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Six Key Elements of High Quality Technical Writing

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Six Key Elements of High-Quality Technical Writing

Prof. Xianming Shi, Ph.D., P.E.

March 8, 2019



Definition of “High Quality”

- High Impact Factor of the Journal?
- High Citation of the Paper?
- Intellectual Merits?
- Broader Impacts?
- Something to be proud of (CREATE VALUE!),
or to be ashamed of ...

Ethics:

- Avoid plagiarism
- Avoid fabricating data, modifying data, or partial use of data

What is FRAUD?

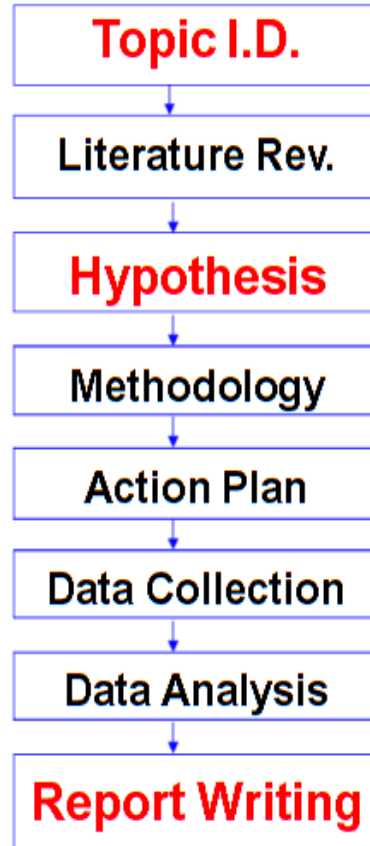
Rossiter (2006)

“Knowingly representing the work of others as your own.”

- ▶ Paraphrasing too directly even when giving credit
- ▶ Inventing data or lying about the procedures
- ▶ Manipulating data to obtain a desired outcome.
- ▶ Omitting “inconvenient” data or changing values to more “reasonable” ones.
- ▶ Note: During sampling or analysis, data may be omitted when explicitly acknowledged with clear criteria. Example: “outliers”

Credit: Slide from Dr. Jennifer Adam
at WSU, 2015

General Process of Research



Six Key Elements

1. Innovation

2. Engaging

3. Hypothesis

4. Logic

5. Synthesis

6. Details

April 11, 2013

Editor, *Industrial & Engineering Chemistry Research*

Subject: Cover letter for current research paper

Dear Editor,

Cover Letter



We would like to submit the research manuscript entitled...,
which has been prepared to meet requirements by the journal.

Novelty statement + Abstract

We attest hereby that our manuscript has not been previously published, in whole or in part, and that it is not under consideration by any other journal. All authors are aware of and accept responsibility for the manuscript. Thank you for your time and I look forward to hearing from you.

K1: Innovation

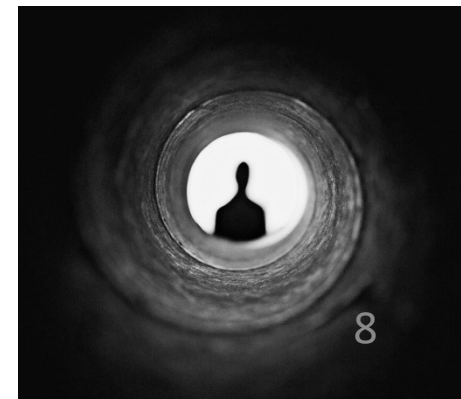
1. Follow the Cutting Edge (*Sci. or Tech.*)
2. Derive from the Practice (*Needs driven*)
3. Cross the borders of disciplines
 - Identify the Knowledge Gap (as an outsider!)
 - Identify the Research Area & Subject
 - Challenge or Greatly Enhance Current Understanding

~~**Old Problem, Old Theory, Old Method**~~

K1: Innovation

Reasonable Doubts

- Question the current understanding
- Always ask WHY
- There is always more room for improvements
- Be a master of knowledge, **instead of a slave of knowledge**



K1: Innovation



What makes the biggest difference

- Innovation or novelty statement
- Potential to challenge the textbook or add a key section to it
- *Transformative* vs. incremental

The state of knowledge remains unchanged with or without it?

