

Constructability Issues and Consequences

OHIO ASPHALT PAVING CONFERENCE
WEDNESDAY, FEBRUARY 4, 2015

Murphy Pavement Technology

Timothy R. Murphy, P.E.

The background is a solid teal color. It features several large, faint circular halftone patterns. A solid red rectangle is positioned in the upper right corner.

aka The Post-Recession Depression of Asphalt

FROM 2008 UNTIL TODAY

aka
of A
FROM



Our Job is to Evaluate Risk



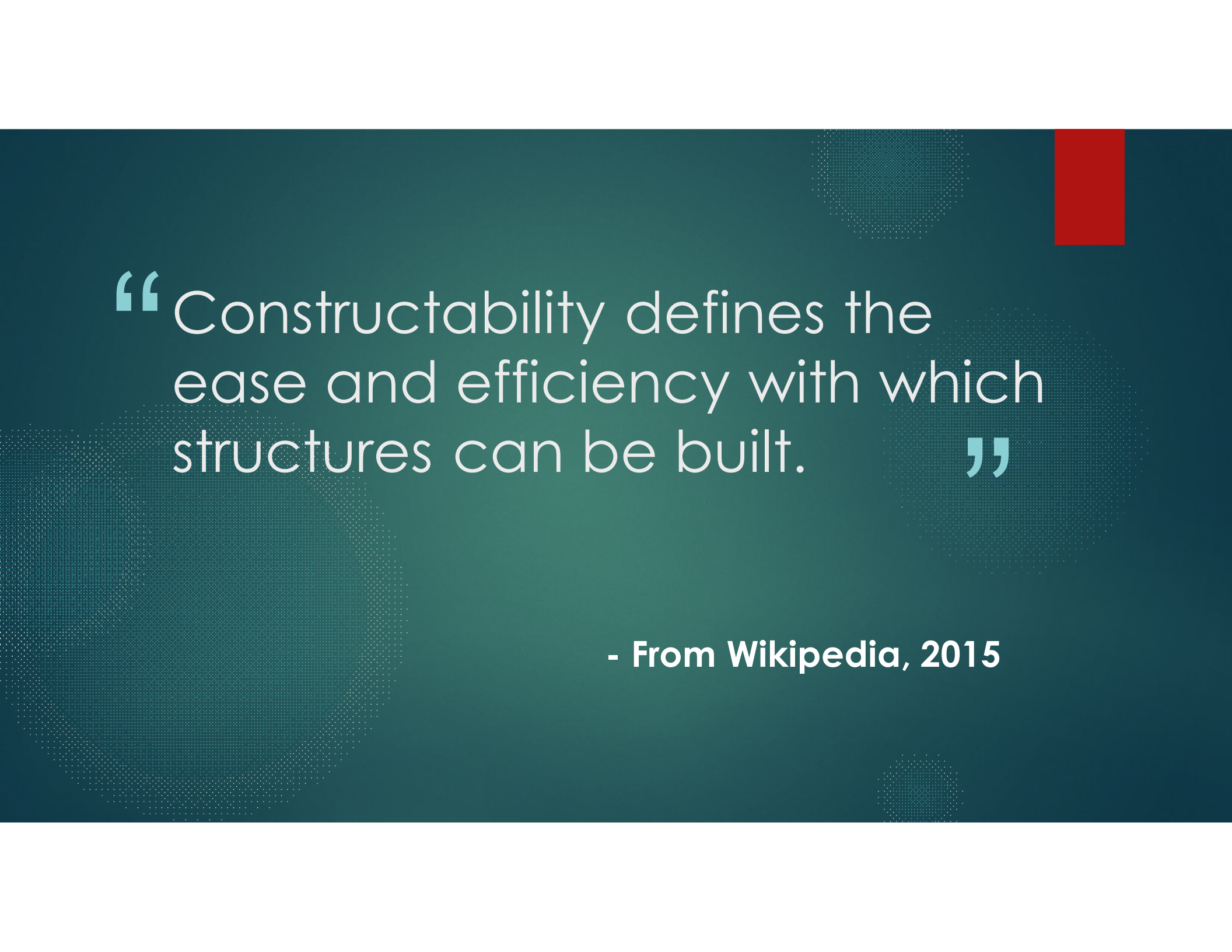
**RUGGED REVIEW OF PRACTICES WITH
NUMEROUS NATIONAL EXPERTS WAS
COMPLETED IN 2014 BY THE FEDERAL
HIGHWAY DISTRICTS.**

Our Job is to Evaluate Risk

FOCUS ON THE:

- TYPICAL PAVEMENT CROSS SECTION,
- ASPHALT MIX DESIGN AND PRODUCTS,
- PRODUCTION, AND
- CONSTRUCTION PRACTICES CURRENTLY IN PLACE.





