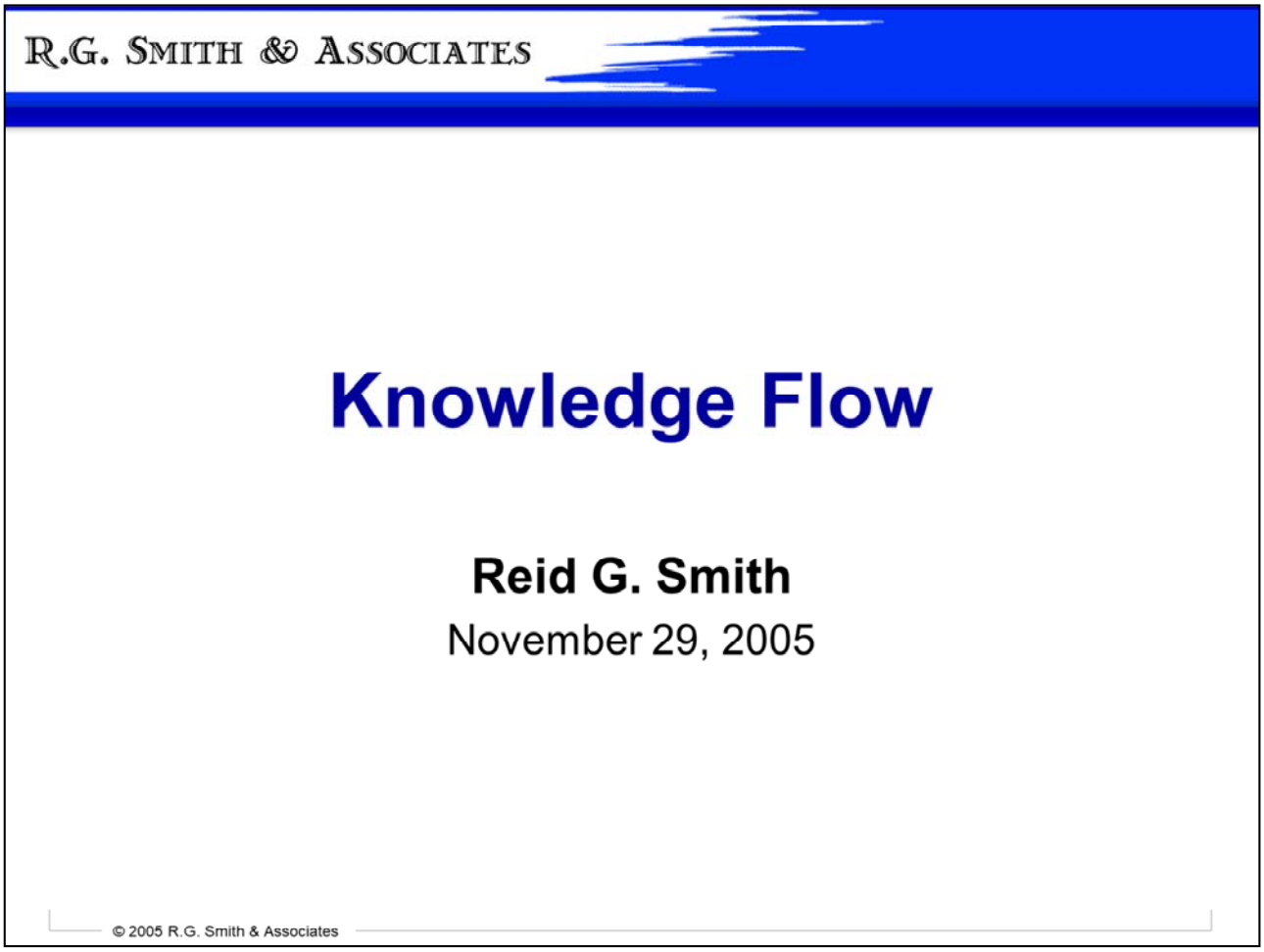


See http://www.reidgsmith.com/Flow.htm for the article. The web site also contains related materials.

Knowledge is sticky.
Without a systematic process and enablers, it won't flow.