K1: Innovation

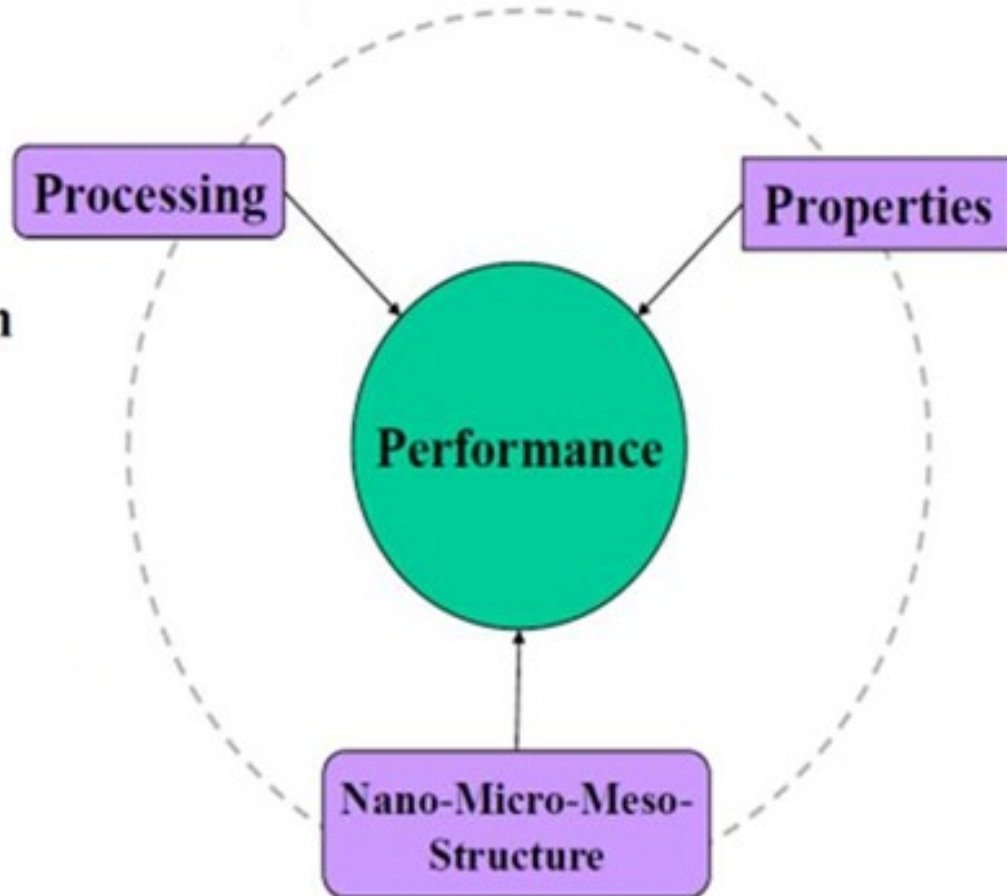
Address cross-cutting issues with trans-disciplinary thinking

- Shed new light on the subject
- Enable new insights via the transition from HOW to WHY
- Cultivate a more **holistic** way of thinking

K1: Innovation

Nanotechnology for more durable and sustainable concrete materials

- Characterization
- New materials
- Sensors



(Credit: Prof. Surendra Shah, Northwestern University, 2010)

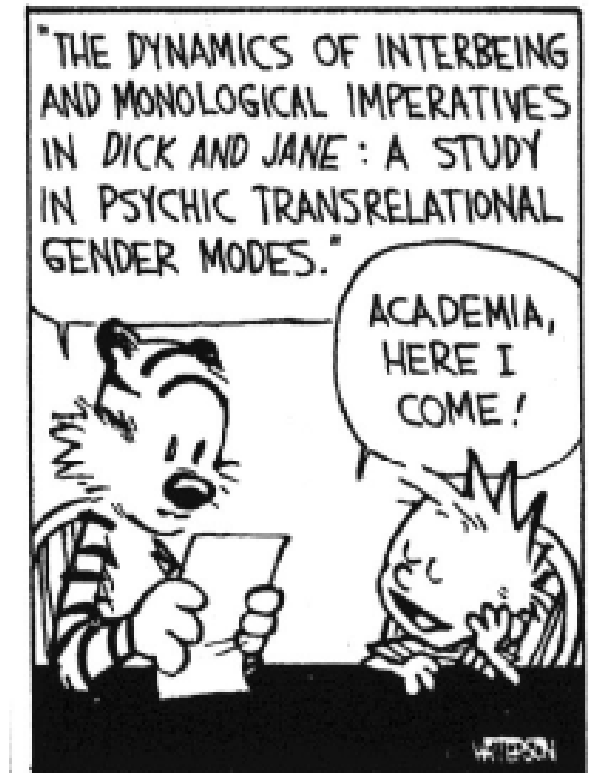
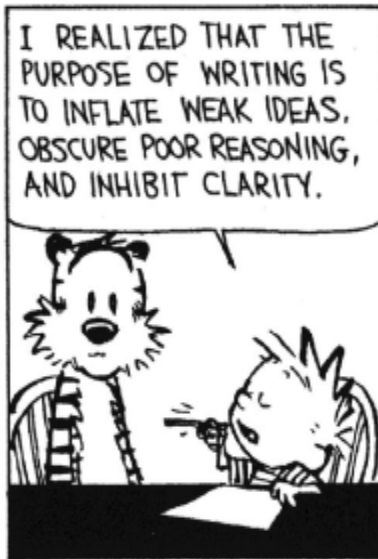
K2: Engaging

