

Where Are We Going In This Hand Basket?

**Lawrence Devon Smith
CIM Montreal, April 17, 2019**



Lawrence Devon Smith



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Lawrence Devon Smith is Principal Consultant at LDSA. He is a mining engineer with over 40 years experience in economic evaluations and project engineering for mining, metallurgical, and industrial projects. He holds a B.A.Sc. from the University of Toronto and an M.Eng. Mining from McGill University.

Larry has worked as Director Project Evaluations at Barrick Gold and has held similar positions with BHP-Billiton Base Metals, Rio Algom, SNC-Lavalin, Kilborn, Inco, and Vale.

His evaluation experience includes economic evaluations, targeting and ranking studies, scoping studies, optimization studies, pre-feasibility and feasibility studies, risk assessment, and due diligence work for banks and mining companies. Larry has published a number of papers on mineral project evaluation, discount rates, and risk assessment, and is considered an expert in these fields.

Larry teaches mineral economics, mineral project evaluation, and "Introduction to Mining". He is an adjunct professor at the University of Toronto and Schulich School of Business at York University, as well as teaching in-house courses and seminars.

He is on the executive of the CIM Mineral Economics Society (MES) and is a past chair of CIM Toronto Branch. He is the recipient of the CIM Robert Elver award for Mineral Economics, a Fellow of CIM, and a CIM Distinguished Lecturer.



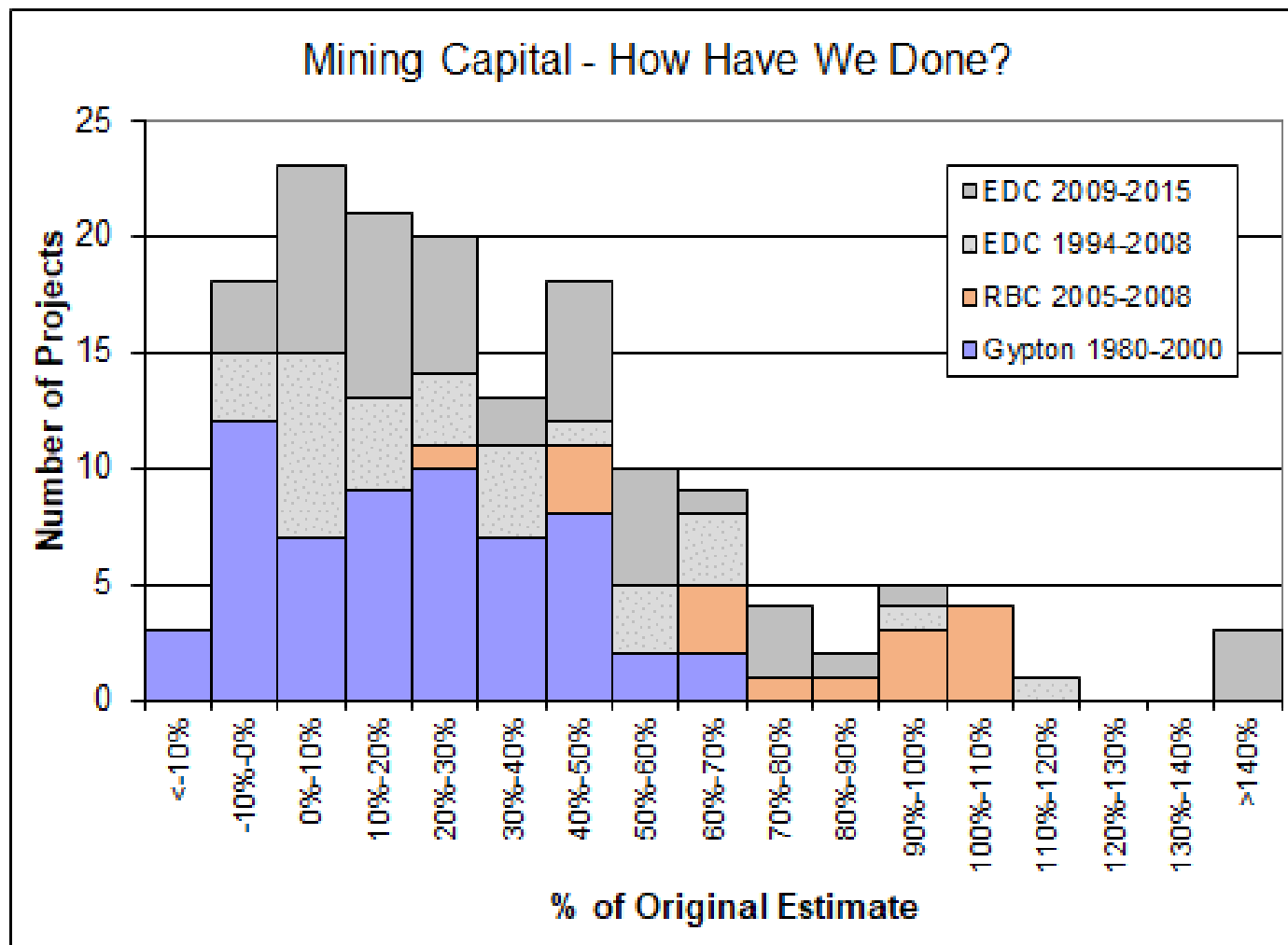
How Have We Done?



How Have We Done?

Feasibility Studies & Capital Performance

Where are We Going In This Handbasket?



C.Haubrich, Why Building A Mine On Budget Is Rare – PDAC 2014

C. Gypton, How have we done? E&MJ - 1Jan2002

RBC - Capital Punishment - 3Apr2008

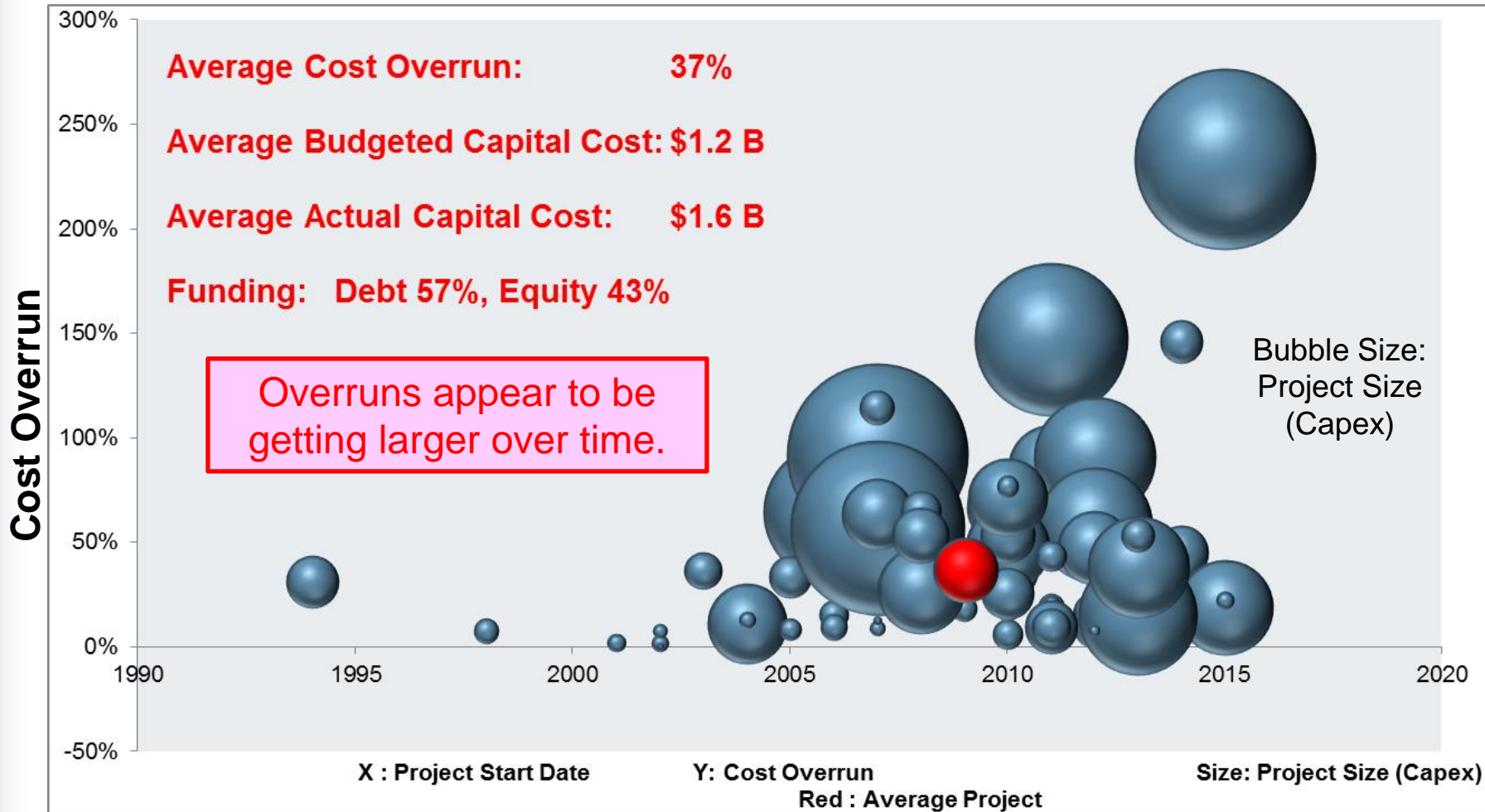
Performance of Mining Operations, T. Lwin, EDC - May2017



How Have We Done?

