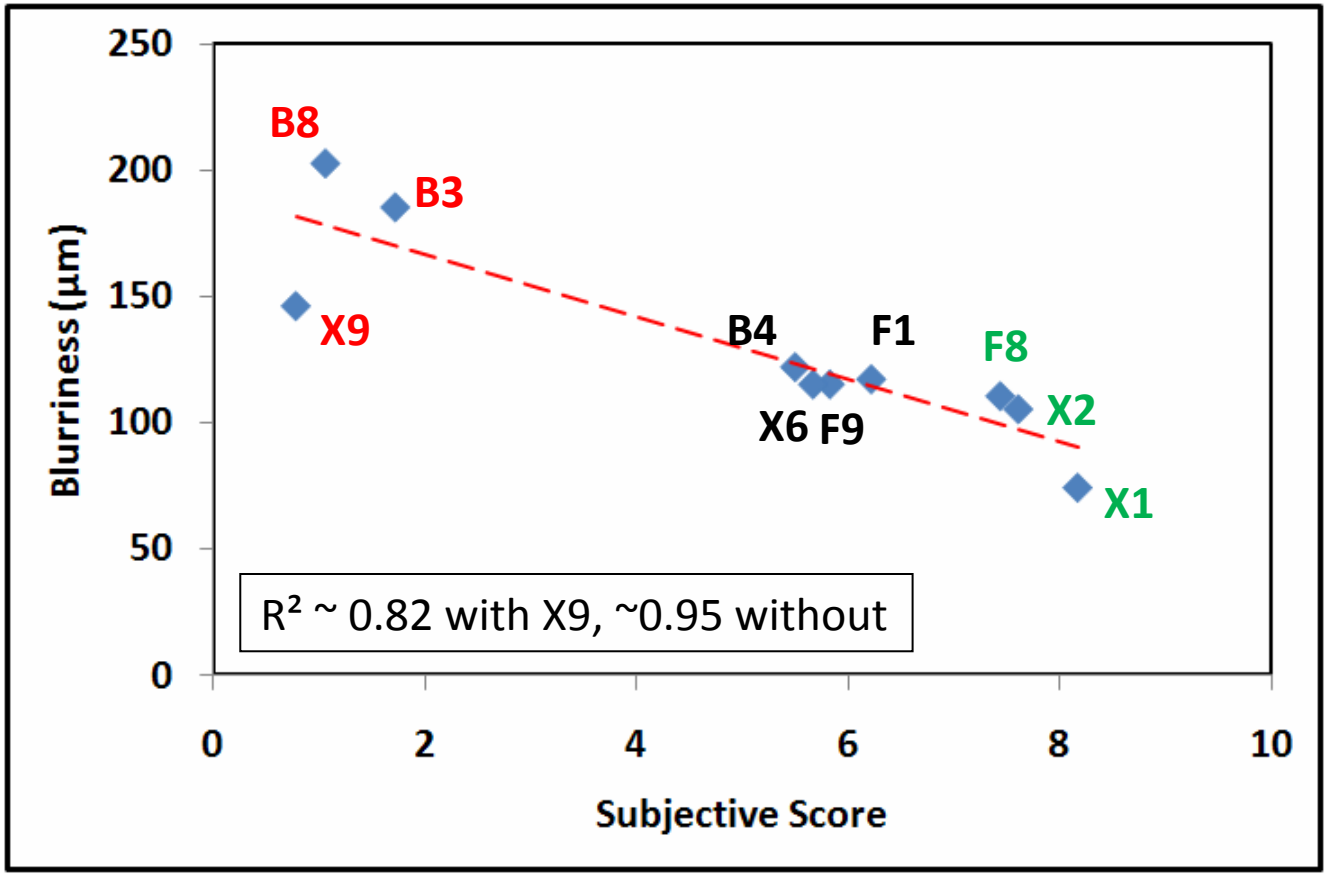
Correlation with stroke width is somewhat unclear – perhaps an optimum at 400µm? *(ref. R. Edinger's study)*

Objective Analysis Results (3)



Correlation with contrast (or density) exists but “noisy”

Objective Analysis Results (4)



Correlation with blurriness (or raggedness) is quite strong.