1. Adopt the Right Attitude
2. Make the job of the reader easier!
3. Tell an engaging story w/cohesive structure

The order of writing the paper

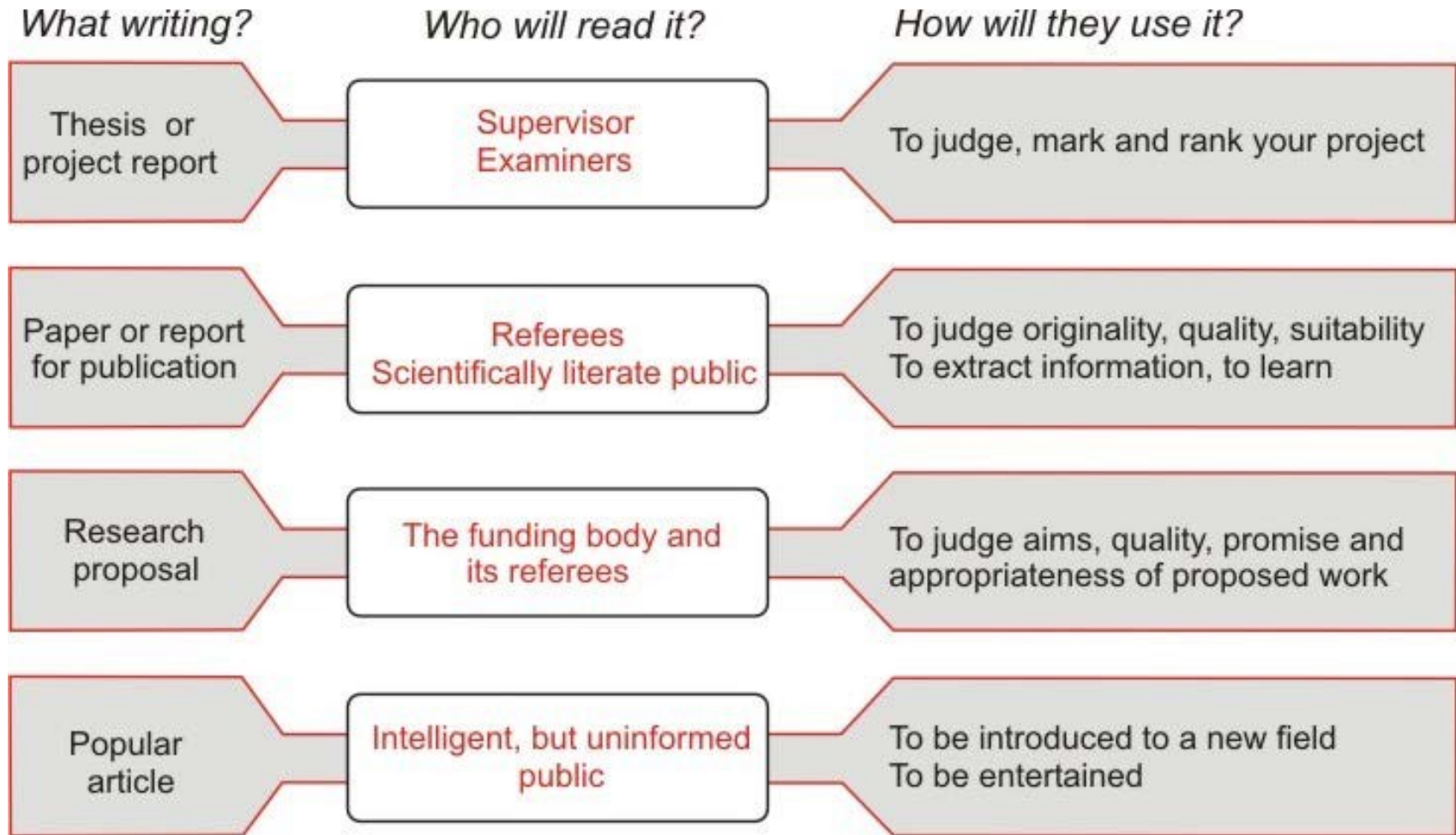
- Results and discussion
- Conclusions
- Introduction
- Abstract

- ▶ Do not try to be literary or clever. Clear, direct, unambiguous and forceful writing is appropriate for scientific communication



Credit: Slide from Dr. Jennifer Adam at WSU, 2015

K2: Engaging



Ashby, M., How to Write a Paper. University of Cambridge, Cambridge, U.K. 6th Edition, April 2005.

A phenomenological model for the chloride threshold of pitting corrosion of steel in simulated concrete pore solutions

Xianming Shi

Corrosion and Sustainable Infrastructure Laboratory, College of Engineering, Western Transportation Institute, Montana State University, Bozeman, Montana, USA and

Civil Engineering Department, Montana State University, Bozeman, Montana, USA, and

Tuan Anh Nguyen, Prathish Kumar and Yajun Liu

Anti-Corrosion Methods and Materials

58/4 (2011) 179–189

The Cl_{th} data in published literature are scattered over a wide range of values (Glass and Buenfeld, 1997, 2000a; Alonso *et al.*, 2000). One possible reason is that



Despite the multitude of studies undertaken, the factors defining the Cl_{th} of steel rebar and their interactions merit further investigation. This work presents a systematic study aimed to provide quantitative understanding of the fundamental factors that influence the chloride threshold of

4. Results

4.1 Electrochemical characterization of pitting risk

4.2 Performance of the ANN model

5. Discussion

5.1 Relative importance of variables

5.2 Effect of chloride concentration and chloride binding on pitting risk

5.3 Effect of pH and DO on pitting risk

5.4 Effect of $[\text{Cl}^-]/[\text{OH}^-]$ ratio on pitting risk

5.5 Limitations and practical implications of research findings



Despite these limitations, the findings from this study can still provide useful guidance in the effort of managing the chloride-induced corrosion of steel rebar in concrete.

