

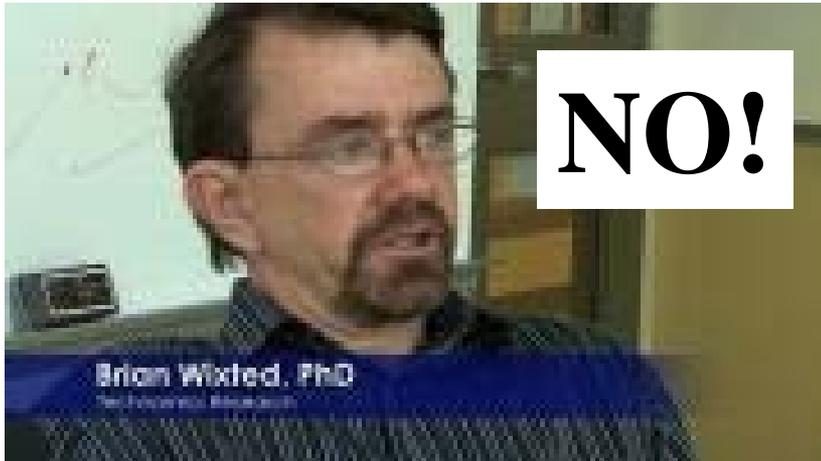
# Differential adoption of digital technology in the Canadian agriculture and mining sectors

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# Is Canadian mining exploiting digital opportunities?



Who's right? Brian?  
Peter? Neither? Both?