“Constructability defines the ease and efficiency with which structures can be built.”

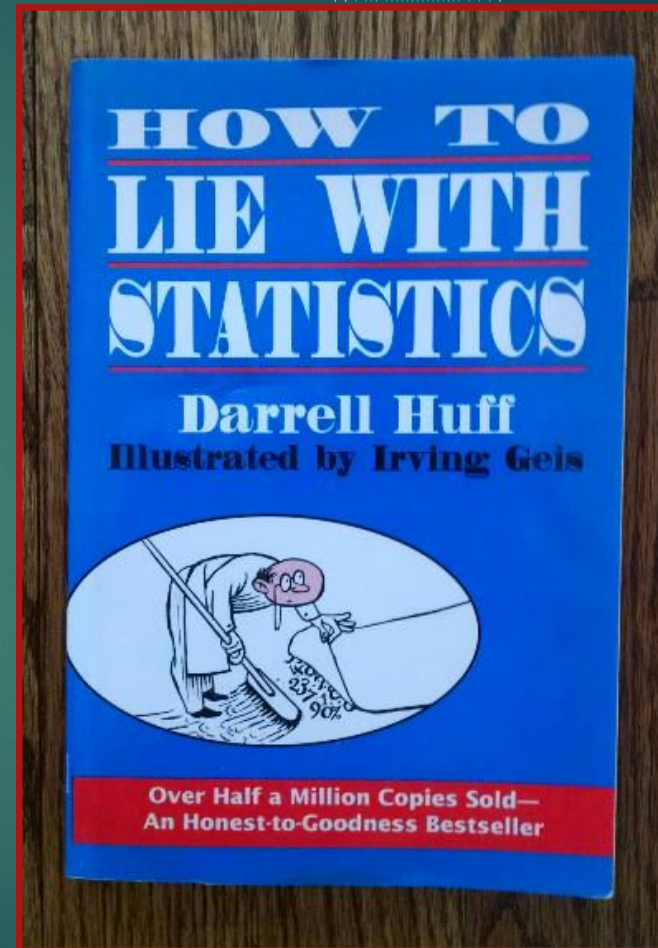
- From Wikipedia, 2015

Constructability (or buildability)

The term refers to the effective and timely integration of construction knowledge into the conceptual planning, design, construction, and field operations of a project to achieve the overall project objectives in the best possible time and accuracy at the most cost-effective levels.

Copyright 1954

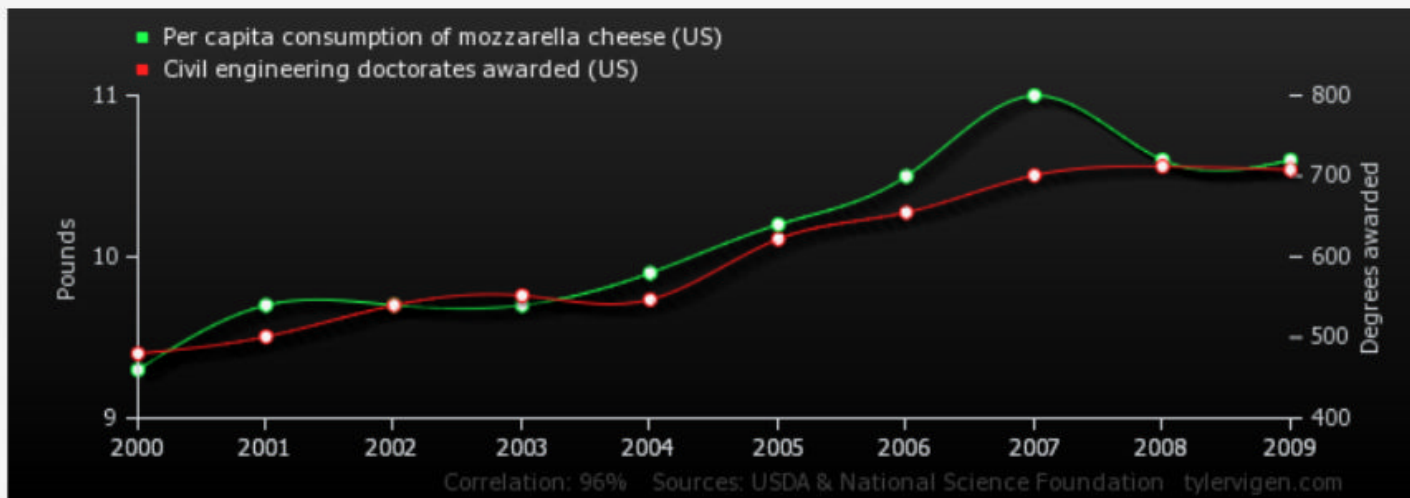
**Recommended reading for
all junior level engineers**