Feasibility Studies & Capital Performance

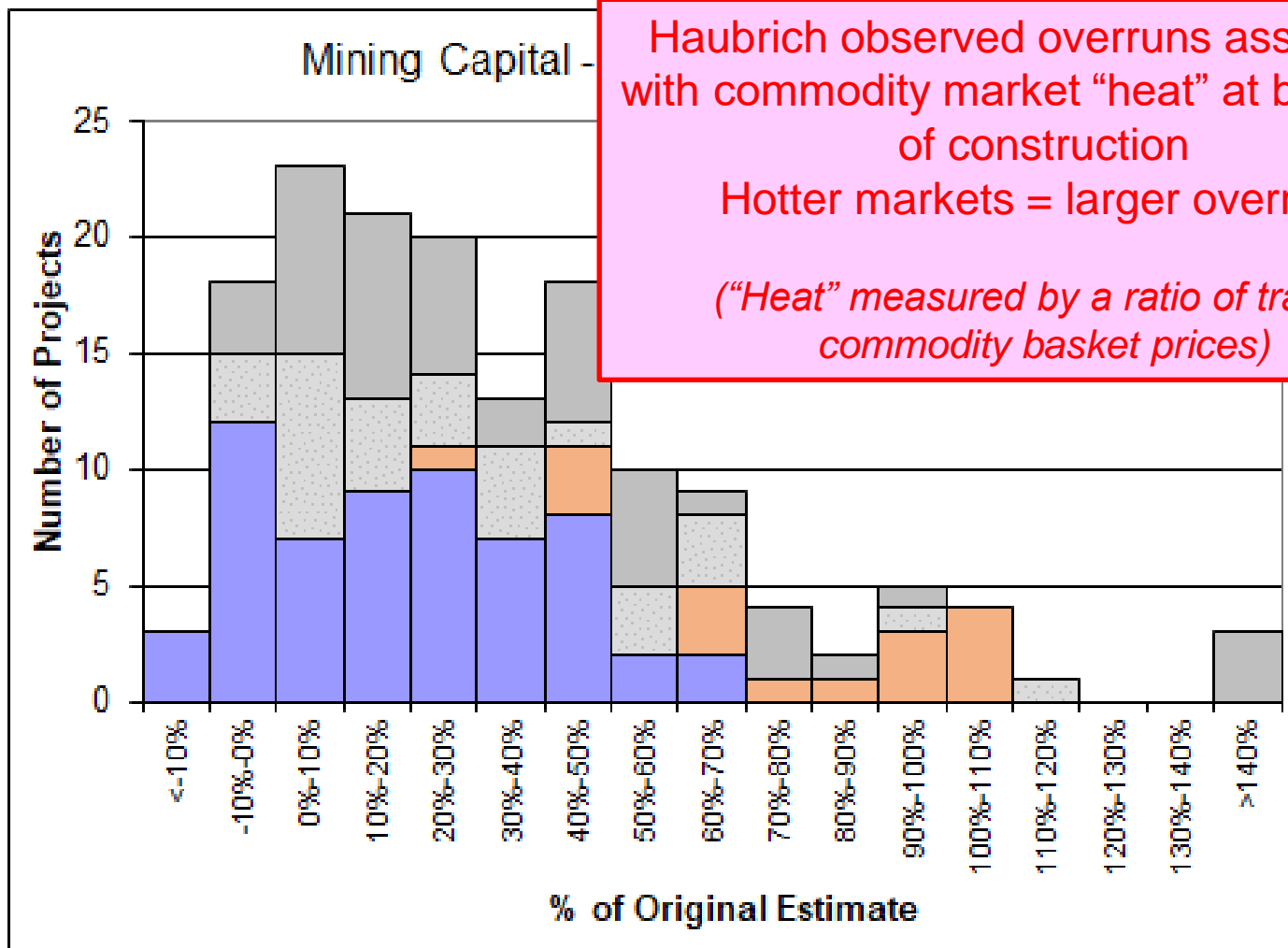
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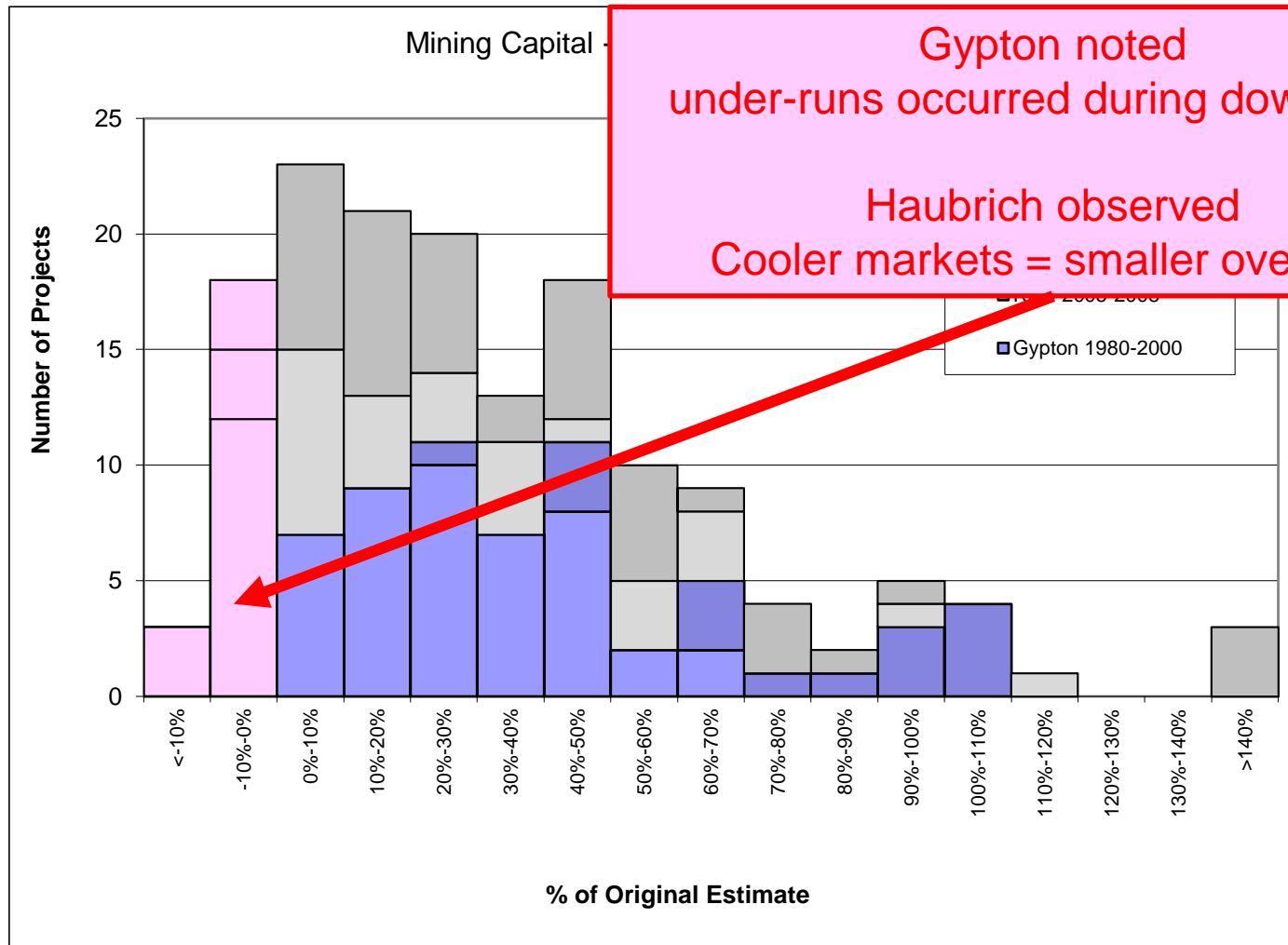
RBC - Capital Punishment - 3Apr2008

Performance of Mining Operations, T. Lwin, EDC - May2017



How Have We Done? Feasibility Studies & Capital Performance

Where are We Going In This Handbasket?



Gypton noted under-runs occurred during downturns.

Haubrich observed Cooler markets = smaller overruns

C.Haubrich, Why Building A Mine On Budget Is Rare – PDAC 2014

C. Gypton, How have we done? E&MJ - 1Jan2002

RBC - Capital Punishment - 3Apr2008

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How Have We Done?

Feasibility Studies & Capital Performance

- “Market Heat” – Hot markets lead to higher overruns
- Changing EPCM contractors following the Feasibility Study appears to lead to higher overruns (lack of continuity; reinvent the wheel; etc)
- Limited resources, specifically:
 - limited risk capital
 - limited qualified personnel
 - Use of unqualified personnel
- Limited time:
 - always pressure to produce the study as quickly as possible.
 - artificial deadlines, such as board meetings and presentations to bankers or analysts.

Christopher Haubrich, CIM 2014
Why Building A Mine On Budget Is Rare
How Have We Done? Feasibility Performance Since 1980
Chris Gypton, E&MJ Jan 1/02



The Problem With Peaks

Making Decisions At the Peak (Market “Heat”)

- Is now a good time to make this decision?
- “A deadly dam burst in Brazil has lit a fire under iron-ore prices, after Vale was forced to take 11 mines offline, impacting on 70-million tonnes a year of production.
- This resulted in iron-ore prices spiking at \$87/t for benchmark 62% iron content fines and to \$101/t for 65% iron content ore.”

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Flying iron-ore prices to boost Black Iron's project economics



8TH FEBRUARY 2019

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BY: [MARIAN WEBB](#)
CREAMER MEDIA SENIOR RESEARCHER
AND DEPUTY EDITOR ONLINE

FONT SIZE:



How Have We Done? Engineering Cost Estimates

Where are We Going In This Handbasket?



Engineer's estimate is
the cost of
construction in heaven



How Have We Done?

Project Costs and Schedule Overruns

- **Remoteness**
 - High elevation (usually accompanied by severe weather)
 - Arctic (with severe weather conditions)
 - Third world (accompanied by poor infrastructure and political instability)
 - **Suggest adding up to 50% to costs and schedule.**
- **Unconventionality**
 - New process, construction or engineering concepts.
 - Problems with ramp-up and reaching full capacity.
 - **Suggest adding up to 50% to costs and schedule.**
- **Earthwork**
 - “The devil is in the dirt.”
 - **Suggest adding up to 100% to earthwork capital budget.**
- **Schedule**
 - **Suggest adding ~ 10% to the schedule and increase capital cost by 1% of total project capital for each month of delay (in addition to the effects noted above)**



How Have We Done?

Management Risk Reserves Excluded

- Contingency is part of the Capital estimate
- Management Risk Reserves are usually not included.
 - They are unknown
 - They might not happen

		RISK RATING MATRIX				
LIKELIHOOD RATING	A	L ₁₈	M ₁₁	H ₆	H ₃	H ₁
	B	L ₂₀	M ₁₄	M ₁₀	H ₄	H ₂
	C	L ₂₂	L ₁₉	M ₁₂	H ₇	H ₅
	D	L ₂₄	L ₂₁	M ₁₅	M ₁₃	H ₈
	E	L ₂₅	L ₂₃	*M ₁₇	M ₁₆	H ₉
			1	2	3	4
		SEVERITY RATING				

**Project
Base
Estimate**

**Feasibility
Study Initial
Capital**

**Total Cost
Including
Risks**

**Project
Contingency**

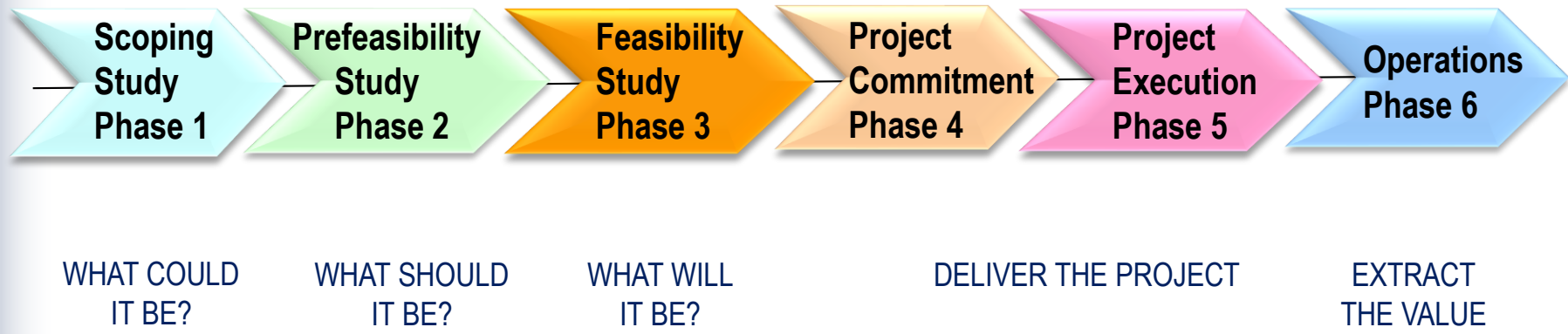
**Management
Risk Reserve**



How Have We Done?

Phased Approach

Where are We Going In This Handbasket?



How Have We Done?

Feasibility Studies & Capital Performance

- After years of work and millions of dollars
- After all those positive press releases
- Can the CEO & board afford to say “No”?