— Carla O'Dell

$$v = -\frac{k}{\mu}\frac{\partial p}{\partial x}$$

flow velocity v, permeability k,
viscosity μ, pressure p, distance x

— Henry Darcy

Washington story. APQC conference.

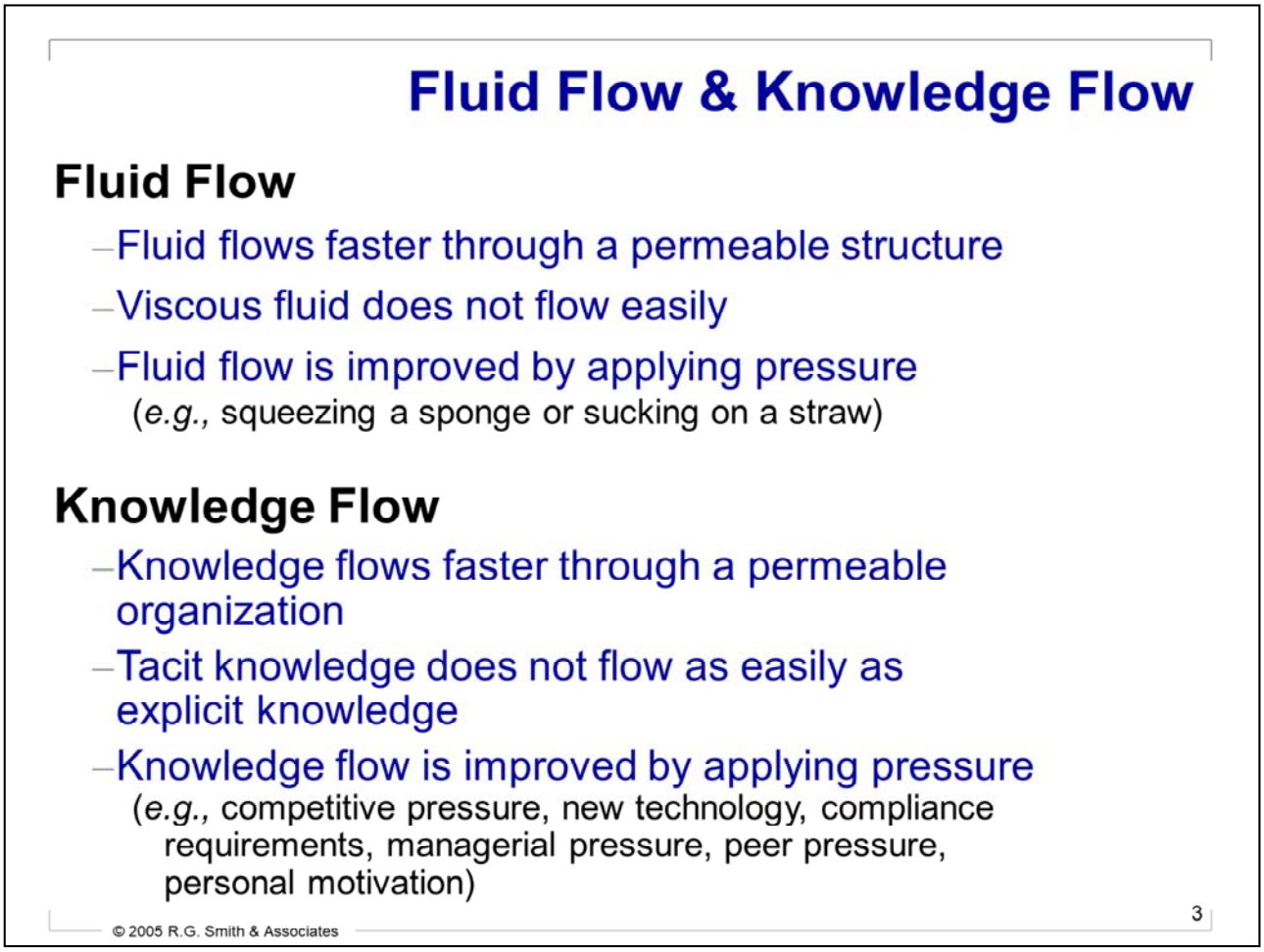
Henry Darcy (1803 to 1858) invented the modern style Pitot tube, was the first researcher to suspect the existence of the boundary layer in fluid flow, contributed in the development of the Darcy-Weisbach equation for pipe flow resistance, made major contributions to open channel flow research and of course developed Darcy's Law for flow in porous media. His law is a foundation stone for several fields of study including ground-water hydrology, soil physics, and petroleum engineering.