Per capita consumption of mozzarella cheese (US)

correlates with

Civil engineering doctorates awarded (US)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Per capita consumption of mozzarella cheese (US) Pounds (USDA)	9.3	9.7	9.7	9.7	9.9	10.2	10.5	11	10.6	10.6
Civil engineering doctorates awarded (US) Degrees awarded (National Science Foundation)	480	501	540	552	547	622	655	701	712	708

Correlation: 0.958648

Constructability (or buildability)



Constructability (or buildability)



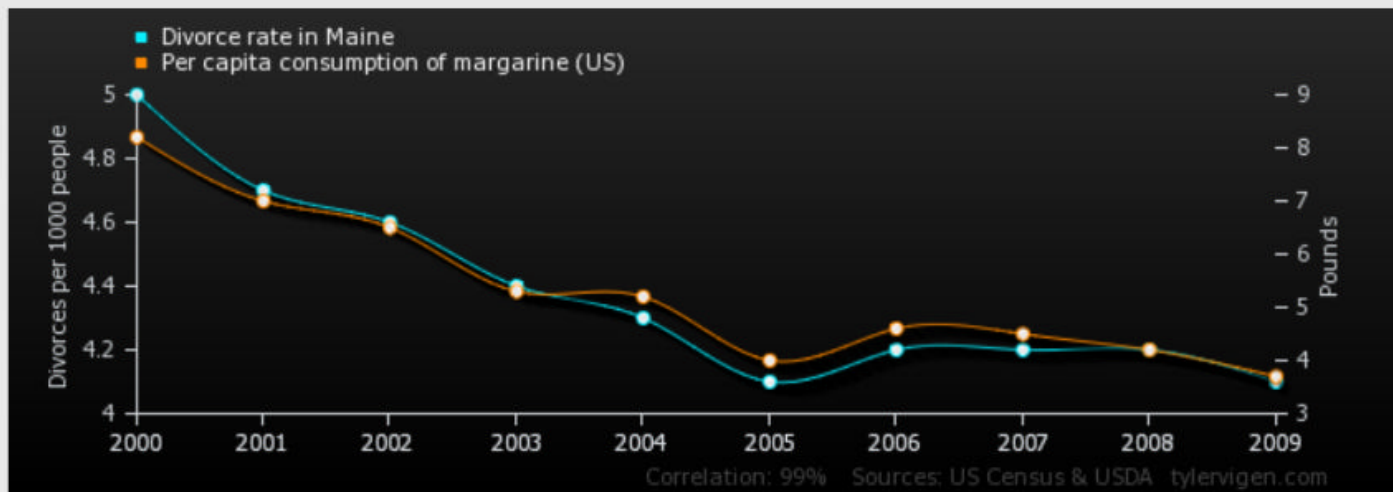
Constructability (or buildability)



Constructability (or buildability)



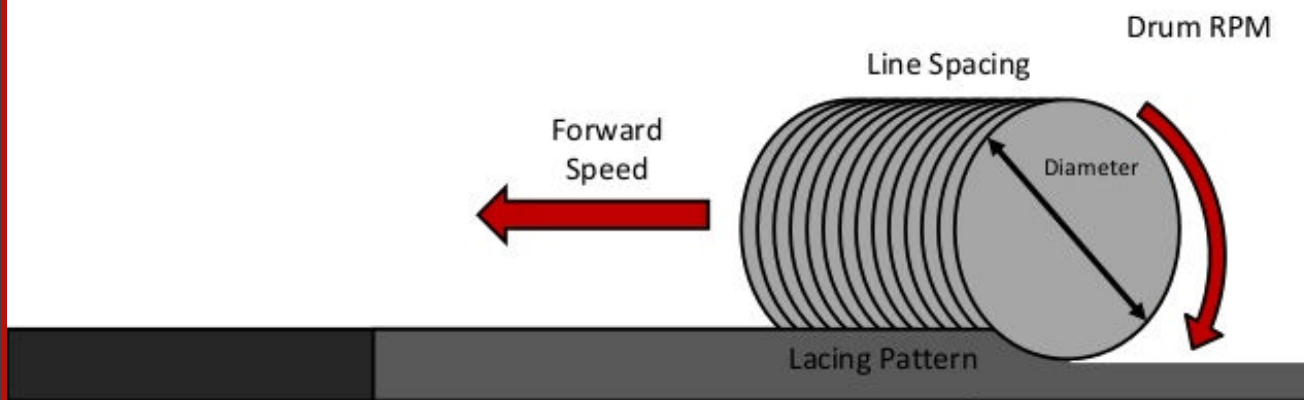
Divorce rate in Maine correlates with Per capita consumption of margarine (US)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
<i>Divorce rate in Maine</i> Divorces per 1000 people (US Census)	5	4.7	4.6	4.4	4.3	4.1	4.2	4.2	4.2	4.1
<i>Per capita consumption of margarine (US)</i> Pounds (USDA)	8.2	7	6.5	5.3	5.2	4	4.6	4.5	4.2	3.7