Delivering Smarter Solutions

ISSUE NO. 57 — August 2004

***Feasibility Study Does Not
Necessarily Mean Feasible***

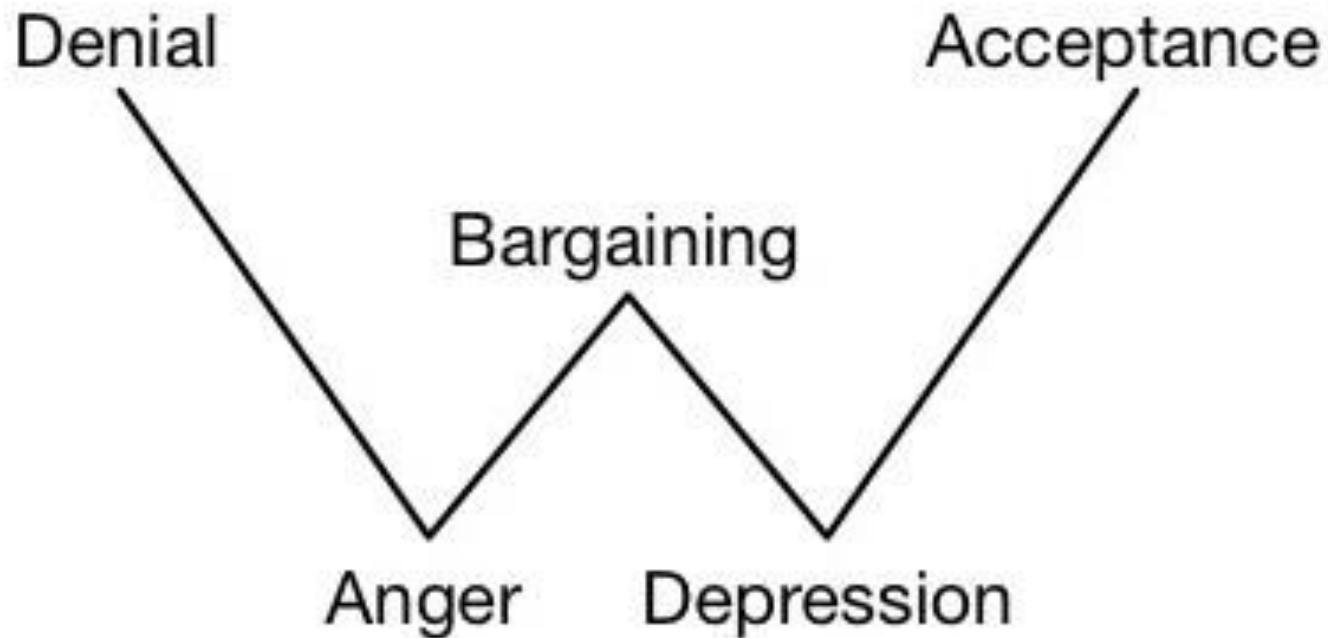
Sometimes the answer is NO!



How Have We Done?

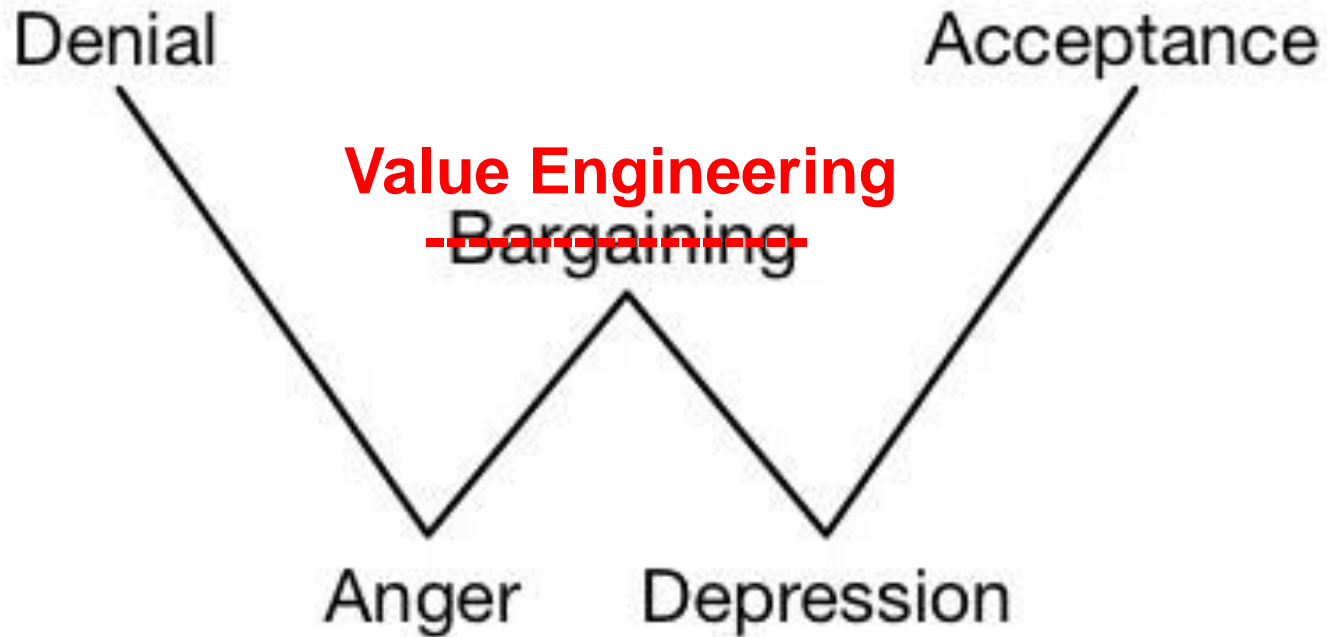
Elisabeth Kubler-Ross - Stages of Dying

Where are We Going In This Handbasket?



How Have We Done? Stages of A Project

Where are We Going In This Handbasket?



How Have We Done?

What Is The Value Of “Value Engineering”

- Value Engineering has become part of the process
 - Is it adding value?
 - Is it just cutting costs?
 - Do the savings actually materialize?
 - How has it changed the project concepts?



How Have We Done?

Re-Risking Project Estimates

- What risks have been created by “Value Engineering”?
 - The results is essentially a new project with new risks.
- “Re-Risk” the estimate to get it back to a realistic value:
 - Not just adding back dollars to the estimate.
 - Re-assess the risks associated with the “Value Engineered” estimate.



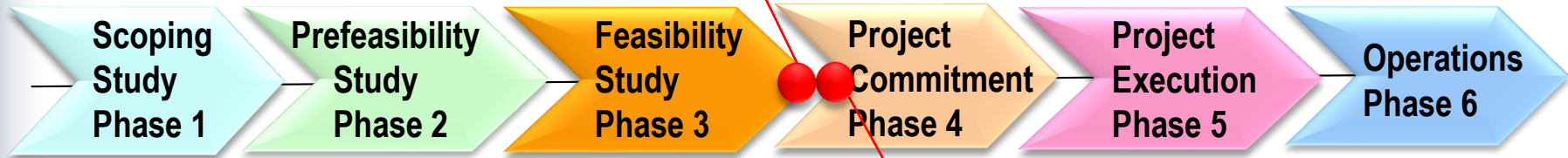
“Re-Risking Project Estimates”, Vancouver 2016
L.D.Smith (LDSA) & Jason Mewis (ENGCOMP)



How Have We Done? Phased Approach (With Amendments)

Where are We Going In This Handbasket?

“Value Engineering”



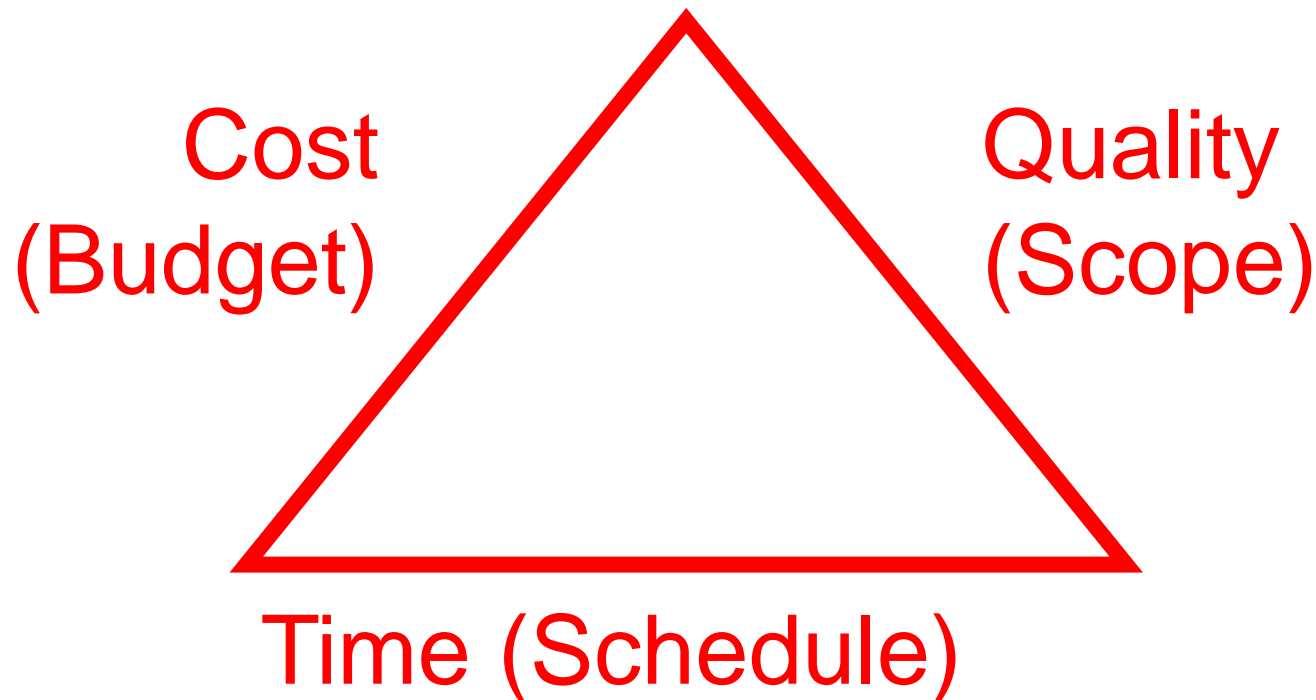
Re-Risking



How Have We Done?

Monitor and Control Schedules & Spending

- A model of project management in which time, cost, and quality are represented as the three sides of a triangle. A change to one side will have some effect on at least one of the other two sides.
- **“Cost, Quality, Time - Choose any two”.**



How Have We Done?

Scope Changes: Original Contract & Change Orders

Where are We Going In This Handbasket?



Skills Shortage



Skills Shortage

Top 10 Strategic Business Risks in Mining & Metals

Where are We Going In This Handbasket?

2009-2010

1. Cost containment
2. Industry consolidation
3. Access to capital
4. Maintaining social license to operate
5. Climate change concerns
6. Skills shortage could delay projects
7. Infrastructure access creating bottlenecks
8. Access to secure energy
9. Resource nationalism
10. Pipeline shrinkage (lack of new discoveries)

2011-2012

1. Resource nationalism
2. Skills shortage
3. Infrastructure access (to markets)
4. Maintaining social license to operate
5. Capital Project Execution
6. Price & Currency Volatility
7. Capital Allocation
8. Cost Management
9. Interruptions to Supply (Natural Disasters)
10. Fraud and Corruption, Sovereign Risk

2013-2014

1. Capital allocation
2. Margin protection & productivity improvement
3. Resource nationalism
4. Social license to operate
5. Skills shortage
6. Price and currency volatility
7. Capital project execution
8. Sharing the benefits
9. Infrastructure access
10. Threat of substitutes



Skills Shortage

Develop And Maintain Qualified Personnel

- Mining companies have reduced or eliminated:
 - their technical teams
 - their Capital Projects teams
 - Their project controls teams
- EPCM consultancies have reduced or eliminated their technical personnel.

- At the same time...
- Accountants and lawyers have remained and have been promoted into senior positions:
 - Senior management
 - “C Suite”
 - Boards of Directors



Skills Shortage Millennials

Caution 1:

- The generation of children coming through schools now have been trained from birth to hate mining.
- Many are not likely to seek careers in mining.

Caution 2:

- As Baby Boomers begin to close out their RRSPs mining stocks will be coming onto the market.
- Mining stocks are not attractive to Millennials.