A Linear Regression Model

- Using a least-square method (excluding X9):

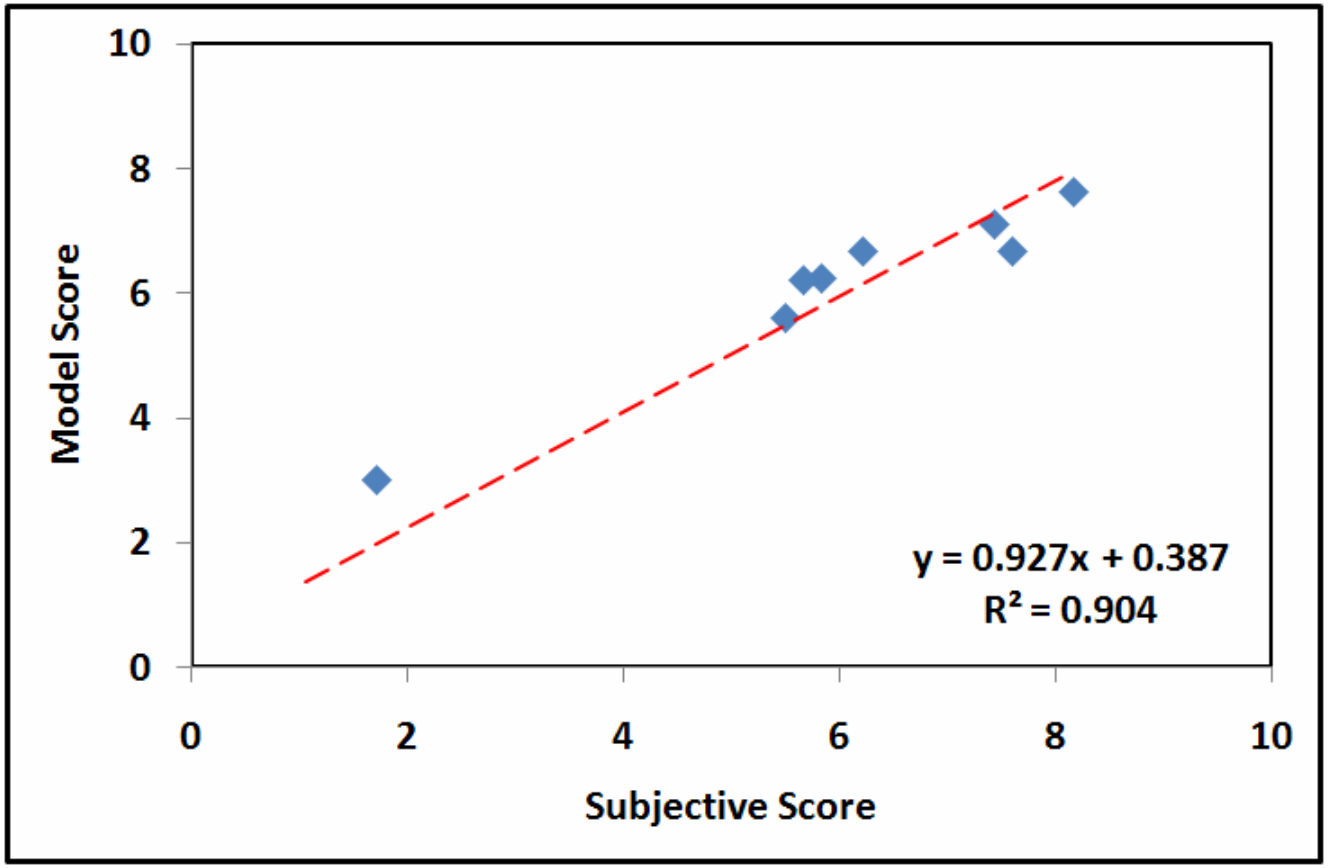
Score = -37.7B + 5.38C + 16.4W

Where: B = edge blurriness, mm

C = stroke contrast

W = stroke width, mm

Checking the "Reasonableness"