Correlation: 0.992558

The Math of Milling



The 4 Main Factors that
Affect Surface Texture

1. Line Spacing
2. Forward Speed
3. Drum RPM
4. Lacing Pattern



ASTEC INDUSTRIES, INC.



Constructability (or buildability)



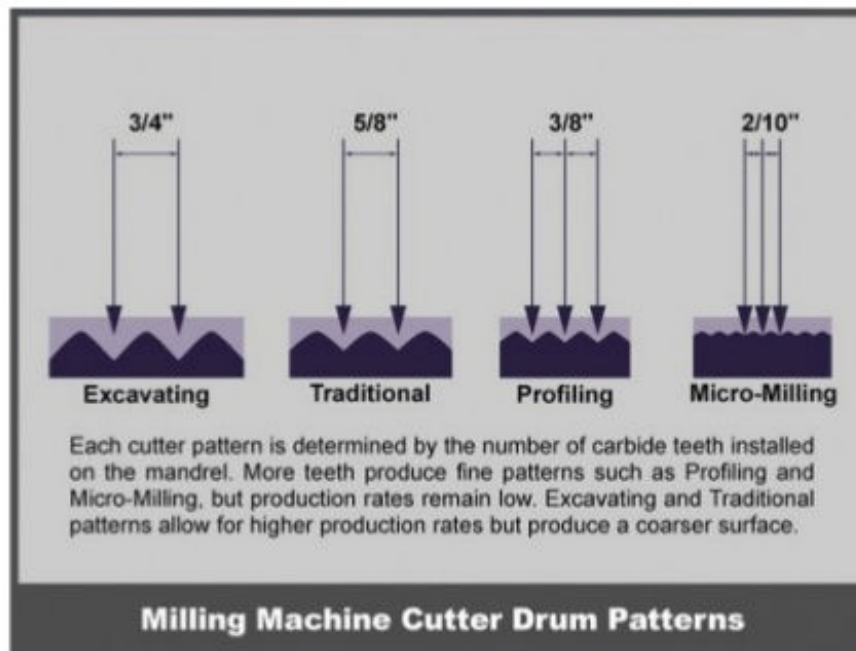
Constructability (or buildability)



Constructability (or buildability)



Line Spacing and Texture



ASTEC INDUSTRIES, INC.



Indiana Glass Bead Test (ITM 812)



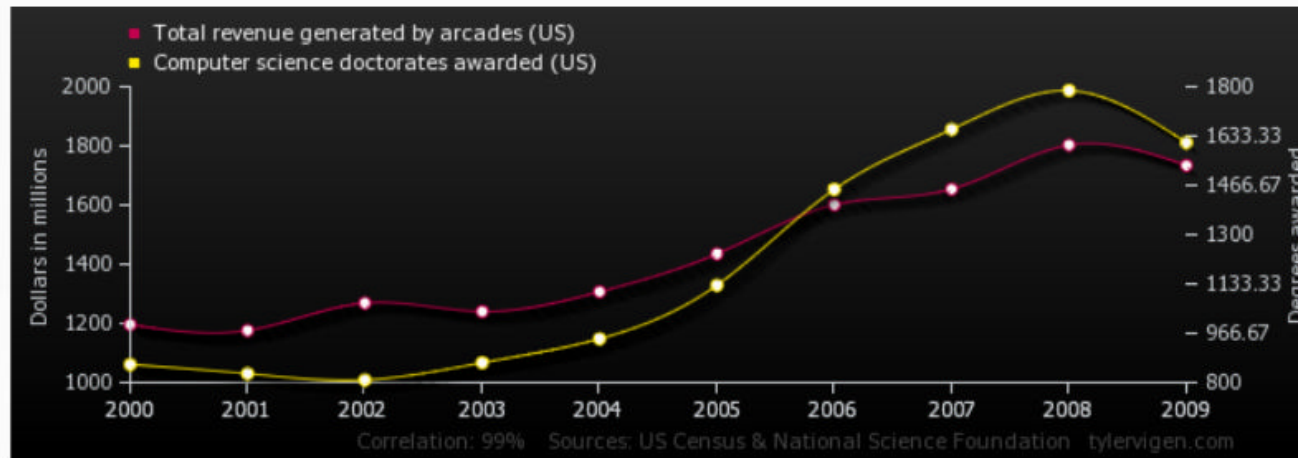
http://www.in.gov/indot/div/mt/itm/pubs/812_testing.pdf



ASTEC INDUSTRIES, INC.