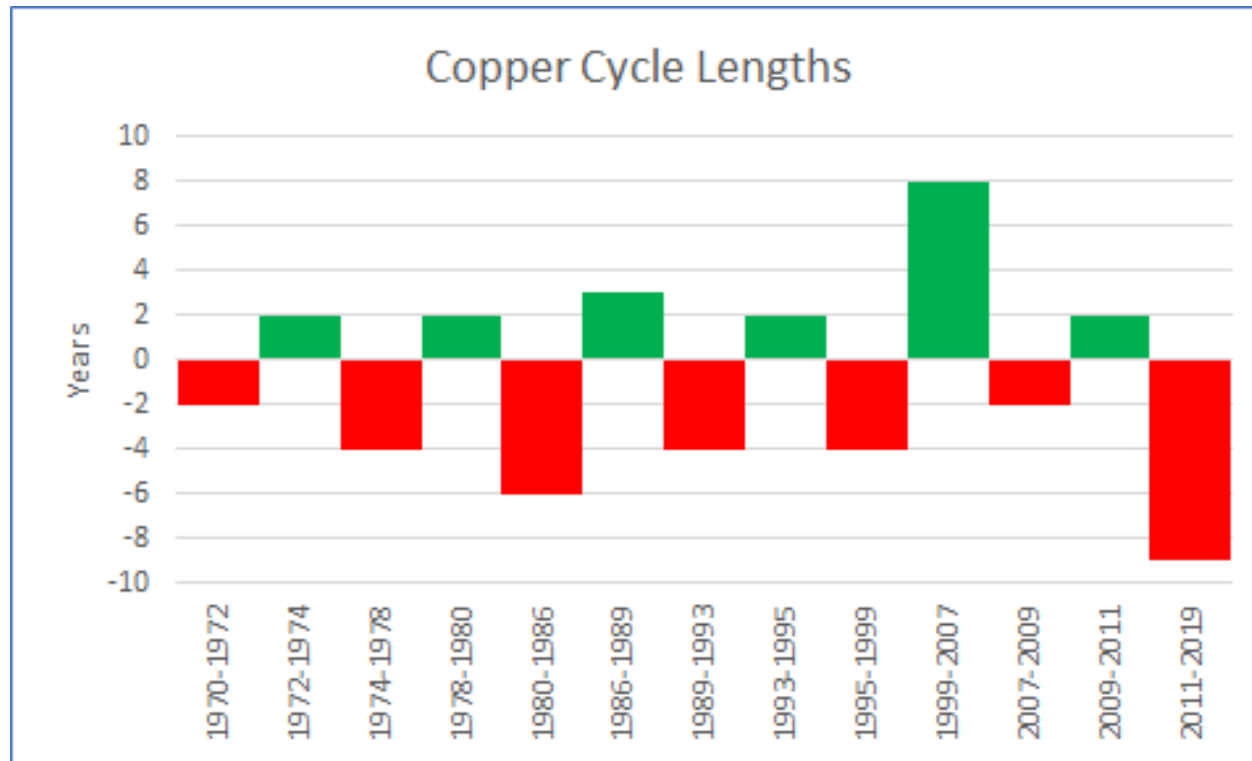
Cycles, Timing & CEOs



Cycles & Timing

Think Past The Current Cycle

Where are We Going In This Handbasket?



Average Cycle Lengths (BMO):

- 4.4 year Down Cycle
- 3.2 year Up Cycle including 1999-2007
- 2.2 year Up Cycle excluding 1999-2007

Base Metal Project Timing (CRU):

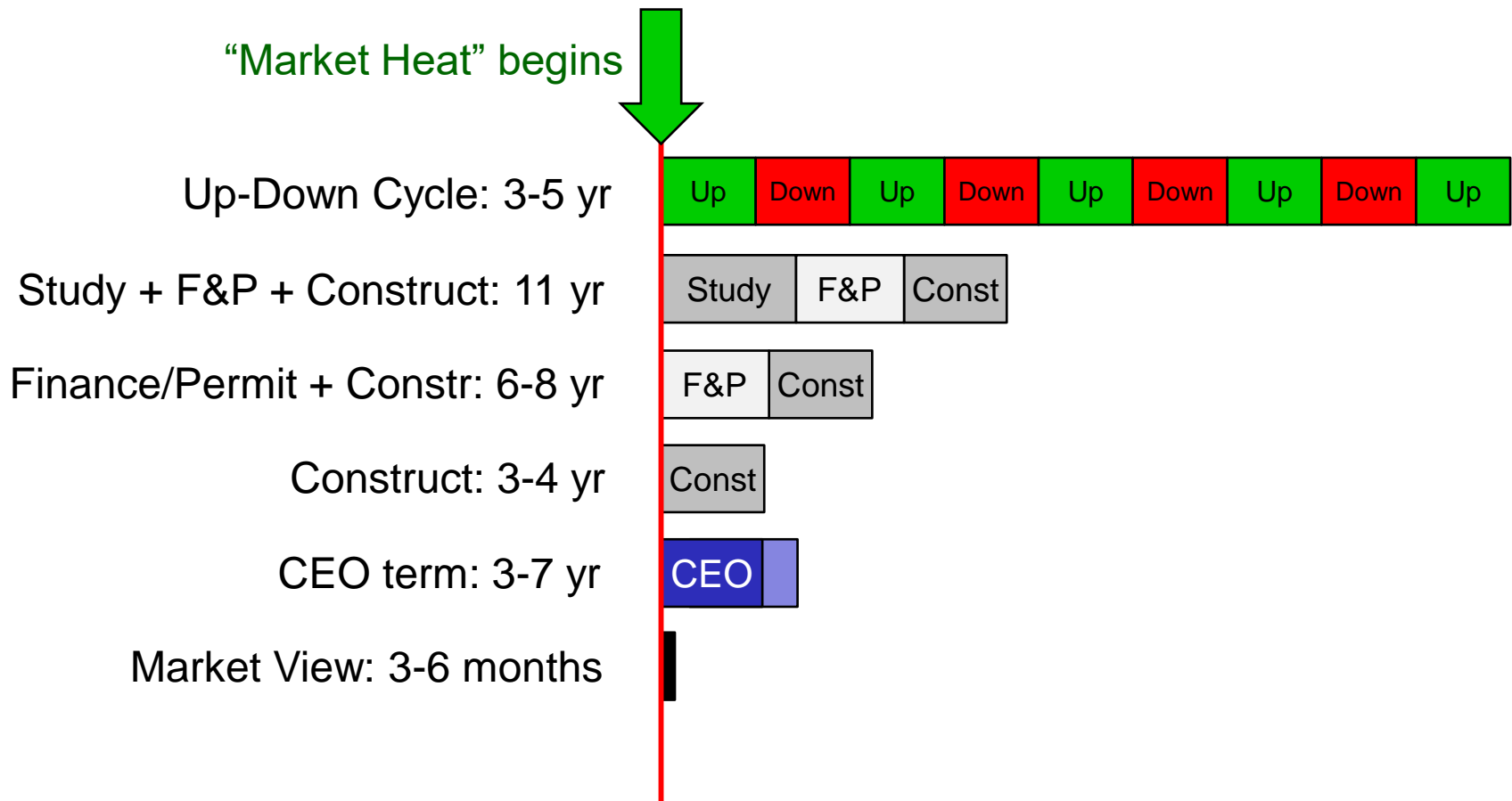
- 4.8 years Studies
- 3.3 years Permitting & Finance
- 3.4 years Construction



Cycles & Timing

I Haven't Got Time For This

- Given the average term expectancy of a CEO, why would they commit to a project at any stage? It will not show any benefit until after they are gone.
- If approval and construction are at the beginning of an up cycle, operational start-up will likely be in a down cycle.



Social License To Operate



Social License To Operate

A Major Issue

Where are We Going In This Handbasket?

2009-2010

1. Cost containment
2. Industry consolidation
3. Access to capital
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Social License To Operate How Is Mining Seen?

Where are We Going In This Handbasket?

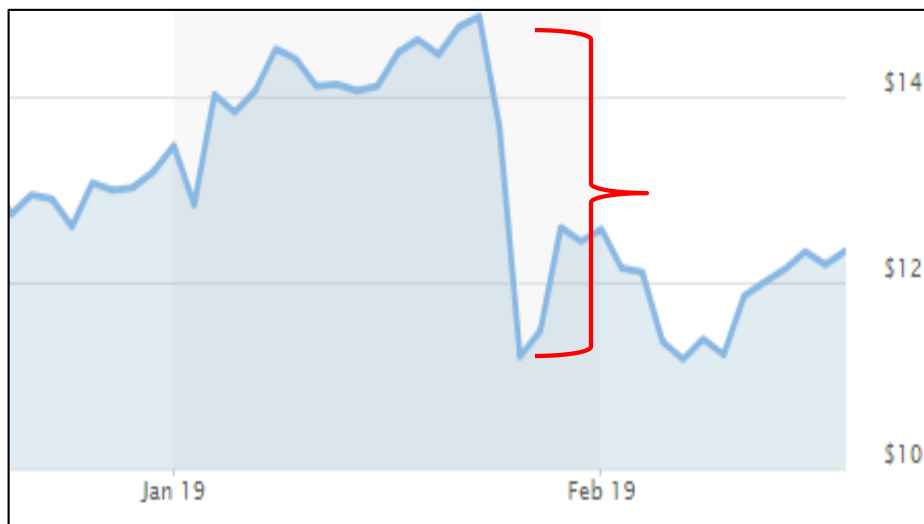


Perceptions of Mine Waste Tailings Dam Failures – CSR & Share Price Impact

Where are We Going In This Handbasket?



Imperial Metal's share price dropped \$7.43/share in 1 day on 75 million shares. Loss in Market Capital C\$550 million



Vale share price dropped \$2.5/share on 5.3b shares
Loss in Market Capital \$13 billion



Social License To Operate Not Just The Local People

- There will be increasing social pressure from people who are:
 - Far from the mines
 - Are not directly impacted by a mine not going forward.
 - Don't recognize the role of metals and mining in their lives.
- They will be more concerned with the welfare of “endangered” species ...
- ... than the livelihood of local people who want the opportunities the mines would bring



Social License To Operate

Costs & Schedules

Environmental

- Most of our environmental obligations are “known”:
 - Existing legislation & international standards
 - They may be expensive but the limits are known
 - The schedules may be long but they are “known”
 - They will continue to evolve

Social

- Much of our social obligation is not yet known:
 - Little legislation or international standards or examples as guidelines
 - The costs seem to have no limit
- Negotiations are time consuming and highly political
- Local people want a “piece of the action”.
 - The new “resource nationalism”