Darcy's Law and the concepts we will discuss apply to a number of domains. Petroleum reservoirs, water aquifers, blood flow, flow across cell membranes … It holds for all Newtonian fluids. A Newtonian fluid has a constant viscosity at a given temperature regardless of the rate of shear. Single-grade oils are Newtonian fluids. Multigrade oils are NON-Newtonian fluids because viscosity varies with shear rate.

Dimensional Analysis: v - *distance / time;* k - *distance*^{2}*;* μ - *force • time / distance*^{2}*;* p - *force / distance*^{2}*;* x - *distance.* We take *distance* to be organizational distance (*e.g.,* from a knowledge creation point to a knowledge application point). We take *force* to be supplied by the business and regulatory environment, by management, by peers and by personal motivation.

1 centimeter^3 / second = (1 darcy / 1 centipoise) * 1 atmosphere / centimeter

Example: Ghawar Field, Shedgum Area, Arab-D Reservoir: Oil viscosity at reservoir conditions: .62 cP; Average permeability: 639 mD. (From: http://www.gregcroft.com/ghawar.ivnu)



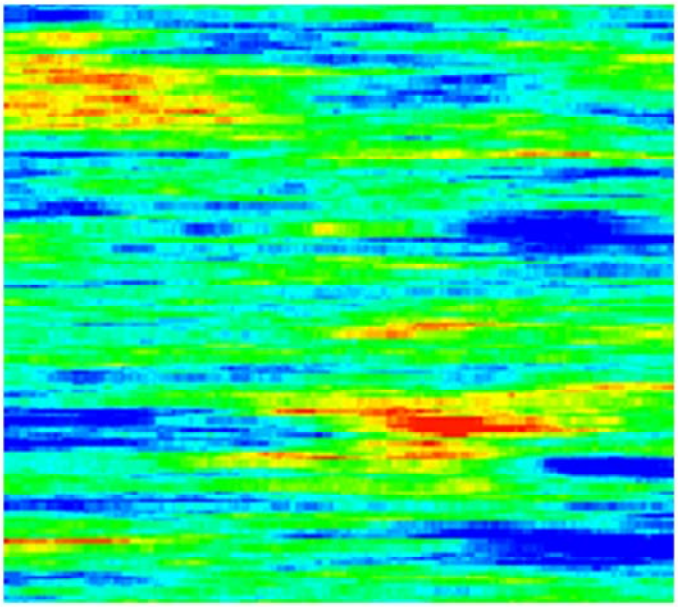
Knowledge flow and fluid flow obey analogous laws. The analogy suggests a way of thinking for the knowledge manager. To improve the knowledge productivity of an organization, take actions to:

- increase organizational permeability, reduce knowledge viscosity, increase business pressure gradient.

New technology creates pressure in the hands of competitors. If competitors aren't using it, then its effect is typically on permeability or viscosity. Remember also that we are talking about "knowledge management" technology here – personal, group and/or enterprise. We are not talking about technology in the large (e.g., new sensor technology).

Analogies

- Flow
- Porosity
- Permeability
- Relative Permeability
- Pressure Gradient
- Channel
- Barrier
- Stimulation



4

Two-dimensional slice through a petroleum reservoir (depth increasing from top to bottom).
Red - Low Permeability; Blue - High Permeability.