Information Abstract

Purpose – This work seeks to present a systematic study that aimed to provide the chloride threshold of pitting corrosion of steel in concrete, by conducting a set of potential (E_{pit}) of steel coupons in simulated concrete pore solutions.

Design/methodology/approach – With the aid of artificial neural network, the correlating the influential factors (total chloride concentration, chloride binding, solubility risk (characterized by $E_{corr} - E_{pit}$)). Three-dimensional response surfaces were then constructed on the complex interactions between various influential factors.

Findings – The results indicate that the threshold $[Cl^-]/[OH^-]$ of steel rebar in simulated concrete pore solutions is dependent on the total chloride concentration and chloride binding, instead of a unique value.

Research limitations/implications – The limitations and implications of the research are discussed.

Practical implications – This research could have significant practical implications in chloride-laden environments.

Originality/value – This study further advances the knowledge base relevant to

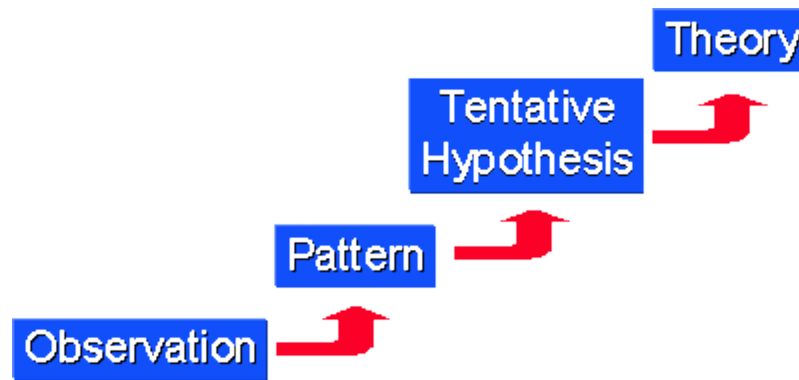
K3: Hypothesis

Three Types of Research

- **Hypothesis-driven (WHY)** : Nanomaterials serve not only as nano-sized fillers in the concrete but also effectively alter the chemical composition of hydrated cement paste.
- **Problem-driven (HOW)**: How to best achieve the uniform dispersion of nanomaterials in concrete?
- **Product-driven (WHAT)**: What is the most cost-effective formulation for nano-modified concrete pavement?

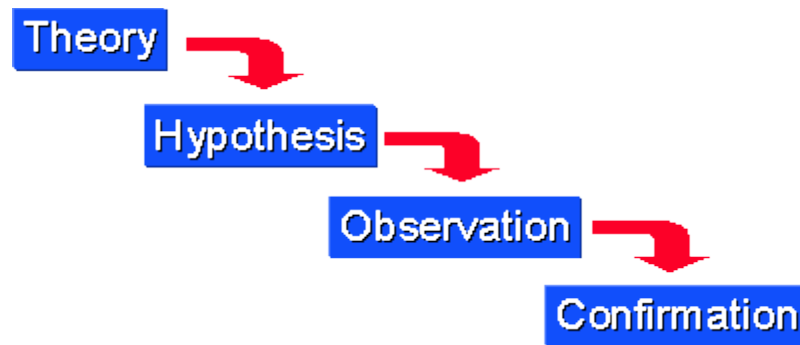
K3: How to Propose a Hypothesis

✓ **Induction:** from nano-SiO₂, nano-Al₂O₃, etc. to all nano-sized materials



K3: How to Propose a Hypothesis

- ✓ **Deduction:** electrons for Pulse Electric Field regulation of biofilm growth and biomineralization



K3: How to Propose a Hypothesis

- ✓ **Induction**
- ✓ **Deduction**
- ✓ **Extrapolate:** nano-electrochemical treatment (from concrete to soil: both are porous and heterogeneous materials)

K3: Hypothesis

Portland cement paste modified by TiO₂ nanoparticles: A microstructure perspective

Industrial & Engineering Chemistry Research 2013, 52, 11575

Nanotechnology has demonstrated its substantial benefits in empowering the development of concrete with enhanced durability and mechanical properties. **Yet, the mechanisms of concrete nano-modification, particularly by TiO₂ nanoparticles, remain unclear.**

One hypothesis to test is that the admixing of TiO₂ nanoparticles into cement not only leads to denser hardened cement paste but also alters the morphology and chemical compositions of cement hydration products.