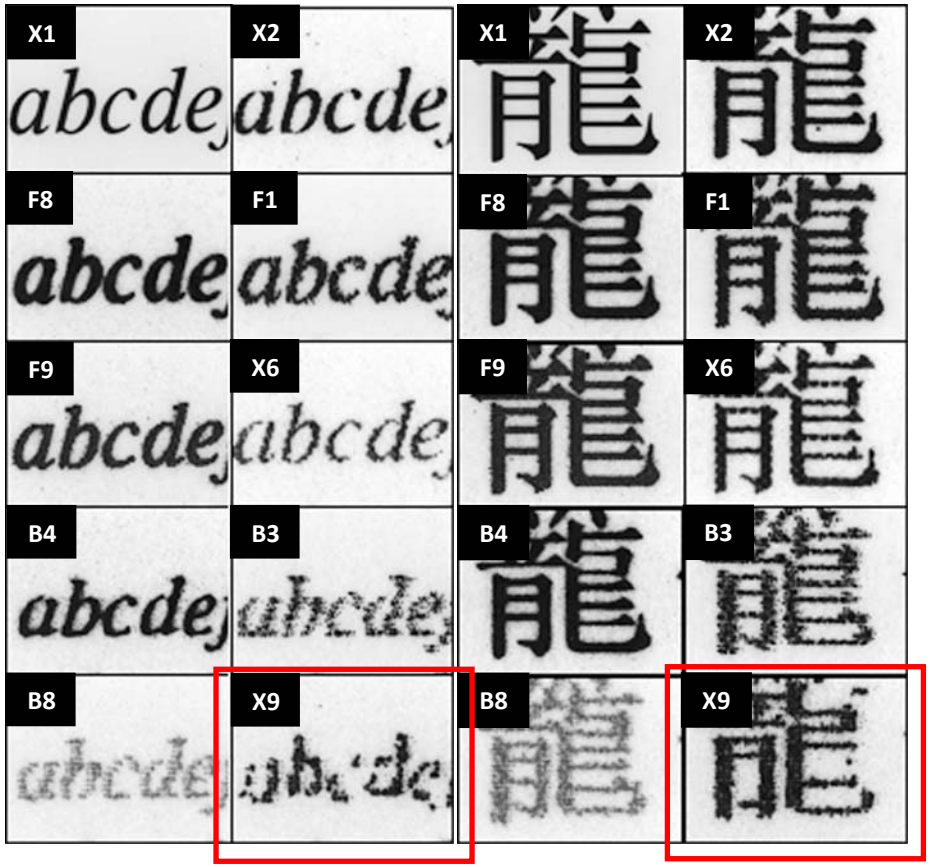
Limitation of the Model

- Doesn't account for **Text Defects**!!
- Text defects – examples:

  Poor formation, missing serifs, jitter, voids, distortion, unattractive character spacing, …

Text Defect - Example

- Sample X9 is an outlier in the model – much lower subjective score than B3 & B8 despite:
  - + Wider, lower blurriness and higher contrast than B3 & B8
  - + Better MTF than B3 and B8
  - – Character formation problem
  - – High edge distortion & roughness



Summary

- Text Quality "goodness" attributes:
  - Clarity, sharpness and distinctness (measured in terms of blurriness or raggedness)
  - Contrast and density
  - Stroke width (perhaps an optimum exists)
- Empirical model allows reasonable prediction of subjective score
- Needs to account for effect of text "defects."

Acknowledgment

- Thanks to all the colleagues in the INCITS W1.1 Line and Text Quality Ad Hoc Committee (working towards the ISO19751 Perceptual Image Quality Standard) for providing a stimulating environment for many valuable discussions and insights. The Ad Hoc Group Chairman is Dr. Edul Dalal of Xerox Corporation.