Connected Porosity: interconnected people, knowledge bases and workflows

To Improve Knowledge Flow

Increase organizational permeability

- Knowledge connections
  - Channels, barriers, dynamics

Reduce knowledge viscosity

- Tacit information → explicit, actionable knowledge
- Knowledge mapping, technology and processes

Increase business pressure gradient

- Reduce outlet pressure; increase inlet pressure
- Management leadership

$$v = -\frac{k}{\mu}\frac{\partial p}{\partial x}$$

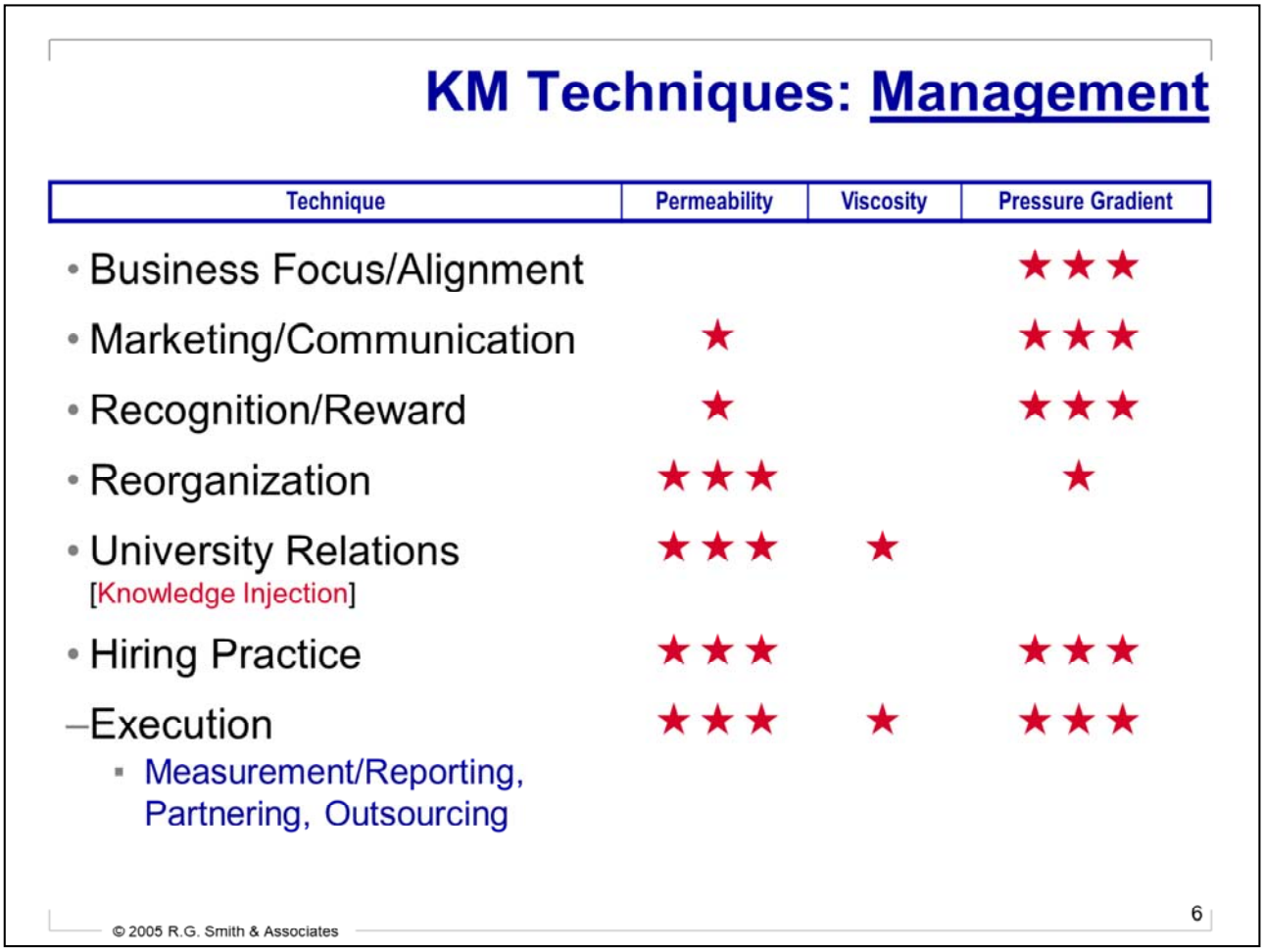
5

Increase organizational permeability. First, remind ourselves that porosity is people, knowledge bases and workflows. Focus on connecting them: p2p, p2i, p2w, …

How do you reduce viscosity in oilfield applications: raise temperature (big effect); raise pressure (small effect); gel breakers (used in fracturing … normally done with enzymes at the lower temperatures and oxidizers at elevated temperatures. The challenge has been adding sufficient breaker to provide a complete break while being able to place the proppant before breaking begins);

Note that in the oilfield, sometimes we want to increase viscosity and sometimes to reduce it.