K3: Hypothesis

Carbon and Steel Surfaces Modified by *Leptothrix discophora* SP-6: Characterization and Implications

TUAN ANH NGUYEN,[†] YUZHUO LU,^{†,‡}
XINGHONG YANG,[§] AND
XIANMING SHI^{*,†}

VOL. 41, NO. 23, 2007 / ENVIRONMENTAL SCIENCE & TECHNOLOGY ■ 7987

Effect of Electrochemical Polarization on the Ennoblement. As discussed in the Introduction it was hypothesized that polarizing the substrate material might alter the ennoblement processes as the external electric field served either as an electron sink or reservoir. To test this hypothesis, a short-duration electrochemical polarization was applied to glass carbon and stainless steel electrodes in the early stage of ennoblement by *L. discophora* SP-6.

K4: Logic



- Flow of logic between paragraphs
- Flow of logic between sentences
- Avoid fragmentation of your message
- The order of writing the paper
 - **Outline 1st!** Agree on the storyline, structure your thinking and then...
 - Use TOPIC LISTS to organize your arguments
 - 1st sentence of each paragraph should tell you about the key message in the paragraph (Topic Sentence)

A self-healing cementitious composite using oil core/silica gel shell microcapsules

Zhengxian Yang^{a,c}, John Hollar^a, Xiaodong He^a, Xianming Shi^{a,b,*}

Cement & Concrete Composites 33 (2011) 506–512

With a smaller fracture energy relative to that of mild steel (about 0.1 kJ/m^2 vs. 100 kJ/m^2), cementitious materials are known to be inherently brittle and tend to crack under stress.



In recent years, the biomimetic concept of self-healing has been demonstrated for cementitious materials by incorporating healing agents in hollow porous fibers, or in hollow glass tubes with a brittle breakable sealer [2–6].



The use of short fibers to reinforce cementitious composites seems to be a promising strategy in mitigating cracking at the micro-scale.



This paper presents work towards the development of a new family of self-healing materials that are expected to offer potential synergy with microfibers in arresting cracks formed in concrete or

Always use a TOPIC sentence

With proper siting, an infiltration BMP will not adversely impact the ground water. Best management practices (BMPs), including pervious concrete pavement, were studied on the campus of Villanova University (Kwiatkowski et al., 2007). Copper and chloride were the two constituents of concern at this site. Copper was introduced to the system from a roof, while chloride was introduced from deicing practices. Copper was not found in pore water beneath 0.3 m and the chloride was not significant enough to impact the ground water.

Always use a TOPIC sentence

The last decade has seen increased use of pervious concrete pavement and the maturation of its design and fabrication. A typical mix design Zaldo (2006) claimed that the durability of pervious concrete depends on three primary factors, i.e., mix design, placement, and proper maintenance. Wang et al. (2006) and Putman and Neptune (2011) studied mix proportioning and preparation techniques of pervious concrete. Schaefer et al. (2006) found saturated freeze-thaw performance of pervious concrete could be improved by several different changes to the mix design. That is, using a small amount of fine aggregate (sand), adding polypropylene fibers, using a slightly higher water/cement ratio, increasing compaction (lower porosity), introducing

Use transition/summary paragraph for each section

5. Durability and Maintenance of Pervious Concrete

Freeze-thaw durability and clogging are two important issues affecting the life cycle performance of pervious concrete pavement. The following sections will focus on these two important issues hindering the widespread use of pervious concrete pavement, especially in cold climates where deicers and traction sand are applied to achieve safe level of friction on the winter pavement.