Total revenue generated by arcades (US) correlates with Computer science doctorates awarded (US)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total revenue generated by arcades (US) Dollars in millions (US Census)	1,196	1,176	1,269	1,240	1,307	1,435	1,601	1,654	1,803	1,734
Computer science doctorates awarded (US) Degrees awarded (National Science Foundation)	861	830	809	867	948	1,129	1,453	1,656	1,787	1,611

Correlation: 0.985065

Constructability (or buildability)



Constructability (or buildability)

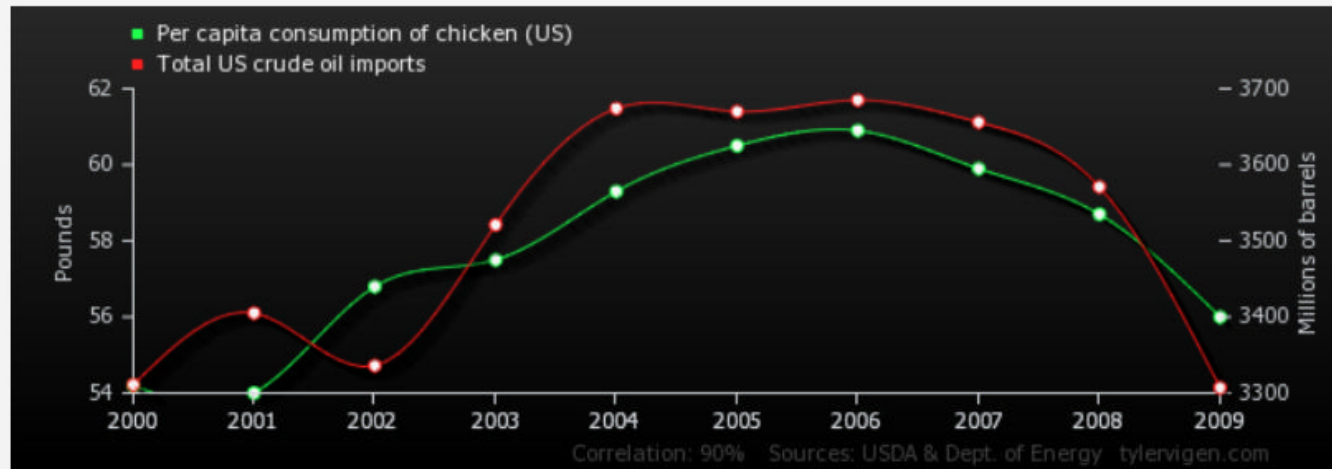


Constructability (or buildability)



correlates with

Total US crude oil imports

[illegible]

Has the surface been thoroughly cleaned and properly tacked?



Constructability (or buildability)



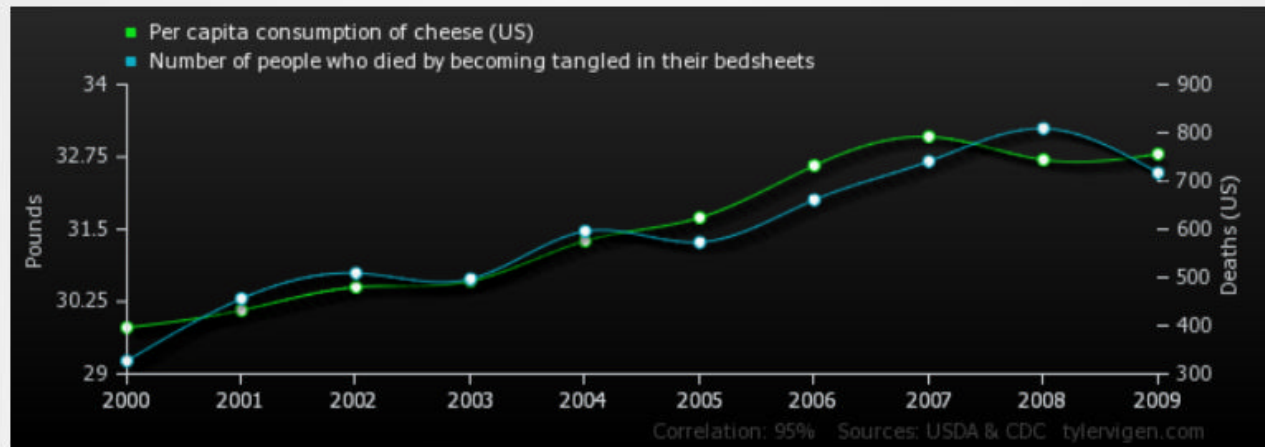
Constructability (or buildability)