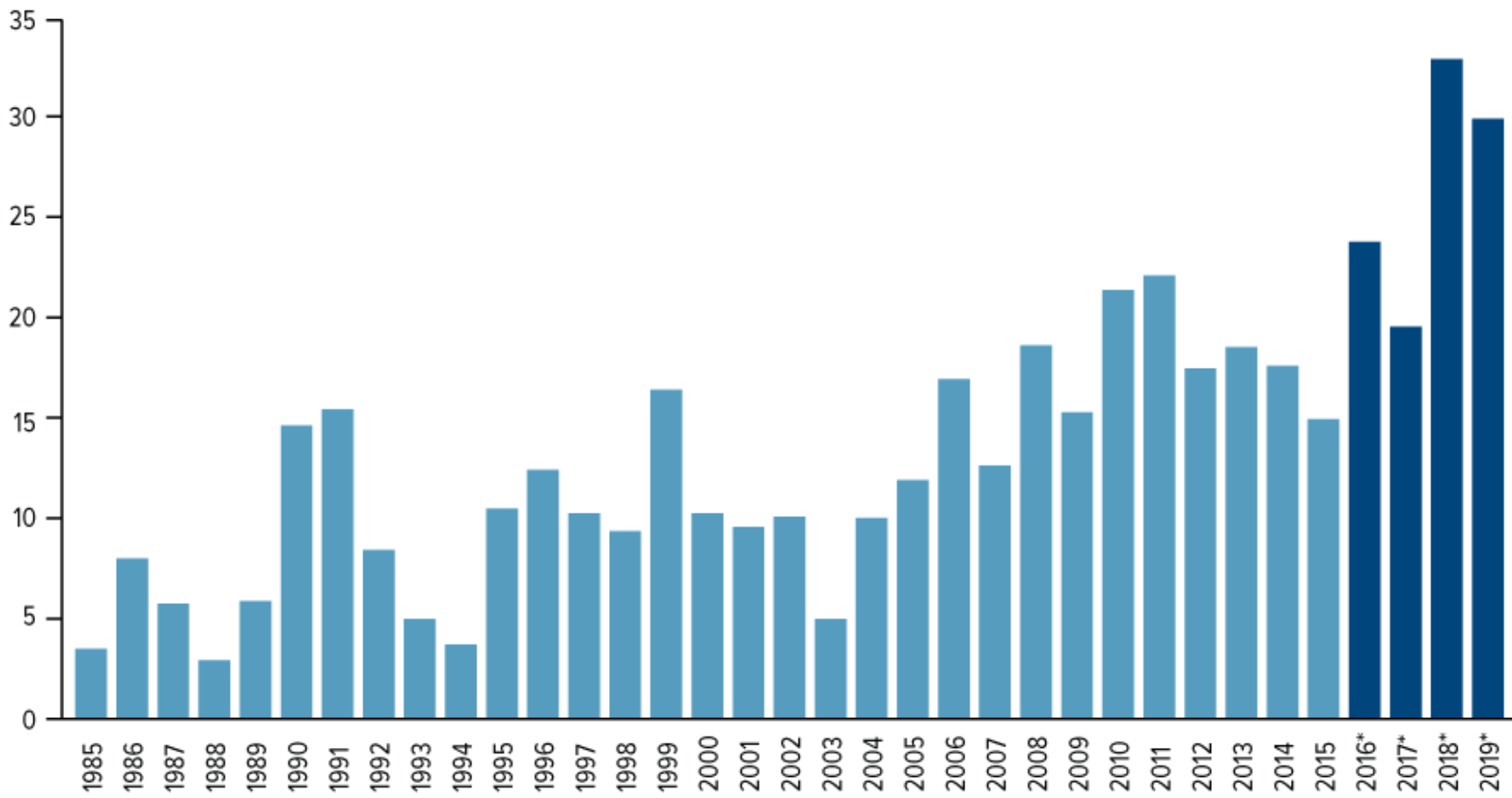


Mine Life Cycles - Delays

New Discoveries Taking Longer to Bring to Market

Where are We Going In This Handbasket?

Number of Years Between Deposit Discovery to Production Is Growing



*Projected Source: SNL Metals & Mining, U.S. Global Investors



Where Are We Going? The Mine Of The Future



The Mine Of The Future

Disclaimer

Please read all instructions and warnings before use. Must be 18 years of age or older to proceed further. Enter at your own risk. Do not enter. Speed limit - 28.8 or higher. Stop here on red. Hostess will seat you. Trucks over 4 tons excluded. Void where prohibited by law. Some assembly required. This is a test of the emergency broadcast system - this is ONLY A TEST! List each check separately by bank number. Batteries not included. Contents may settle during shipment. Any resemblance to persons living or dead is purely coincidental. Use only as directed. For indoor or outdoor use only. Wearing of this garment does not enable you to fly. We make no other warranties, expressed or implied. Do not use while operating a motor vehicle or heavy equipment. Postage will be paid by addressee. Postal service will not deliver mail without postage. No postage necessary if mailed in the United States. Subject to CAB approval. This is not an offer to sell securities. May be too intense for some viewers. See other side for additional listings. This product is meant for educational purposes only. For recreational use only. For office use only. For entertainment purposes only. Only 1 winner per household. Do not disturb. All models are over 18 years of age. Apply only to infected areas. If condition persists, consult your physician. Take two of these and call me in the morning. An apple a day keeps the doctor away. Now with new plastic applicator. High altitude directions-increase cook time by 10 minutes. This is not an attorney advertisement or referral service. No user-serviceable parts inside. Website contains small parts and is not intended for use by children under the age of eighteen. This compact disc was originally recorded on analog equipment. Freshest if eaten before date on carton. Times are approximate. Do not disturb. Simulated picture. Please remain seated until the ride comes to a complete stop. Return your seatback and tray table to their normal upright position. Your seat cushion can be used as a flotation device. In the event of decreased air pressure, oxygen masks will pop out of the top of your monitor. The call you have made requires a 20 cent deposit. Breaking seal constitutes acceptance of agreement. For off-road use only. Do not block intersection. No trespassing. No stopping or standing. Don't even think about parking here. No parking when road is snow covered. As seen on TV. One size fits all. Product will be hot after heating. Do not iron clothes on body. Remove clothing before distributing in washing machine. Do not use while sleeping. Do not use on food. Many suitcases look alike. Contains a substantial amount of non-Tobacco ingredients. Colours may fade. Insert this end first. We have sent the forms which seem right for you. This page made from 100% recycled electrons. Slippery when wet. No substitutions allowed. For a limited time only. Void where prohibited, taxed, or otherwise restricted. Caveat emptor. Provided "as-is" without warranty. Reader assumes full responsibility. We are an equal opportunity employer. No shoes, no shirt, no service. Quantities are limited while supplies last. If any defects are discovered, do not attempt to fix them yourself, but return to an authorized service centre. Read at your own risk. Parental advisory - explicit lyrics. Text may contain explicit materials some readers may find objectionable, parental guidance is advised. Keep away from sunlight. Keep away from pets and small children. Limit one per family please. No money down. No purchase necessary. Not affiliated with the American Red Cross. Drop in any mailbox. Edited for television. Keep cool. Process promptly. Return to sender, no forwarding order on file, unable to forward. Not responsible for direct, indirect, incidental or consequential damages resulting from any defect, error or failure to perform. Webmaster is also not responsible for items left, lost or stolen. At participating locations only. Sold by weight, not by volume. Penalty for private use. See label for sequence. This web site rated 'R' for Mature audiences. Do not take with alcohol. Sealed for your protection - do not use if safety seal is broken. Substantial penalty for early withdrawal. Do not write below this line. Falling rock. Use seatbelts even with airbags. Do not stop on railroad tracks. Lost ticket pays maximum rate. Your cancelled check is your receipt. Add toner. Place stamp here. Avoid contact with skin. Sanitized for your protection. Employees must wash hands before returning to work. Caution, coffee is served HOT. Be sure each item is properly endorsed. Sign here without admitting guilt. Slightly higher west of the Mississippi. Employees and their families are not eligible. Beware of dog. Contestants have been briefed on some questions before the show. Filmed in front of a live, studio audience. Call now to ensure prompt delivery. Leave off the last S for savings. Calls may be monitored for quality assurance or training purposes. Please make your selections from the following menu. All representatives are still busy assisting other callers. Please stay on the line and a representative will be with you when they feel the need. Please call back during our normal business hours. You must be present to win. Winners need not be present to win. No passes accepted for this engagement. This space (_____) intentionally left blank. Do not use this product with a petroleum based lubricant. No animals were harmed in the preparation of this web site; only humans. This web page contains no CFCs. Discontinue use if nausea or dizziness occurs. Shading within a garment may occur. Use only in a well-ventilated area. Keep away from fire or flames. No soliciting. Bridge freezes before road surface. Stop, get ticket. Right lane must turn right. Left lane must turn left. Middle lane must make up their damn minds. This site runs on unleaded fuel only. Objects in mirror may be closer than they appear. Buses and carpools with two or more people only. No hitchhiking. Components may be hot. Silica gel - do not eat. Not to be used in conjunction with any other offer. Details on reverse side. Shoplifters will be prosecuted to the fullest extent of the law. We reserve the right to check all bags, coats & personal belongings upon exiting this page. Recycle. Fragile - handle with care. This side up. No jumping or diving. No running by the pool. Register has less than \$50 after dark. Driver does not carry cash. No swimming unless lifeguard is present. Swim at your own risk! Please do not wade in fountain. Guaranteed low prices. Not transferable. Actual size not shown. Contents under pressure. Do not intentionally inhale vapours. Replace with same type. Approved for veterans. Please be kind, rewind. Booths for two or more. Check here if tax deductible. Action figures sold separately. No preservatives added. Some equipment shown is optional. Price does not include tax. Do not remove any HTML tags under penalty of law. Hand wash only - tumble dry on low heat. No Canadian coins. Short circuit may cause fire. No more than 3 transactions per car. Not recommended for small children. Pre-recorded for this time zone. Reproduction strictly prohibited. No alcohol, dogs or horses. Not for resale. List at least two alternate dates. Blackout dates may apply. Viewing by pregnant women may result in fetal injury, premature birth and low birth weight. First pull up, then pull down. Insert Tab A into Slot B. Call toll free number before digging. Some of the trademarks mentioned in this product appear for identification purposes only. Record additional transactions on back of previous stub. Unix is a registered trademark of AT&T. Do not fold, spindle or mutilate. No transfers issued until the bus comes to a complete stop. Doors do not rebound or bounce back. Your mileage may vary. This article does not reflect the thoughts or opinions of either myself, my company, my friends, or my cat. Don't quote me on that. Don't quote me on anything. All rights reserved. Patent pending. For external use only. Avoid extreme temperatures. Avoid contact with eyes and skin. Do not puncture, incinerate, or store above 120 degrees Fahrenheit. Do not place near a magnetic source. Smoking could be hazardous to your health. Cigarette Smoke Contains Carbon Monoxide. Smoking Causes Lung Cancer, Heart Disease, Emphysema. The best safeguard, second only to abstinence, is the use of a condom. No salt, MSG, artificial colour or flavouring added. If ingested, induce vomiting. Ribbed for her pleasure. Offer valid only at participating locations. Slightly higher west of the Rockies. Allow four to six weeks for delivery. You may distribute this article freely, but may not make a profit from it. 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Innovation

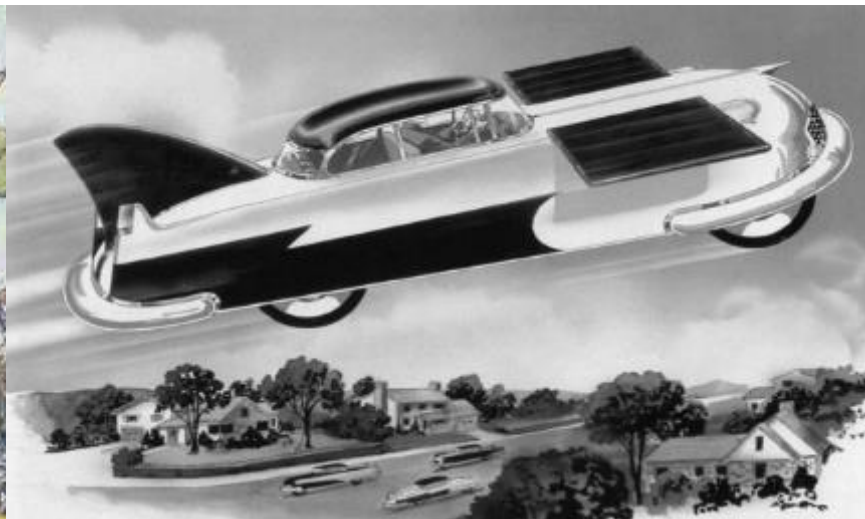
The Next New Thing



The Next New Thing

Remember When The Future Looked Like This?

“The future is not what it used to be.”



Where are We Going In This Handbasket?