5.1 Freeze-thaw in cold climates

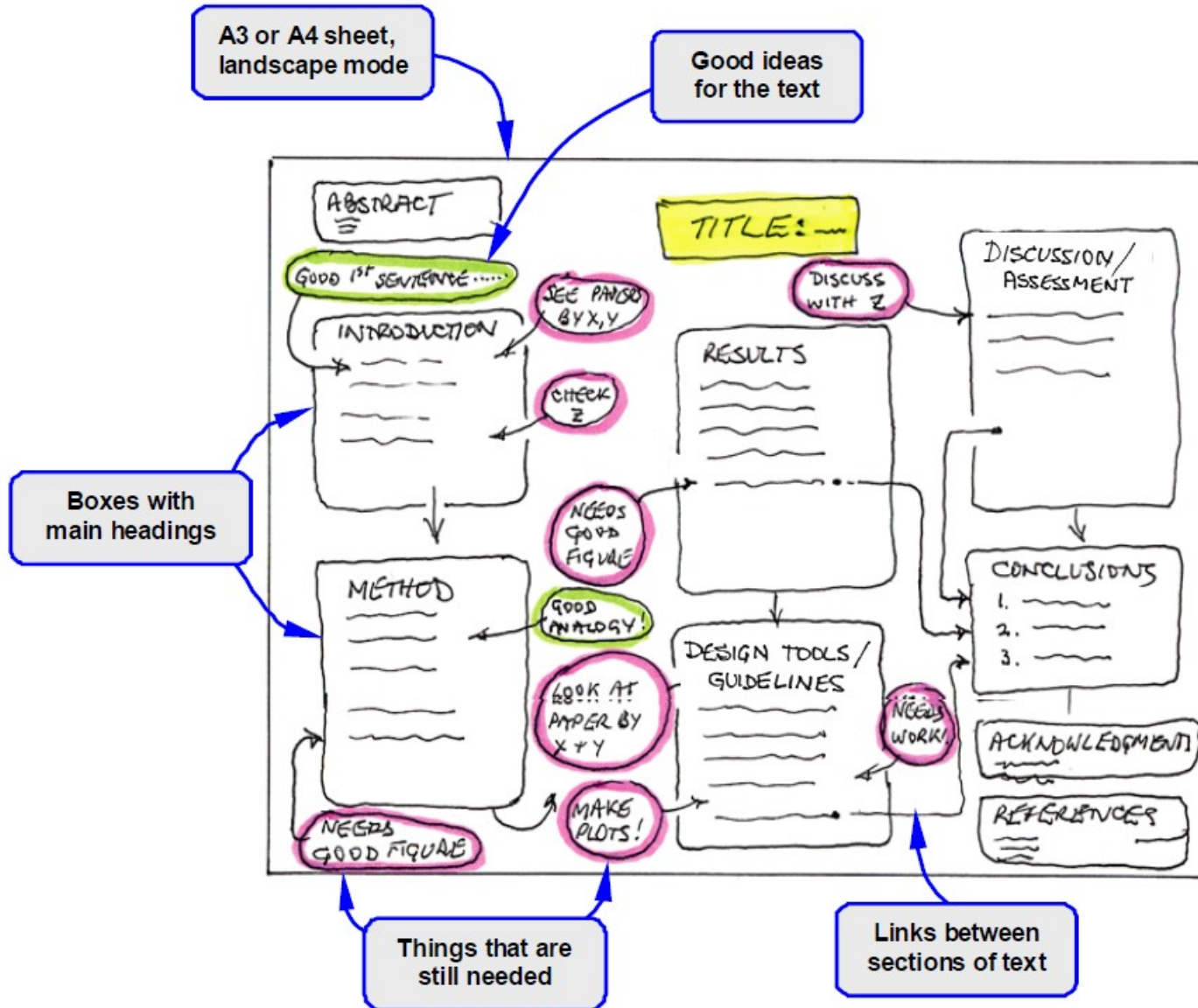
Laboratory studies have been conducted to investigate the freeze-thaw durability of pervious concrete as a function of mix design, saturation level, and clogging. Yang (2011) found that the admixing of silica fume or polypropylene fibers increased cement content improved the freeze-thaw durability of pervious concrete, particularly for water-cured specimens. McCain et al. (2006) found that a high application rate of a sand-salt mixture (2:1 by weight) at 0.24 lb/ft² (equivalent to 15,200 lb/lane-mile)

Flow of logic between sentences

As shown in [Figure 2](#), all the OCP of the steel protected by the NBGE coatings was higher than that of the 6E coated steel at any time during the 8 days of immersion in 3.5 wt % NaCl solution. During the first day of immersion, the OCP of the nacre-biomimetic coatings generally shifted to more-noble values with the increase in the number of GO/epoxy layers. Such differences in the initial OCP reading are mainly attributable to the fact that the smaller the ohmic drop between the steel and the reference electrode, the more negative the OCP reading. In other words, the neat epoxy coating (6E) layer likely featured the lowest electrical resistance, whereas the 5NBGE featured the highest one after 1 day of immersion in 3.5 wt % NaCl solution.

Zhang, Y., Tian, J., Zhong, J., **Shi, X.** Thin Nacre Biomimetic Coating with Super-Anticorrosion Performance, *ACS Nano*, 2018, DOI: [10.1021/acsnano.8b05183](https://doi.org/10.1021/acsnano.8b05183).

Make a Concept Sheet



Ashby, M., How to Write a Paper. University of Cambridge, Cambridge, U.K. 6th Edition, April 2005.

K5: Synthesis

Effect of nanoparticles on the anticorrosion and mechanical properties of epoxy coating

Xianming Shi ^{a,b,*}, Tuan Anh Nguyen ^a, Zhiyong Suo ^c, Yajun Liu ^a, Recep Avci ^c

Surface & Coatings Technology 204 (2009) 237–245

It was also observed that over the time of immersion in the corrosive electrolytes R_1 decreased and C_1 increased, indicating the entry of electrolyte into the epoxy coatings, which is consistent with previous research [21,22].



It is interesting to note that Fe_2O_3 nanoparticles were previously reported to alter the magnetic properties of epoxy resin as well [31].