Per capita consumption of cheese (US)

correlates with

Number of people who died by becoming tangled in their bedsheets



[Upload this image to imgur](#)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Per capita consumption of cheese (US) Pounds (USDA)	29.8	30.1	30.5	30.6	31.3	31.7	32.6	33.1	32.7	32.8
Number of people who died by becoming tangled in their bedsheets Deaths (US) (CDC)	327	456	509	497	596	573	661	741	809	717

Correlation: 0.947091

Constructability (or buildability)



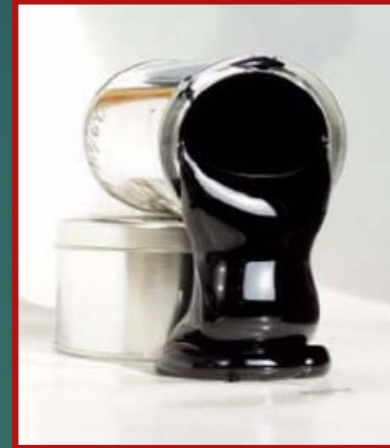
Constructability (or buildability)



Principles of Constructability Mapped on to the Procurement Process

- ▶ Integration
- ▶ Construction knowledge
- ▶ Team skills
- ▶ Corporate objectives
- ▶ Available resources
- ▶ External factors
- ▶ Programme
- ▶ Construction methodology
- ▶ Accessibility
- ▶ Specifications
- ▶ Construction innovation
- ▶ Feedback

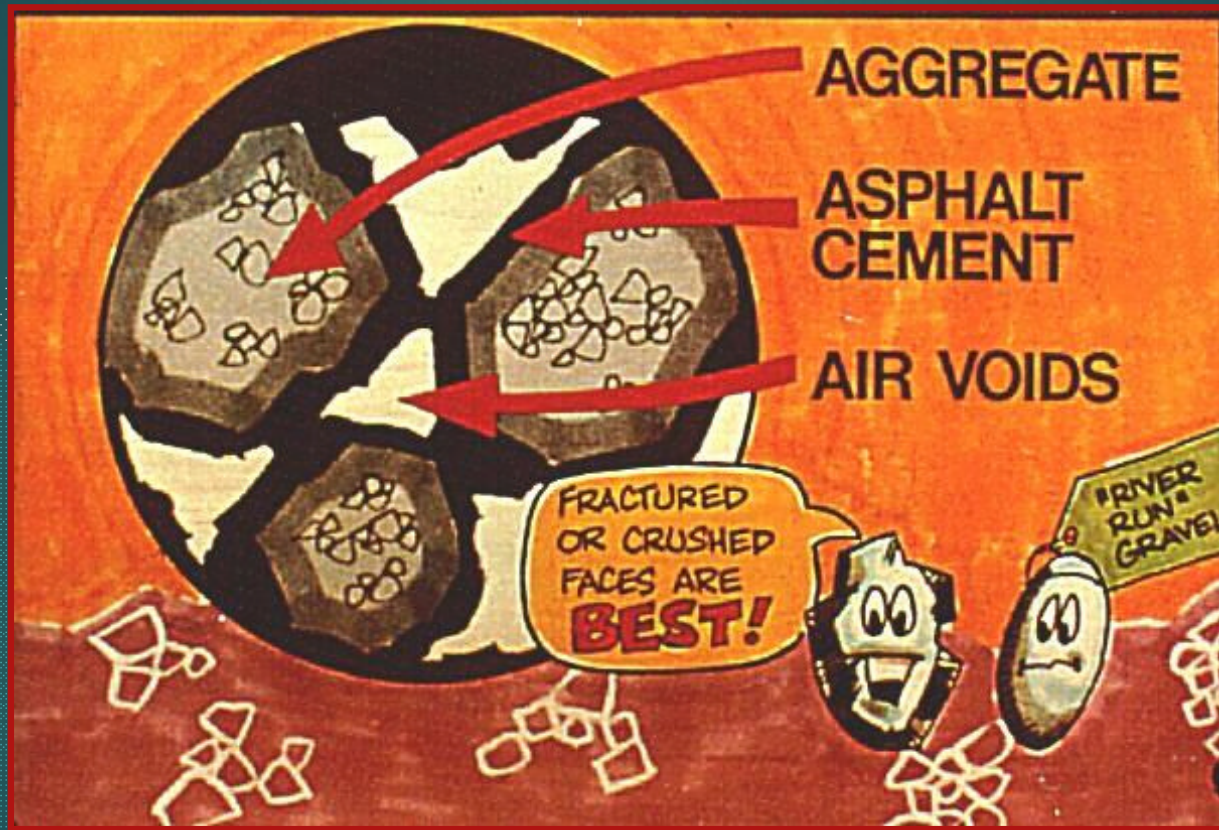
Standard Specifications, current EVER CHANGING edition



Standard Specifications

- ▶ **Minimum VMA,**
- ▶ **Optimum Air Voids,**
- ▶ **Reasonable Gradation Bands,**
- ▶ **Achievable Compaction Levels, and**
- ▶ **Defendable Recycling Levels.**

Hot Mix Asphalt (HMA)



Mix Design Submittal



Is the plant producing the mix per the design?