Remember that in changing the pressure gradient in an organization, you have two variables to work with: pressure and distance. You can reduce organizational distance (e.g., via reorganization).



In the next three slides, we explore the notion of an intervention and the effect it might have. What flow variables do various techniques influence?

Note that these are all Stimulation techniques.

Business Focus: can be achieved via a Performance Scorecard, understanding the KPIs of the organization. There may also be a compliance component (e.g., Sarbanes-Oxley) that adds additional pressure.

Marketing/Communication and Recognition/Reward can be categorized as “Change Management”.

Reorganization obviously has the potential to change permeability. However, it can also have an impact on pressure gradient: first, by demonstrating that the management is willing to reorganize to improve knowledge sharing; and second, some reorganizations reduce organizational distance between knowledge creation points and knowledge application points. The chart is intended to highlight the second point.

Knowledge Injection (e.g., University Relations) … increases permeability directly, may reduce viscosity … worth separating from Execution (e.g., Partnering). Also indirectly impacts pressure gradient because putting one in place communicates the importance of knowledge injection (including recruiting). But we don’t need to highlight this. It is true for every point on the slides.

Knowledge Continuity program … reduces viscosity … we will cover it separately.

Execution … increases Pressure Gradient

KM Techniques: Process

Technique	Permeability	Viscosity	Pressure Gradient
• Community of Practice	★★★	★★	★
• Education	★★	★★★	
– Training, Mentoring			
• Storytelling	★	★★	
• Learn Before/During/After	★★	★★★	
• Knowledge Asset Development	★	★★★	
• Validation Workflow [Separation]	★	★★★	
• Social Network Analysis	★★	★★	
–Knowledge Service Desk	★★★	★★	

CoPs … overarching framework, setting, … not fine-grain enough for our discussion. Analogous in granularity to secondary production … must dive deeper and consider the individual techniques.