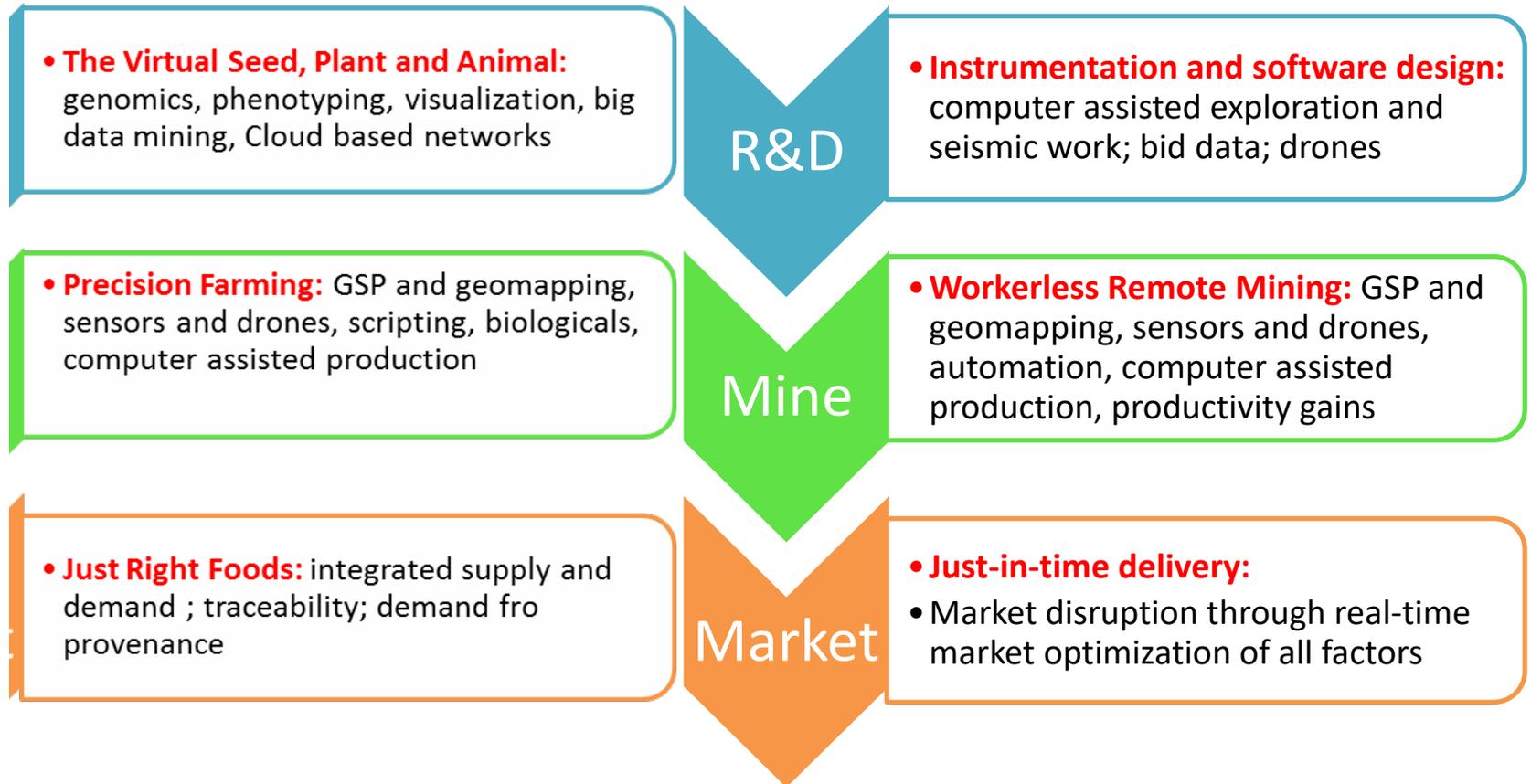
# Anchoring the discussion

Agriculture	Mining
<ul style="list-style-type: none"> <li>• &gt;\$100 B impact on GDP</li> <li>• 2.1 million workers</li> <li>• Low wages</li> </ul>	<ul style="list-style-type: none"> <li>• \$56B impact on GDP</li> <li>• 373,000 workers</li> <li>• Highest wages of all sectors</li> </ul>
<ul style="list-style-type: none"> <li>• Top 4 global exporter</li> <li>• Top 5 exporter in most crops and some animals</li> <li>• Most key technologies owned and exploited by foreign owned MNEs</li> </ul>	<ul style="list-style-type: none"> <li>• Global leader in potash and second in uranium</li> <li>• Top 5 in 11 other ores</li> <li>• 3700 world class suppliers</li> <li>• 57% of global companies listed on TSX and 53% of global equity raised in Canada</li> <li>• Canadian owned MNEs</li> </ul>

# The digital opportunity

## Agriculture

## Mining



# Evidence of digital adoption

<b>Agriculture</b>	<b>Mining</b>
<ul style="list-style-type: none"><li>• <b>Heavy investment in research (albeit from low base)</b></li><li>• <b>49% of farmers use precision ag on entire farm; 37% on part of farm</b></li><li>• <b>~ 40% of total acres soil sampled &amp; geo-tagged</b></li><li>• <b>98% use GPS guidance systems to apply 85% of fertilizer, 70% of chemicals and 26% of seed</b></li><li>• <b>~ 40% use remote imagery in-season to monitor crops (28% satellite &amp; 19% captured drones)</b></li><li>• <b>&gt; 85% of combines use real-time monitoring</b></li><li>• <b>~ 66% use temperature and moisture sensors to monitor stored grain</b></li></ul>	<ul style="list-style-type: none"><li>• <b>Geomatics industry thriving</b></li><li>• <b>Some instrumentation being trailed</b></li><li>• <b>One automated truck in operation in oil sands</b></li><li>• <b>No automated transportation</b></li></ul>

# Why? Adoption theory says...

- Firms respond to new technology possibilities by:
  - Considering objective evidence of costs and benefits
  - Following Rogers' (2003) stages: awareness; persuasion; decision; implementation; and confirmation
- Business school does not dispute the economic model, but is concerned it has limited application:
  - Bower & Christenson (1995) assert consistent pattern in business is failure of leading companies to stay at the top of their industries when technologies or markets change
  - Possible factors: Sunk costs? Trailability? Scalability? Investment cycle? ...

# Is there a need? Yes for both sectors but more for mining!

Annual average 1997-2007	Canada	AB	SK	MB
<b>Agriculture &amp; FFF – MFP</b>				
Multifactor Productivity	2.44	<b>4.07</b>	<b>1.01</b>	2.87
Labour productivity	4.55	<b>8.75</b>	<b>5.46</b>	5.59
Capital Productivity	1.91	<b>2.80</b>	<b>0.08</b>	2.51
<b>Mining and Oil &amp; Gas Extraction</b>				
Multifactor Productivity	-4.64	<b>-6.10</b>	<b>-6.36</b>	-1.11
Labour productivity	-1.56	<b>-2.98</b>	<b>-4.52</b>	2.05
Capital Productivity	-5.10	<b>-6.90</b>	<b>-6.57</b>	-2.72

# Are there barriers to adoption of ICT?

2012	Firm size	Private sector	Ag	Mining, oil & gas
Unaware of new technologies	Total	16.4	20.1	5.8
Employee resistance to new technology	Total	9.6	11.5	17.6
Lack of technical expertise & skilled personnel in-house	Total	29.5	54.5	12.6
	Large	18.4	--	6.8
New systems incompatible with existing systems	Large	18	61.8	5.5
Security and/or privacy concerns	Total	18.7	30.9	6.9

# Maybe firms are not spending on ICT?

Type ICT service expense	Size of firm	Private sector	Agriculture and FFH	Mining, and oil and gas
Any expenditures on ICT services in the past 3 years	Total	51.5	<b>29.9</b>	<b>51.6</b>
	Large	88.7	-	<b>99.2</b>
Data processing services	Total	7.5	<b>6.1</b>	<b>1.6</b>
Database services	Total	17.8	<b>11.9</b>	<b>13.1</b>
	Large	54.7		<b>91.1</b>
Software as a service	Total	18.3	<b>3.3</b>	<b>25.7</b>
	Large	44.3	-	<b>79.4</b>
Web site design or hosting	All	31.4	<b>19.3</b>	-
	Large	69.3	-	<b>93.4</b>

Table 358-0202.