The Next New Thing

Remember When We Thought We Had A Better Idea?

“The future is not what it used to be.”



Where are We Going In This Handbasket?



The Next New Thing

What Will the Mine of the Future Look Like?

- Remote control operations?
 - You can't move maintenance off-site.
 - Sensors get dirty and malfunction.
- Amazing new technology?
 - Truckless haulage?
 - Rail-veyors?
 - Dirigibles?
 - Robots and automation?
- Some visions are probably fanciful.



The Next New Thing

What have we learned about the future?

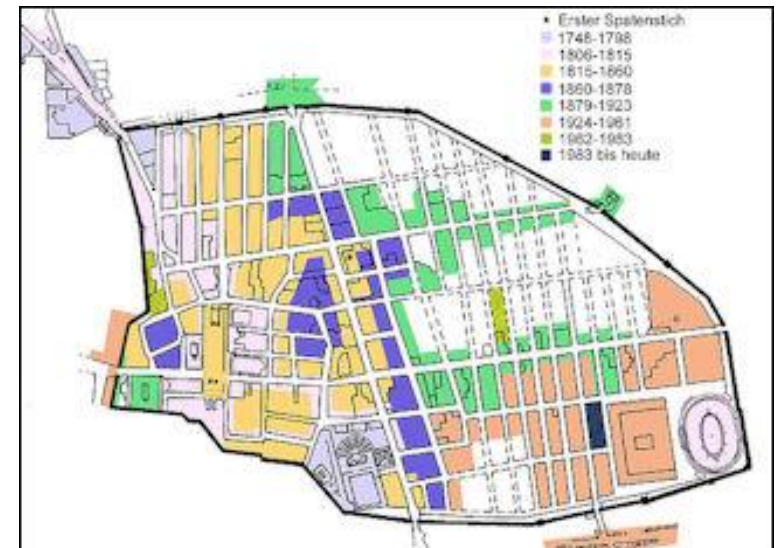
Don Mills

- The modern suburb in 1955
- Curved streets and cul-de-sacs to limit traffic volume
- Model copied all over North America
- Depends on cars and cheap gas
- Poor access for transit



New modern city planning

- Trending towards simple grid system running off of a commercial “high street”
- Easy walking access.
- Simplified infrastructure.
- Very easy access for transit.
- Pompeii



The Next New Thing

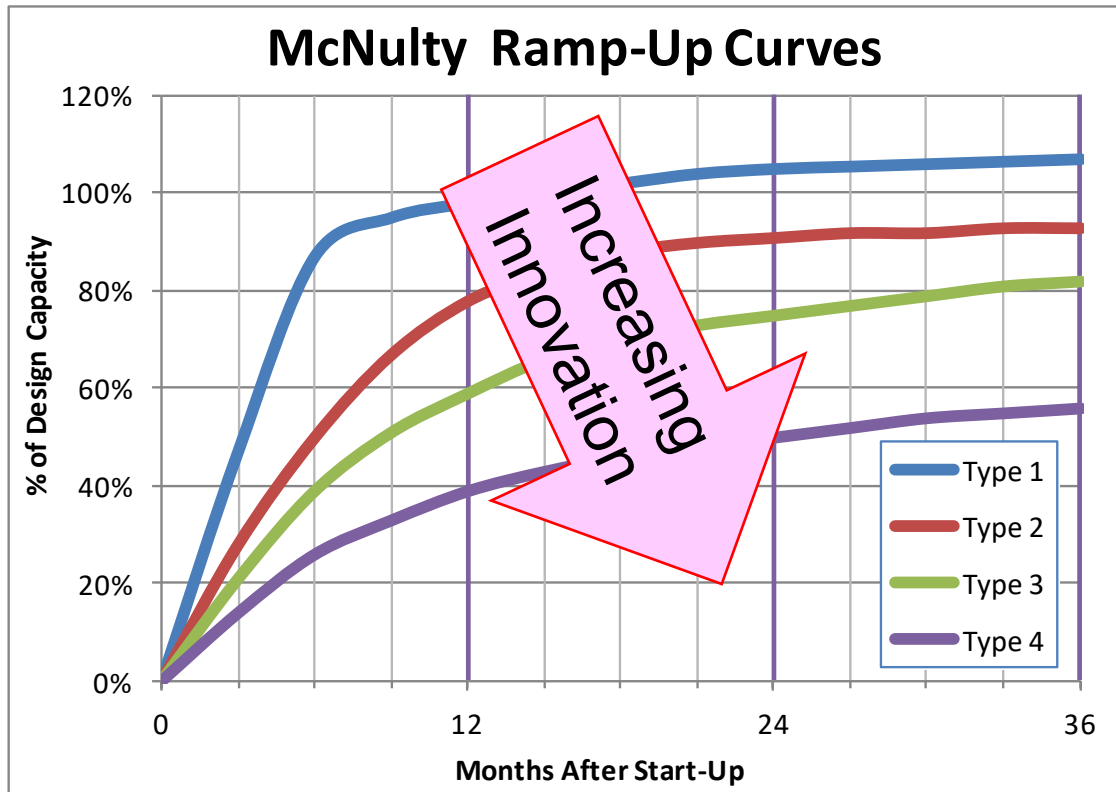
Buzzwords Cost 10%

- Every new management buzzword brought into the boardroom reduces shareholder value by 10%
 - John Rutledge, Forbes columnist



The Next New Thing Ramp-Up (McNulty Curves)

Where are We Going In This Handbasket?



Profile	NPV
Type 1	\$209 M
Type 2	\$110 M
Type 3	-\$25 M
Type 4	-\$240 M

D. Halbe - Business aspects and future technical outlook for hydrometallurgy - 2003

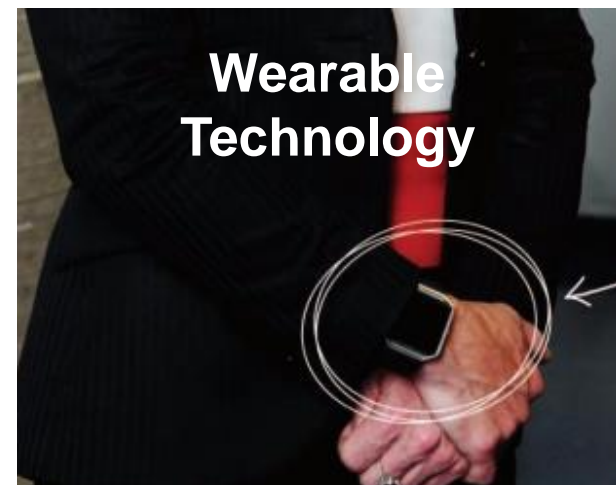
Type 1	Well proven. Mature technology. Used elsewhere. Similar scale
Type 2	Well demonstrated components to be integrated in a new way. Similar scale
Type 3	Adaptation to new circumstances or new scale. Limited pilot testing or limited knowledge of feed variation
Type 4	New. First time implementation. Complex flow sheet.



The Next New Thing

IoT - Internet of Things

- The “Next New Thing”
- All the data, all the time.
- At your fingertips, or on your wrist !
- What are we going to do with that much data?
- Will we respond to every blip?
- If you watch or listen to the 24-hour news, it is all minute by minute and repetitive. Everything is urgent. You don’t hear it after a while.
- If you read a daily newspaper you get the latest view of what was urgent news at press time. There is not usually enough time for analysis.
- If you read a weekly magazine, like The Economist, you get a longer view. The minute by minute panics fade into a longer term view. The trends and true impacts can to emerge.
- Resist the urge to jump on every bandwagon.



The Next New Thing

Another Phish to Fry

- As we become more and more connected we are more and more exposed to hacking and ransomware
- Internet ransom has a business structure like any other multinational business: organizers, sales, technical, marketing.
- They are well organized
- Getting bigger
- Increasingly sophisticated
- Presently ransoms are cheap so people willing to pay it.
- 20% of the phishers cannot actually undo the encryption to release your machine

EQUIFAX®

YAHOO!®



The Next New Thing Another Phish to Fry

- Don't click on that suspicious email
- Back-up often
- Back-up offline
- Tapes on reels:
 - Longer life
 - Offline
 - Quick retrieval