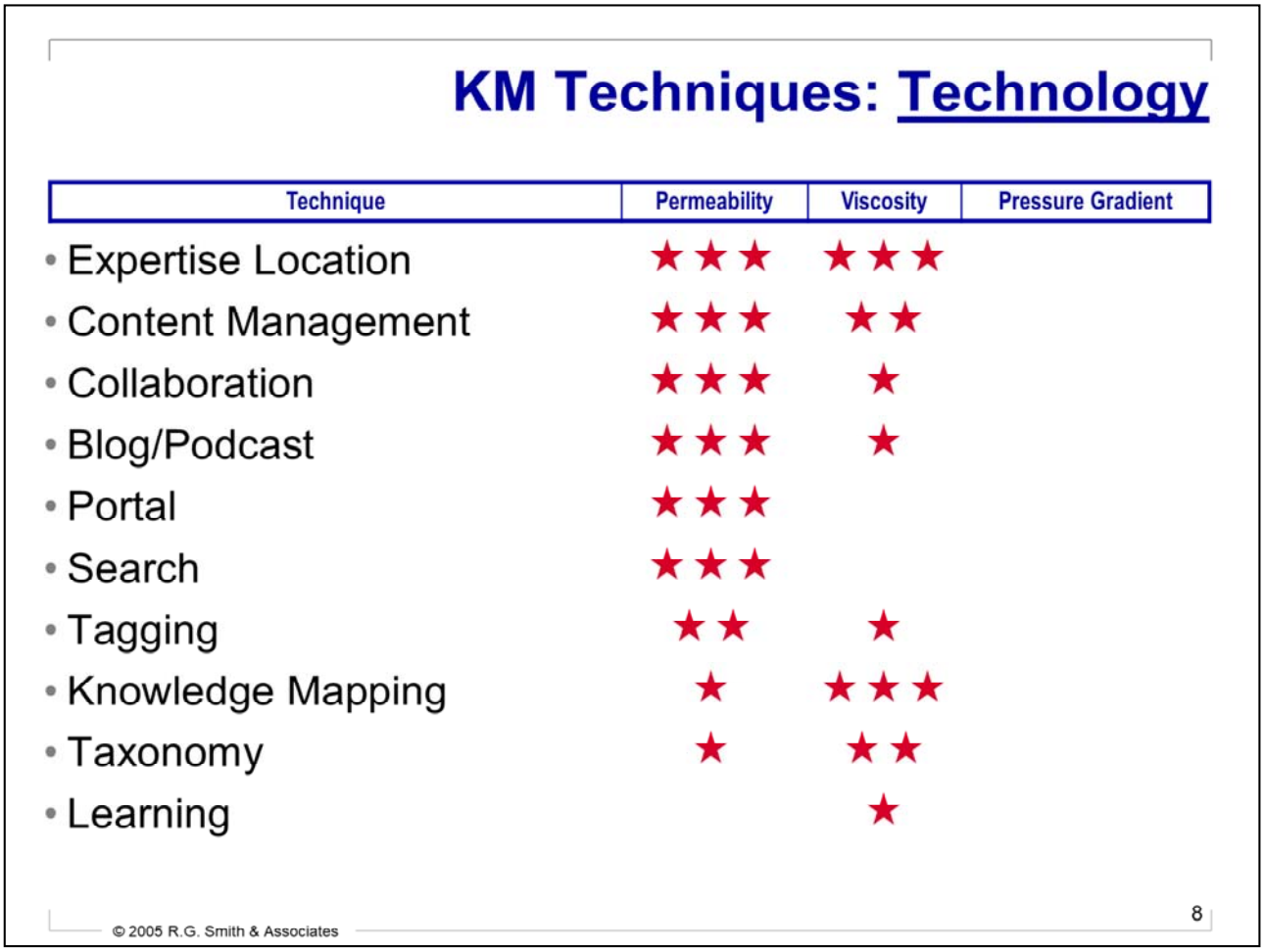
Note that the analog to a CoP is connected porosity.

Learning Before/During/After. Peer Assist, After Action Review, Retrospect, Knowledge Exchange and Expert Interview are all examples.

Knowledge Asset Development – main effect is on viscosity by creating artifacts, but may also connect people as part of the development process.

Validation Workflow has indirect effect on permeability by connecting people (e.g., contributors to experts). Also has an effect on pressure because putting one in place underlines the importance of the knowledge … and of knowledge management. But then, any technique that requires resources is in the same boat. So let's not highlight this explicitly.

Could consider a grouping according to activity vs. setting or framework (e.g., CoP) vs. process/technique