Design with minus #200 to:

- ▶ **Account for breakdown,**
- ▶ **Predict field VMA, and**
- ▶ **Ensure JMF target asphalt content is produced.**

Murphy's Material Minute

Asphalt Mix Design:

- ▶ Requires accurate, reliable, and consistent aggregate bulk (dry) specific gravities that must be run on processed products.
- ▶ Watch the G_{se} from design through production paving. (G_{se} change = G_{sb} change)

Volumetric's 400



Importance of VMA *& Compaction*

- ▶ **Improve Mechanical Stability**
- ▶ **Improve Resistance to Permanent Deformation**
- ▶ **Reduce Moisture/Air Penetration**
- ▶ **Improve Fatigue Resistance**
- ▶ **Reduce Low-Temperature Cracking Potential**

Why do we care about compaction?

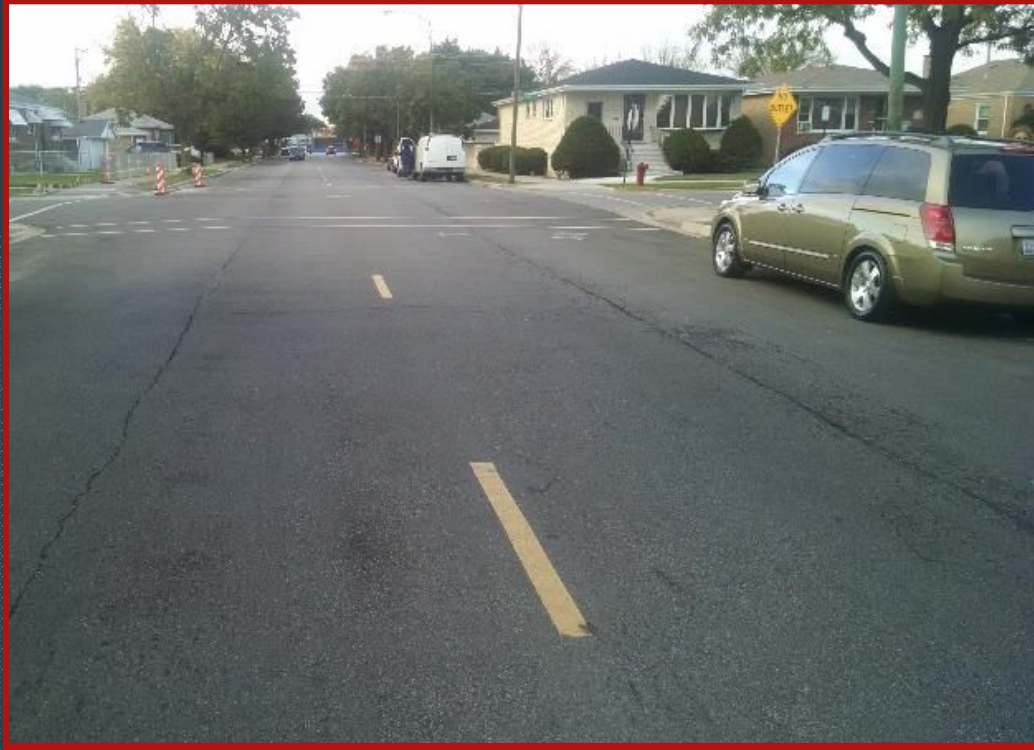
- ▶ Density,  ▶ Permeability,
- ▶ Smoothness,  ▶ Public,
- ▶ Strength.  ▶ Power.

Fatigue and low temperature cracking.

Reclaimed Asphalt Pavement



Constructability (or buildability)



VMA, dust to binder ratio, & AC

At the end it will be:

$$V_{be} = VMA - V_a$$

V_{be} = Effective Volume of Asphalt

VMA = Voids in the Mineral Aggregate

V_a = Air Voids

Murphy's Material Minute

Asphalt Production & Construction:

'Use all equipment in accordance with the manufacturers recommendation.'