Our findings are consistent with previous research in terms of beneficial effect of nanoclay on the anticorrosive performance of coatings. By incorporating 2–6 wt.% montmorillonite nanoclay into the polyurethane coating, Chen-Yang et al. [33] demonstrated that the corrosion rate of coated stainless steel in 5 wt.% NaCl solution was reduced by about 10–30 times. Yeh et al. [34] reported that

Vehicle-based sensor technologies for winter highway operations

Z. Ye^{1,*} X. Shi^{2,*} C.K. Strong³ R.E. Larson⁴

Table 1 Examples of AVL implementation in Northern America

Study	Location/duration	Findings
Anderson [10]; Roosevelt <i>et al.</i> [11]	Northern Virginia, VA, USA/1996–2000	the pilot test performed reasonably well in mapping vehicle location several areas needed for potential improvement (e.g. short update speeds, temporary in-vehicle unit installation)
FHWA [12]; CompassCom [13]	Wayne County, Detroit, MI, USA/1997	there was a 3–4% reduction in 'deadhead' miles (the distance where the vehicle is not actively treating the road) on freeway routes the results showed reduced salt consumption, reduced operational costs, quick response time and reduced fatigue for dispatchers and drivers during peak operations
Maryland Bureau of Highways [14]	Howard County, MD, USA/2000–2001	the system allowed managers to monitor maintenance real-time

4 Looking to the future

Beyond the observations for individual applications, there are a few overall trends regarding the future use of vehicle-based technologies for snow and ice control.

4.1 *Integration*

4.2 *Automation*

4.3 *Barriers to implementation*

5 **Concluding remarks** *IET Intell. Transp. Syst.*, 2012, Vol. 6, Iss. 3, pp. 336³–345

Compare, Integrate, Evaluate,

Correlate & Reason

What to include in “Concluding Remarks”

Once the previous sections are finalized, then revise this section so that it captures the TOPIC sentences from each previous section (the essence of each section, in different words).

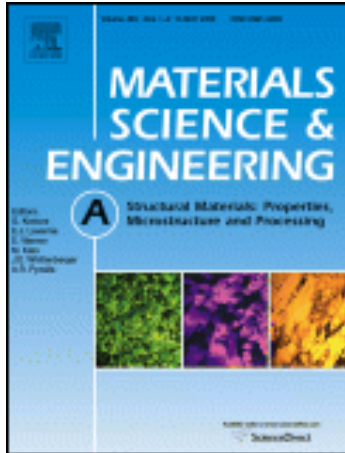
Try to add some text about the remaining challenges (e.g., durability of pervious concrete in the presence of deicers, especially when the pervious concrete pavement accidentally collects the deicer-laden runoff from adjacent impervious pavement, could cite a few references on the detrimental effects of NaCl and MgCl₂ on the durability of concrete).

Also offer some directions for future research (e.g., how to optimize the up-cycling of industrial waste materials in pervious concrete; the use of nanoscience to achieve better fundamental understanding on the hydraulic behavior and deterioration processes of pervious concrete; the use of nanoengineering to endow pervious concrete pavement with better durability).

K6: Details

- Write with heart and professionalism
- Attention to detail would make a difference
- Learn from best examples
 - **Simplistic but not monotonic**
 - ▶ Use the fewest words possible, while still retaining the necessary meaning and detail
 - **Expand your vocabulary**
 - **Grammar**
 - **Subtlety:** consider the melody and vary the sentence length
 - **Elegance**

Detail is Important



- *Materials Science and Engineering A's* yearly page budget only allows space to publish about 30% of all regular submissions in a year...those submissions not meeting the journal's standards might **not be sent on for review**. Therefore, please ensure you have read the Journal's Scope and **Guide for Authors** carefully before submitting to ...

Surface-sulfonated polystyrene microspheres improve crack resistance of carbon microfiber-reinforced Portland cement mortar

Accurate, Self-Evident Title

Zhengxian Yang · John Hollar · Xianming Shi

J Mater Sci (2010) 45:3497–3505

The direct and indirect costs of concrete cracking are substantial, as it entails additional repair, rehabilitation, and monitoring activities to ensure the functionality and aesthetics of concrete structures and components.



the critical stress indicates the onset of unstable or unrecoverable microcrack propagation and is related to a significant increase of microcracks throughout the matrix [23, 24].

Effect of styrene–butadiene rubber latex on the chloride permeability and microstructure of Portland cement mortar

Zhengxian Yang^{a,b}, Xianming Shi^{a,c,*}, Andrew T. Creighton^a, Marijean M. Peterson^a

Construction and Building Materials 23 (2009) 2283–2290

Interest-

ingly, there was a linear correlation between D_{Cl^-} (characteristic of chloride permeability) and Q_{360min} (characteristic of general ionic permeability), as illustrated in Fig. 3b.



It can be seen from

Table 3 that the incorporation of SBR latex improved the chloride penetration resistance of the mortar, as indicated by the reduced apparent diffusion coefficients of chloride ions, D_{Cl^-} .



As shown in

Fig. 3a, D_{Cl^-} decreased linearly with the increase in P/C ratio (i.e., the SBR content admixed in fresh mortar), under the experimental conditions of this study.

- **Avoid very long sentences!**
- **Tabulate details**

Where

m is the mass of the heavy disk mounted at the mid-span of a massless elastic shaft,

e is the eccentricity of the mass center from the geometric center of the disk,

ϕ is the angle between the orientation of the eccentricity and the ξ axis,

k_ξ and k_η are the stiffness coefficients in the two principal directions

The Most Common Habits from more than 200 English Papers written by Graduate Chinese Engineering Students

By Felicia Brittan

Place the most important subject at the beginning of the sentence for emphasis

- Incorrect** Based on the *triangulation structure* built from unorganized points or a CAD model, the extended STL format is described in this section.⁴
- Correct** The extended STL format is described in this section based on the *triangulation structure* built from unorganized points or a CAD model.
- Incorrect** Equations 2~6 can be **respectively** linearized as:.....(equations given)...¹³
- Correct** Equations 2~6 can be linearized as:.....(equations given)...., **respectively**.
- Awkward** In this paper, IDEAS was used to
- Correct** In this study, IDEAS was used to....
- Incorrect** **12** parameters were selected for the experiment.
- Correct** **Twelve** parameters were selected for the experiment.