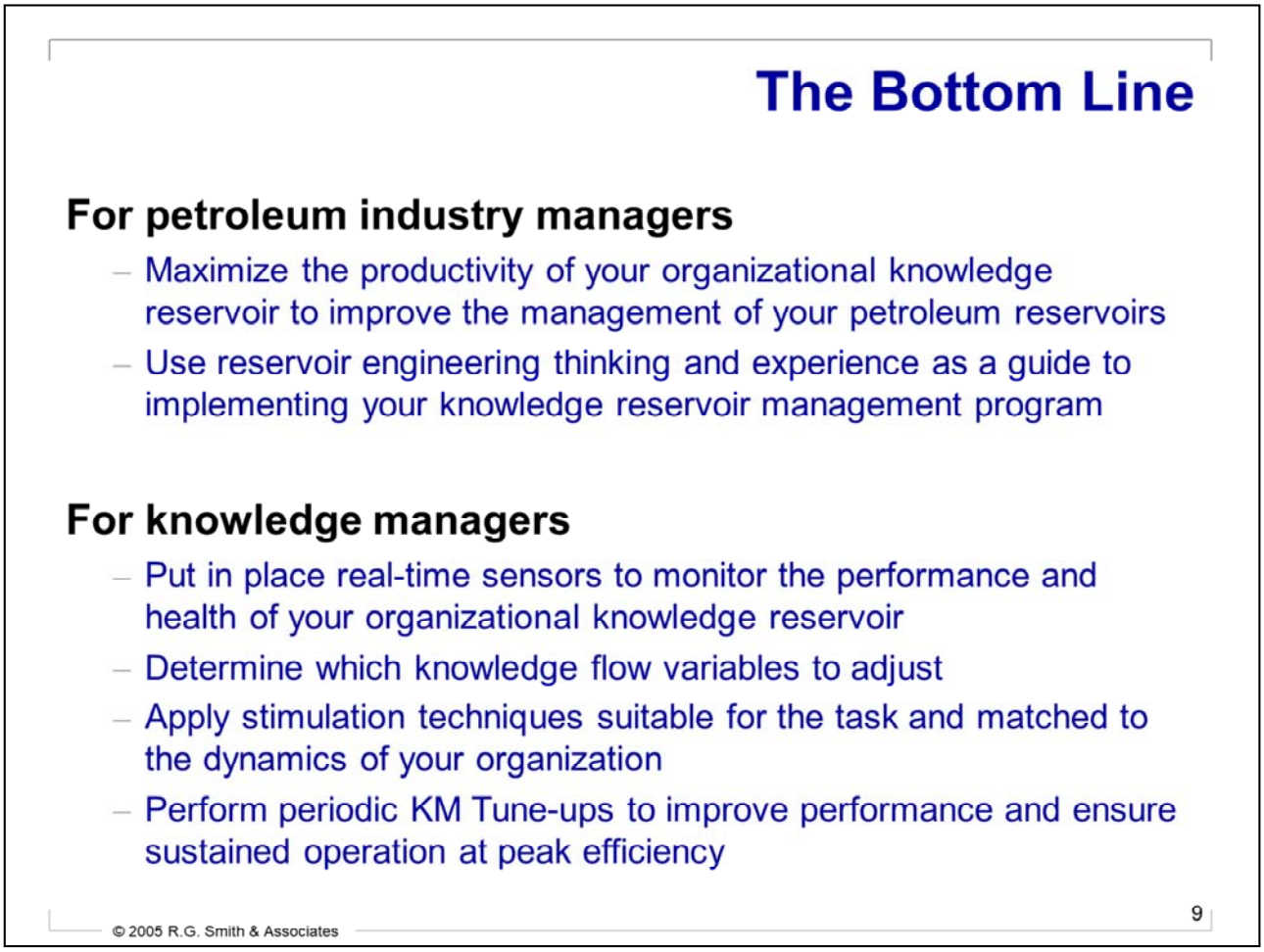
Note that all technology has a process and change management dimension. Otherwise, it doesn't have much effect.

Note grouping (e.g., Content Management ff are all related to Knowledge Repositories (building, maintaining, etc.). When we talk about a Knowledge Repository, it implies all of the processes / assignment of responsibility that goes with the Technology and the Content.

Learning technology can include a broad range, from Learning Management Systems as an aid to management of knowledge transfer to Machine Learning for knowledge creation. Knowledge Creation is beyond the scope of this presentation.

How can technology change permeability? It can open up flow channels. This is apparent for collaboration tools (P2P, P2CoP), but in fact all technology via P2I, P2BB&LL, P2W, etc.

Note also that some "tools" are related (e.g., technology changes the nature of communication).



A useful prism … a new way of seeing … new lens … new perspective … new vantage point.

KM thinking to help petroleum industry professionals manage reservoirs?

KM Tune-up? Importance of maintenance … goes back also to Knowledge Flood ideas …

Storytelling: translation of concepts into something immediate that is comprehensible and applicable to the audience – translates the theory into something that makes sense to the audience.

Use Darcy's law as a common ground in terms of vocabulary and professional context.

KM Tune-up: Check overall operation; identify problems; repair, upgrade or add components; identify actions to start, continue, cease and change.

To understand whether a component is functioning properly, it is important to understand the role it plays in the overall system.

Can think of a KM Tune-up like a Workover program.