# Could it be firm strategy?

**% all firms reporting different innovations, 2007-09**

Type of innovation:	Goods	Services	Process	Organization	Market
<b>Mining &amp; related activities</b>	<b>23.5</b>	<b>6.3</b>	<b>14.6</b>	<b>39.5</b>	<b>19.8</b>
Oil, gas & drilling	6.4	0	8.7	20.9	2.9
Manufacturing	42.6	21.7	15.7	44.9	20.4
Food manufacturing	36.5	14.4	17.7	38.3	20.2
Services	25.3	27.7	14.7	30.9	31.3

# Maybe firms are not investing in training?

Enterprises investing in ICT training	Size of firm	Private sector	Mining, quarrying, oil & gas extraction
Businesses with ICT/IT specialists as of Dec 2013	Total	13.4	<b>27.2</b>
Businesses with ICT/IT specialists as of Dec 2013	Large	74.7	<b>96.9</b>
Businesses with ICT/IT specialists as of Dec 2013	Small	10.1	<b>12.7</b>
Training for ICT/IT specialists	Large	73.5	<b>95.3</b>
Training for other staff using ICTs	Large	77.8	<b>95.4</b>

Table 358-0233 Survey of digital technology and Internet use, enterprises investing in Information and Communications Technology (ICT) training, by North American Industry Classification System (NAICS) and size of enterprise, occasional

# Could it be poor incentives or supports?

- Preliminary GEM analysis in 2015 and 2016 of >75 ICT actors in engaged in Ag and Mining
- Shows relatively strong support for programs from entrepreneurs and industry
- Main people who have a poor view of the programs seem to be experts (in government and financial institutions)
- Not clear whether this is overconfidence of entrepreneurs and/or Dunning Kruger Effect

# So, evidence so far suggests mining should be doing better than ag

	Preparedness	Research and Investment	Technical Barriers	Adoption and use
<b>Agriculture</b>				
Upstream	Above average	Moderate	Above average	Strong
Primary sector	Below average	Weak	Above average	Strong
Downstream	Below average	Weak	Above average	Moderate
<b>Mining</b>				
Upstream	Above average	Weak	Below average	Weak
Primary sector	Average	Weak	Below average	Weak
Downstream	Above average	Weak	Below average	Weak

# So, could the gap due to the industrial structure?

	Agriculture			Mining		
	<i>Sub-sector</i>	<i># firms</i>	<i>C4</i>	<i>Sub-sector</i>	<i># firms</i>	<i>C4</i>
Inputs	Seeds	>50	<b>5-80%</b>	Machinery	<10	<b>&gt;50%</b>
	Chemicals	~5	<b>&gt;70%</b>	Geomatics in W. Can Canada	~525	<10%
	Machinery	~10	<b>60%</b>			
	IT firms	>100	>10%	IT firms	>100	<10%
Primary producers	Farmers	28,642	<1%	Potash mining	13	<b>100%</b>
				Uranium mining	30	<b>100%</b>
Marketing	Grain cos	~160	<b>&gt;75%</b>	Potash	4	<b>100%</b>
	Processors	~30	<25%	Uranium	2	<b>100%</b>
Transport	Custom trucking	>250	<10%	Trucking	~10	<b>&gt;70%</b>
	Rail (incl. shortline)	15	<b>~100%</b>	Rail	2	<b>100%</b>

# Could it be the nature of the sectoral investment cycles?

	<b>Agriculture</b>	<b>Mining</b>
Inputs	<b>Annual</b>	<b>1-5 years</b>
M&E	<b>3-7 year amortization</b>	<b>15-40 year amortization</b>
Technology	<b>Trialable and scalable to most cropping systems</b>	<b>3 systems have limited trialability and scalability:</b> <ul style="list-style-type: none"> <li>• <b>drilling (oil 70%; K20 25%)</b></li> <li>• <b>long-wall (K20 75%; U308 65%)</b></li> <li>• <b>open pit (oil 30%; K20 5%; U308 30%)</b></li> </ul>

**Special issues: Family farm? Social license and SLAs for mines?**

# Conclusions

- Don't assume firms irrational or not trying
  - Standard adoption theory addresses agricultural adoption of digital technologies quite well
  - ... BUT ...
  - fails to explain what is happening in mining
- Industrial structure, investment cycles, scalability and trialability and perhaps some discrete factors (such as social license and regional and FN offsets) must be considered as rational responses to DO pressures



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