Innovation

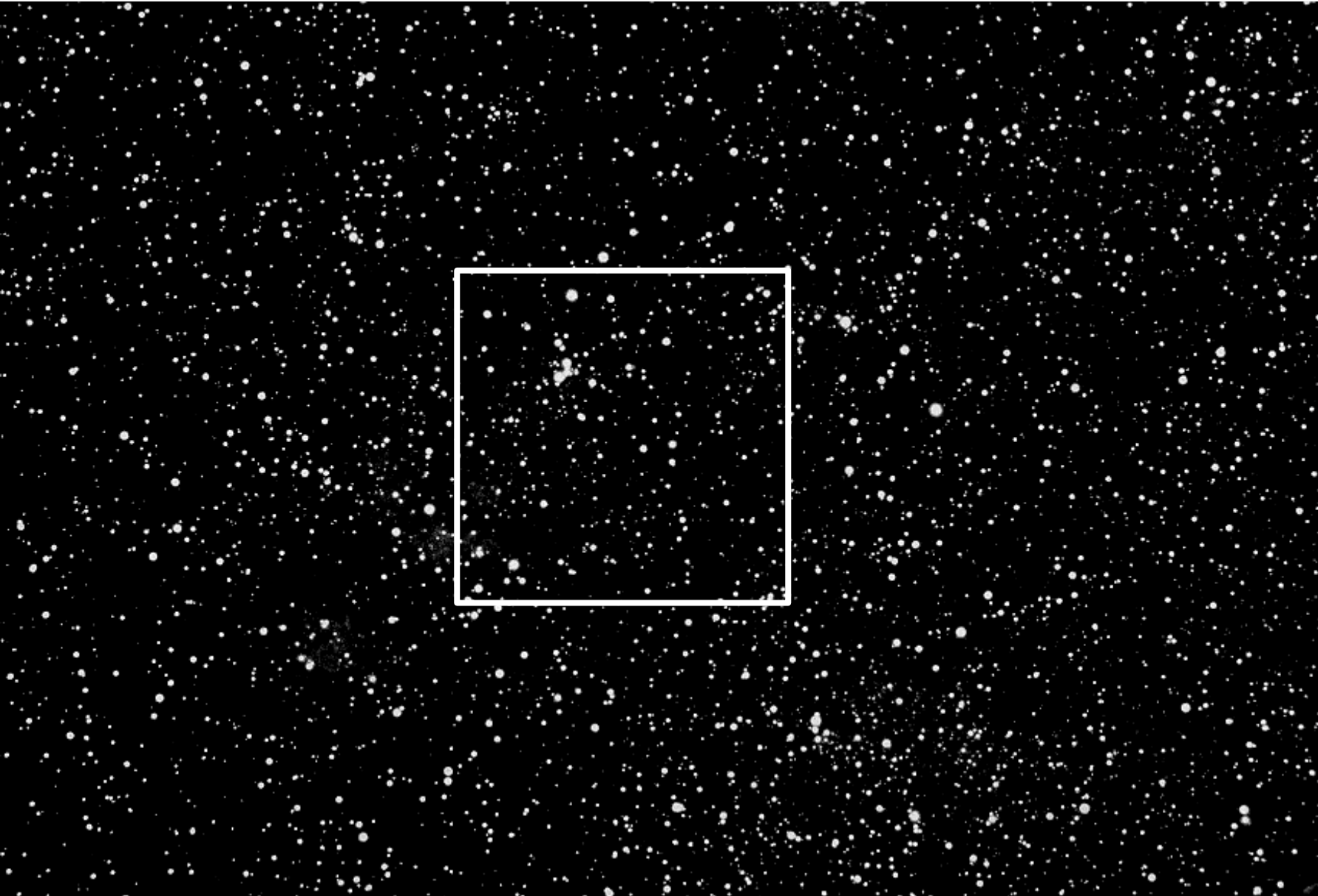
Thinking Outside The Box



Thinking Outside The Box

Is The Box Confining or the Best Set of Solutions

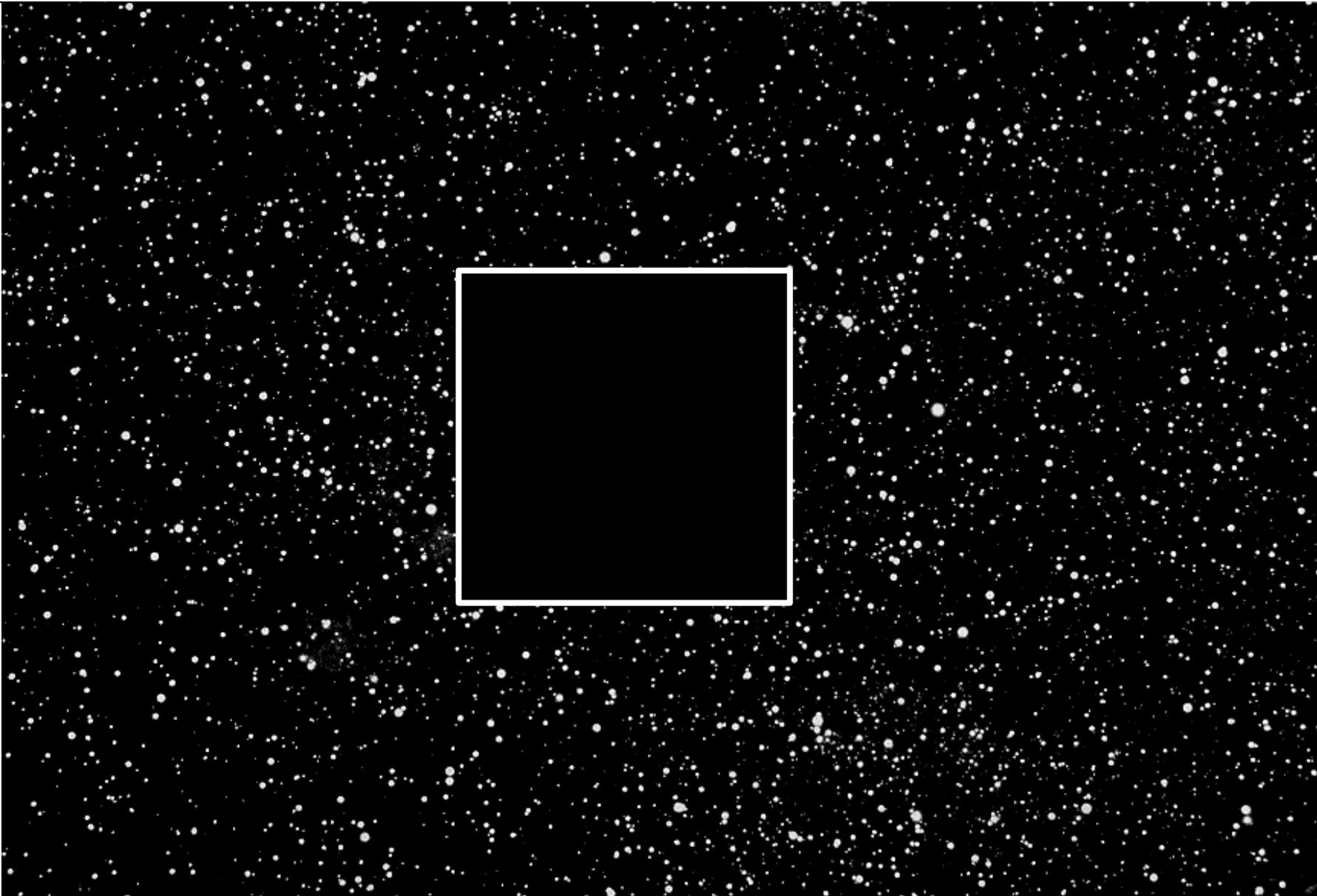
Where are We Going In This Handbasket?



Thinking Outside The Box

The Implication Is To Reject Everything Inside The Box

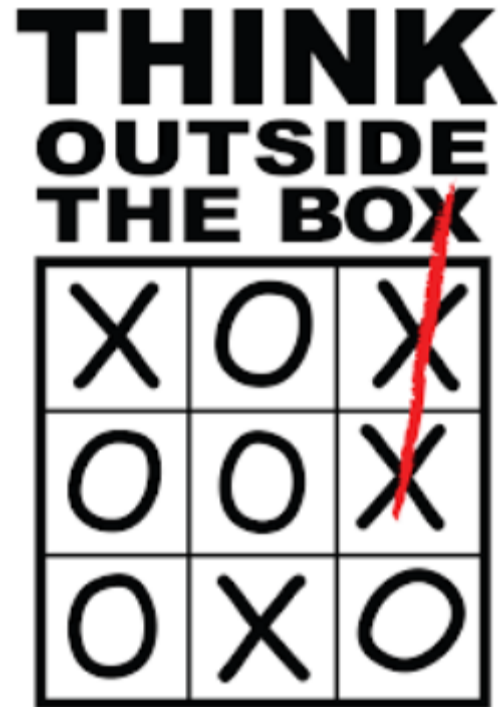
Where are We Going In This Handbasket?



Thinking Outside The Box

Use The Best Ideas, Inside Or Outside The Box

Where are We Going In This Handbasket?



Thinking Outside The Box

The 2011-12 Mine Tire Shortage

- Tire shortage
 - No tires were available, anywhere, at any cost
 - We tried everything; foam, gasses, pressure

- The biggest part of the solution was grading the roads to keep large, sharp rocks away from the tires



Thinking Outside The Box

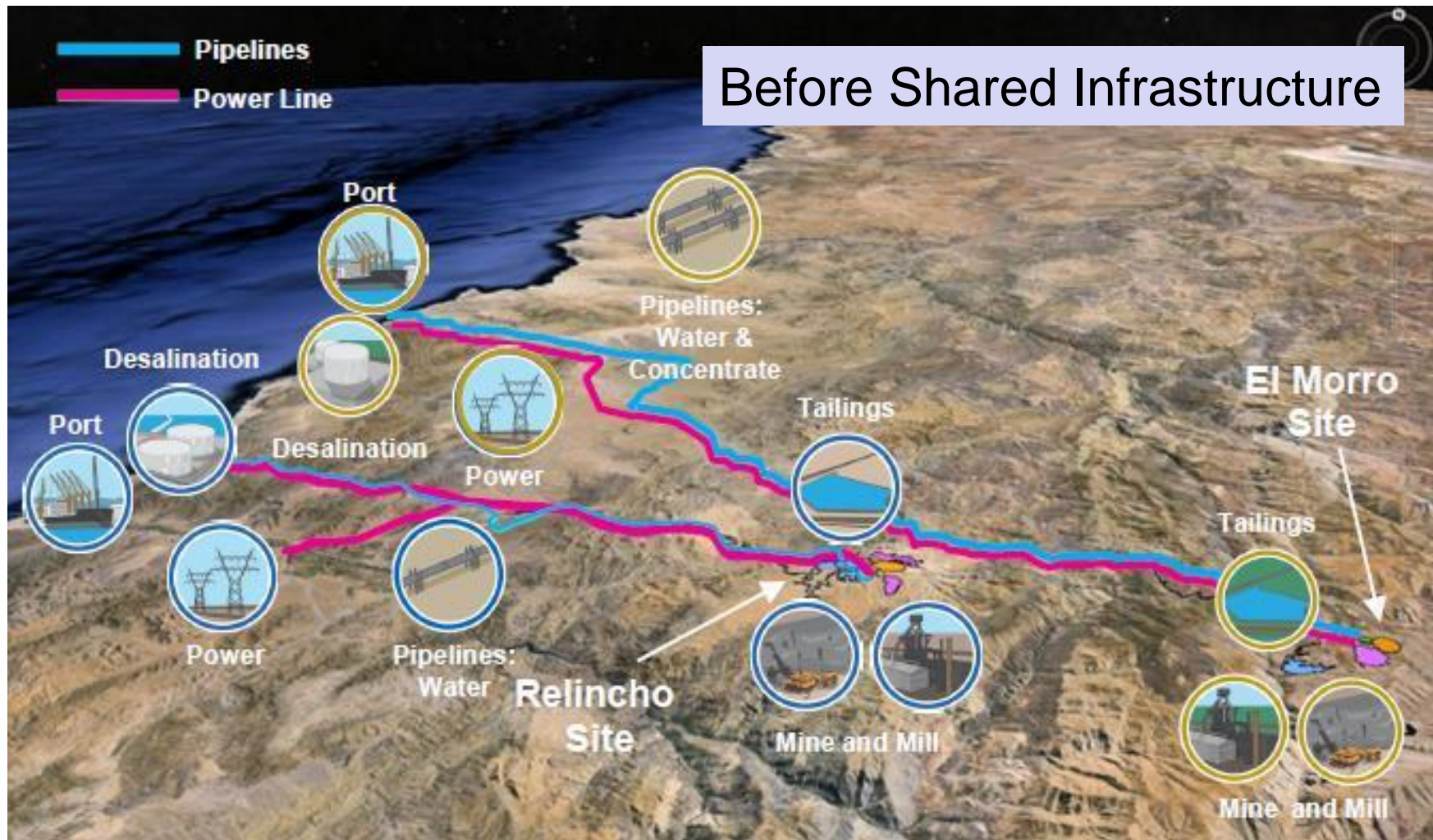
The Goldcorp Challenge

- In 2000 Goldcorp's Red Lake mine was only producing a relatively small 50,000 ounces of gold a year at a high cost of \$360 an ounce.
- The main deposits were deeper underground, but the company's geologists were not sure of the exact location of the precious metal.
- President Rob McEwen wanted new ideas of where to dig so he issued an extraordinary challenge. He put all his company's geological data (which went back as far as 1948) into a file and shared it with the whole world.
- He offered \$575,000 in prizes to the participants with the best methods.