Dust balls



Fat Spots in Pavement



Fat Spots in Pavement



Fat Spots in Pavement

Issue

- ▶ Top half AC = 6.1%
- ▶ Bottom half AC = 4.8%

Solution: Eliminate steam build up in the MTV

Constructability (or buildability)

A project management technique to review construction processes from start to finish during pre-construction phase. It is to identify obstacles before a project is actually built to reduce or prevent errors, delays, and cost overruns.

Constructability (or buildability)

A project management technique to review

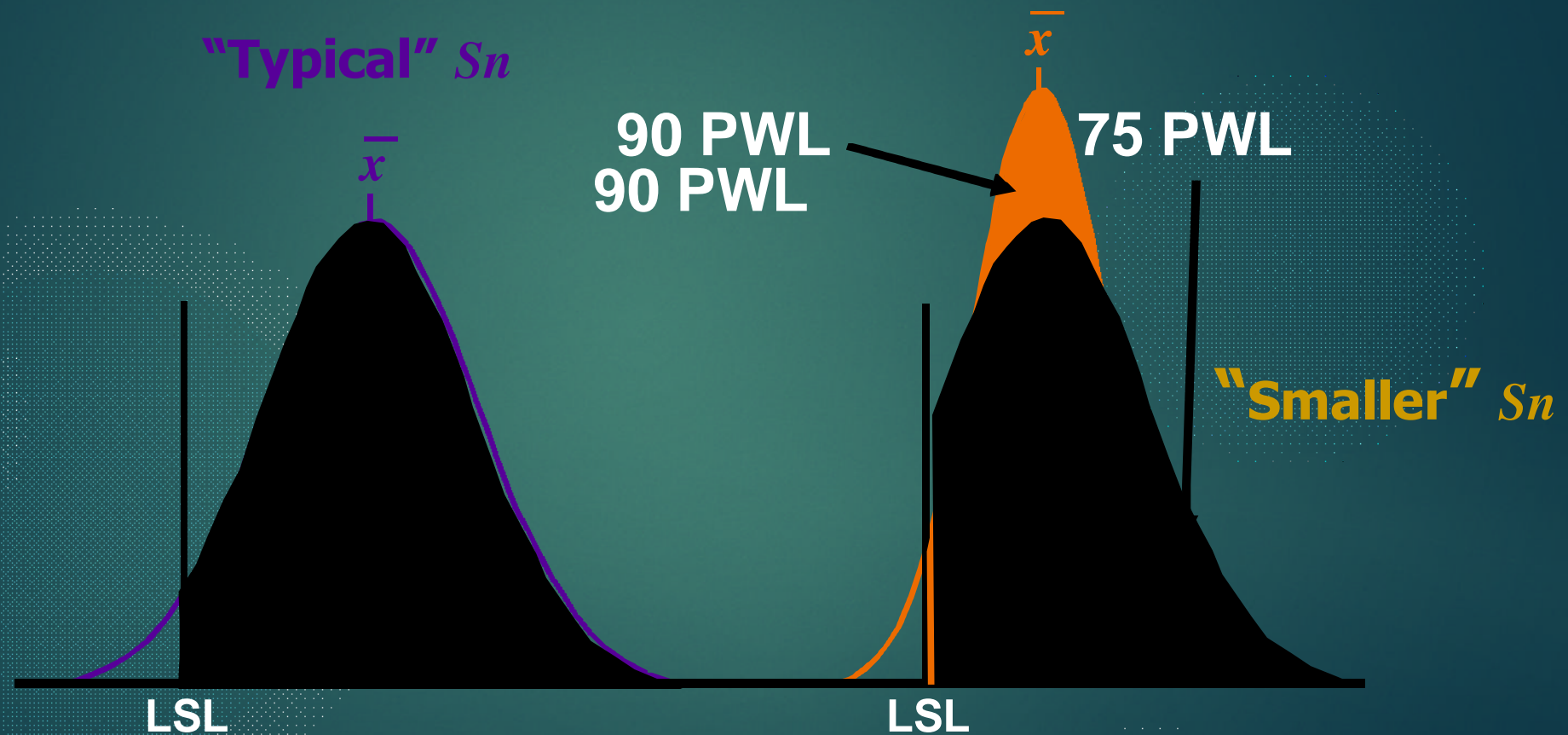
**The more constructible a structure is,
the more economical it will be.**

prevent errors, delays, and cost overruns.

Quit living on the fringe

- ▶ Improve production volumetric measurements. (If you can design it, then you can produce it)
- ▶ Enhance gradation to be a smooth 'S' shaped curve. (Reduce testing variability)
- ▶ Understand that minimums are just that, they are not average minimums. (Improve the life of asphalt)

QC – Mean & Spread Relationship





Questions?



tmurphy@murphypavetech.com