Six Key Elements

- 1. Innovation**
- 2. Engaging**
- 3. Hypothesis**
- 4. Logic**
- 5. Synthesis**
- 6. Details**



Questions?

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www.researcherid.com/rid/A-5108-2012

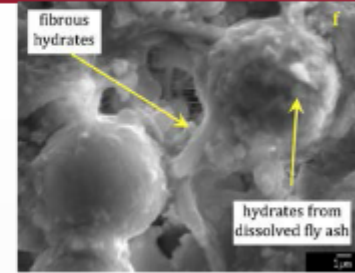
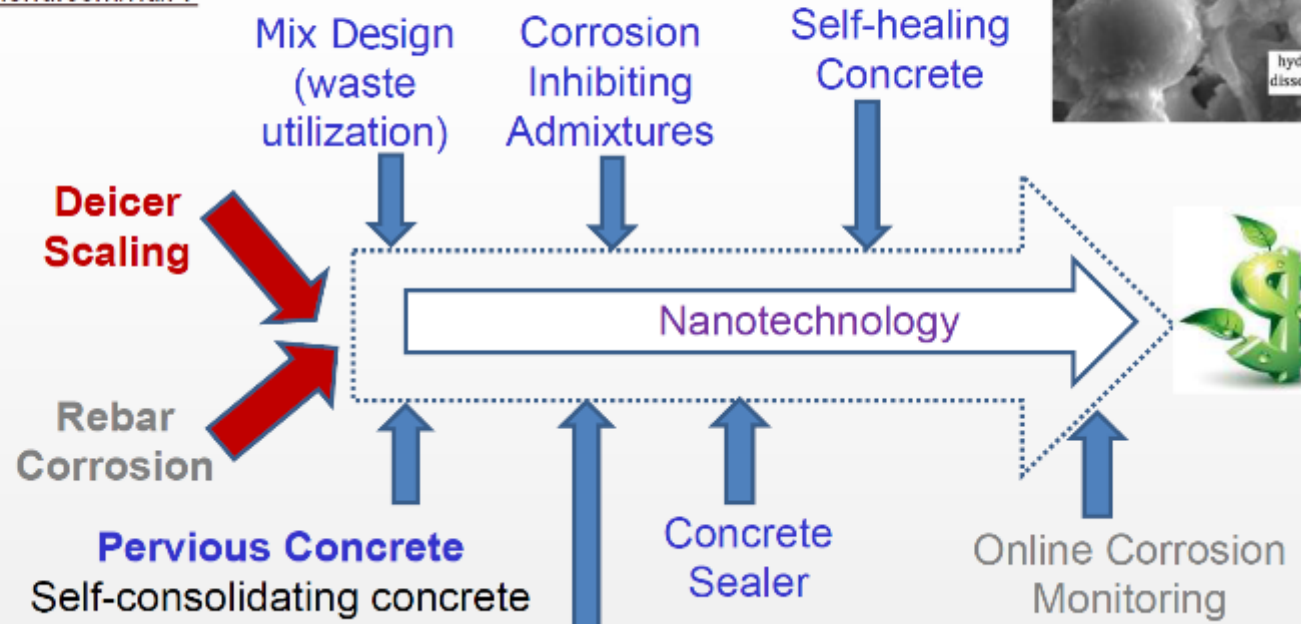
public.wsu.edu/~Xianming.Shi/

Xianming.Shi@wsu.edu

Research Interests

- Durable, sustainable, and smart pavements
- Sustainable materials for the built environment: e.g., value-added utilization of industrial or agro-based byproducts and recycled materials, multiscale characterization and modification
- Corrosion protection, infrastructure preservation or rehabilitation techniques and practices

Smart and Green Infrastructure Enabled by Materials



- Self-healing coating
- Nanocomposite coating ...



➤ Deputy Director, WSU Strategic Initiative Stormwater Program

- ❑ ***Journal of Infrastructure Preservation & Resilience*** (Springer Nature)
- ❑ Topics related to **permeable pavements** and **stormwater**

➤ Associate Director, Center for Advanced Multimodal Mobility Solutions and Education (CAMMSE)

- ❑ Effects of Incorporating **Connected Vehicle Technologies** into No-Notice Emergency Evacuation during Winter Weather
- ❑ Opportunities to leverage UTC \$\$: topics related to **transportation resilience** and Smart Cities

➤ Other ongoing initiatives

- ❑ **Sustainable winter road operations**
- ❑ Geopolymer-based Ultra-High Performance Concrete
- ❑ Utilization of unconventional fly ashes in concrete