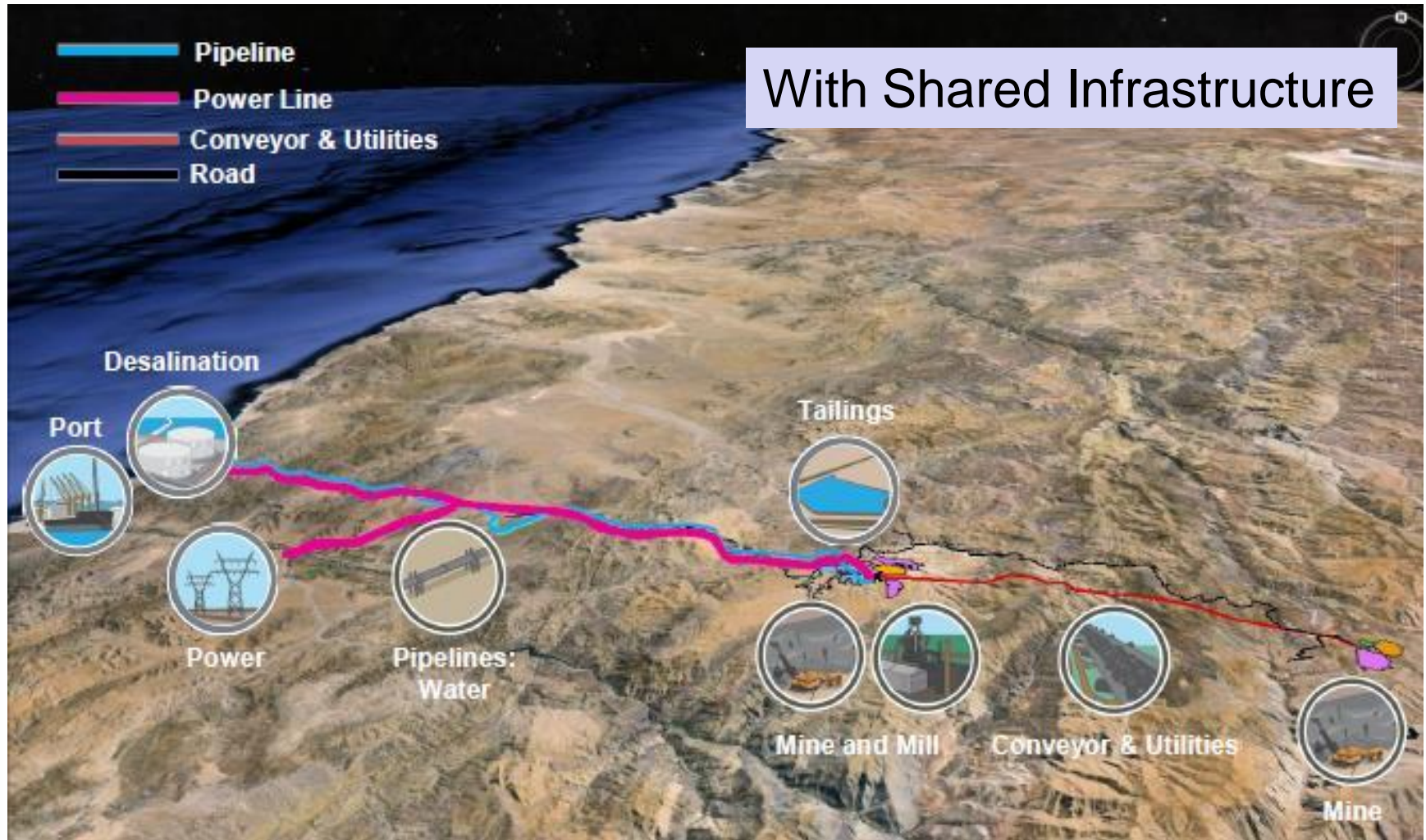
Partnering & Outsourcing Develop Projects Jointly

Where are We Going In This Handbasket?



Partnering & Outsourcing Develop Projects Jointly

Where are We Going In This Handbasket?



Thinking Outside The Box

Partnering & Outsourcing - Develop Projects Jointly

- We already outsource & lease:
 - Mine equipment & maintenance
 - Rail lines, rail rolling stock, ports, ocean freighters
- Can we add these to the list:
 - Camp construction and operation
 - Road construction and maintenance
 - Power supply construction and maintenance
 - Water supply construction, operation, and maintenance
 - Concentrate pipeline construction, operation, and maintenance
- Why not also add:
 - Processing plant construction & maintenance (not operation)
- Don't lose control of, or outsource:
 - Mineral Resource / Reserve
 - Mine planning
 - Metallurgical recovery



Innovation

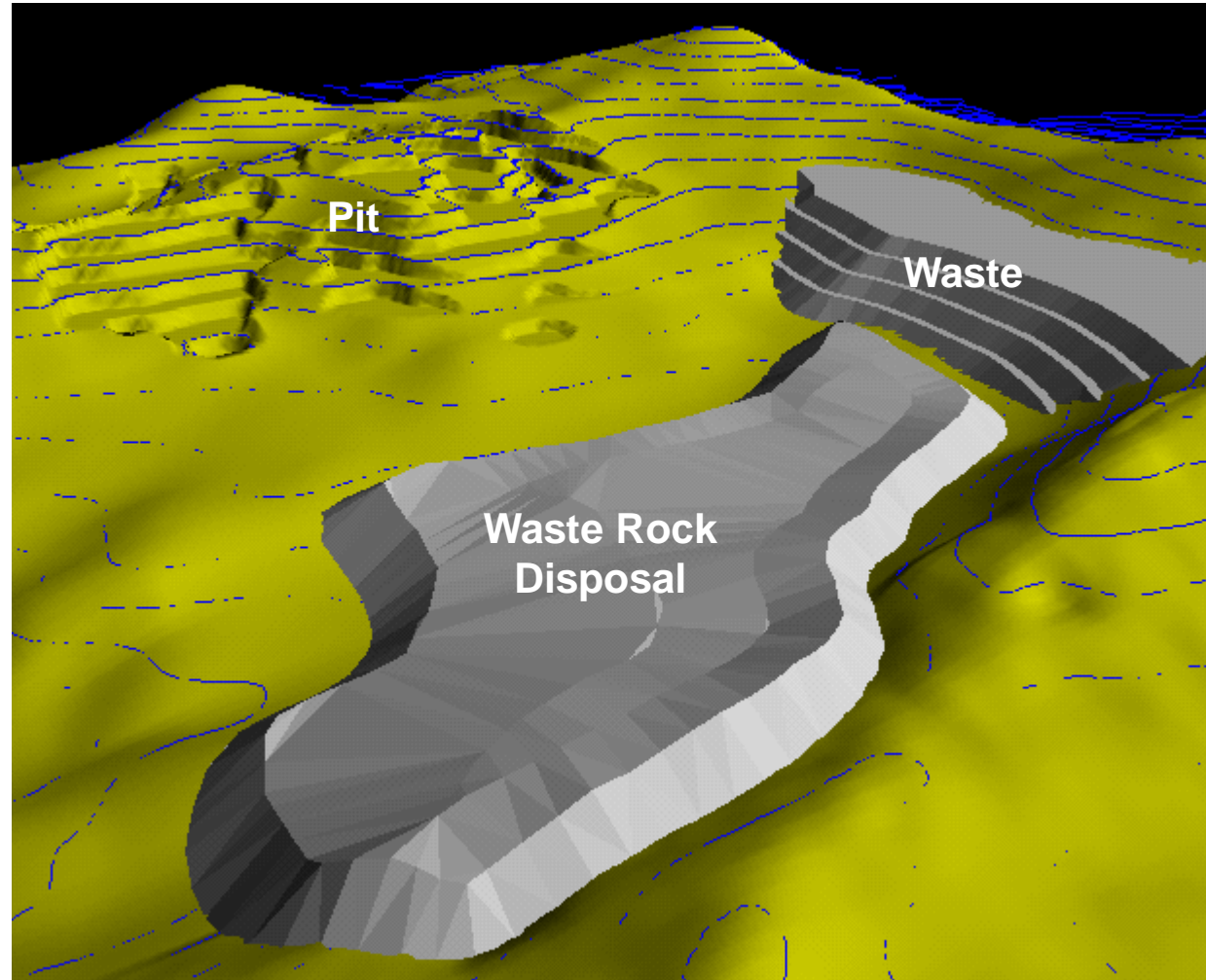
Our Next Big Challenges



Our Next Big Challenges

Mine Waste and Acid Rock Drainage (ARD)

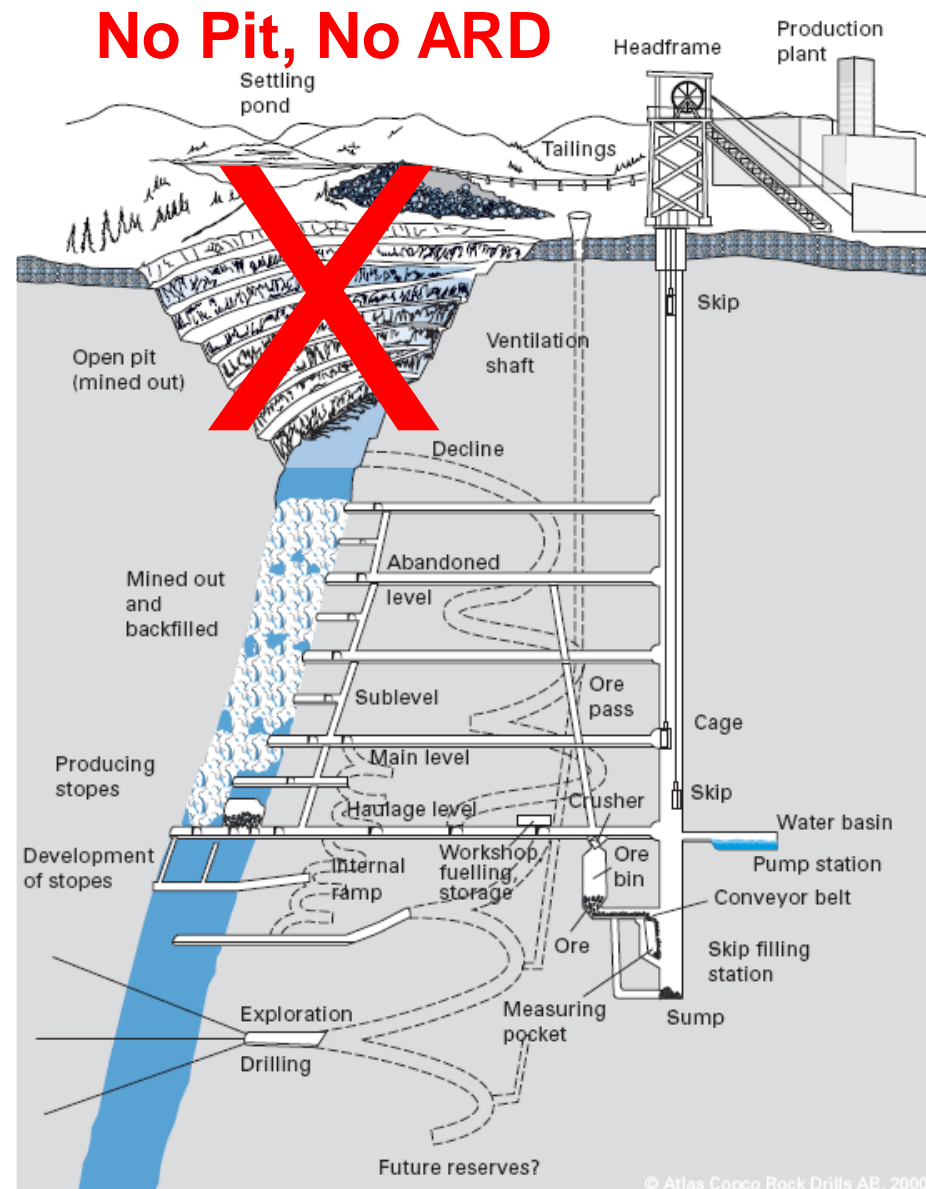
- Most of the material moved for an open pit is waste.
- Open pit mining is essentially waste handling.
- Waste is broken, excavated, and exposed to air, water, and temperature changes.
- Acid Rock Drainage (ARD) from waste disposal areas is a potential problem.
- (ARD depends on the type of rock.)



Our Next Big Challenges

ARD an End to Open Pit Mining?

- Concerns about Acid Rock Drainage from open pit mines could:
 - Cause treatment obligations and costs to become so high that open pit mining might not be economic.
 - Prevent open pit mines with ARD generating waste rock to not be permitted.
- Underground mining could become the economic alternative.
- Underground mines will likely be encouraged or legislated to place their tailings back underground.



Our Next Big Challenges

Waste

- If public pressure is driving miners to reduce waste:
- Take a life-long viewpoint
- Is it really waste?
 - Waste rock as aggregate
 - Waste rock as acid reducing product
 - Tailings fraction as fracking sand
- Take all of the costs into account
 - Is it cheaper to treat the waste when it is in the mill than when it is out in the tailings area?
 - Add closure and long term treatment charges to operating costs to see if they aren't more cheaply dealt with now
 - Some old tailings have better grades than our current deposits, and all the mining and milling has been done.



Our Next Big Challenges

Tailings

Where are We Going In This Handbasket?

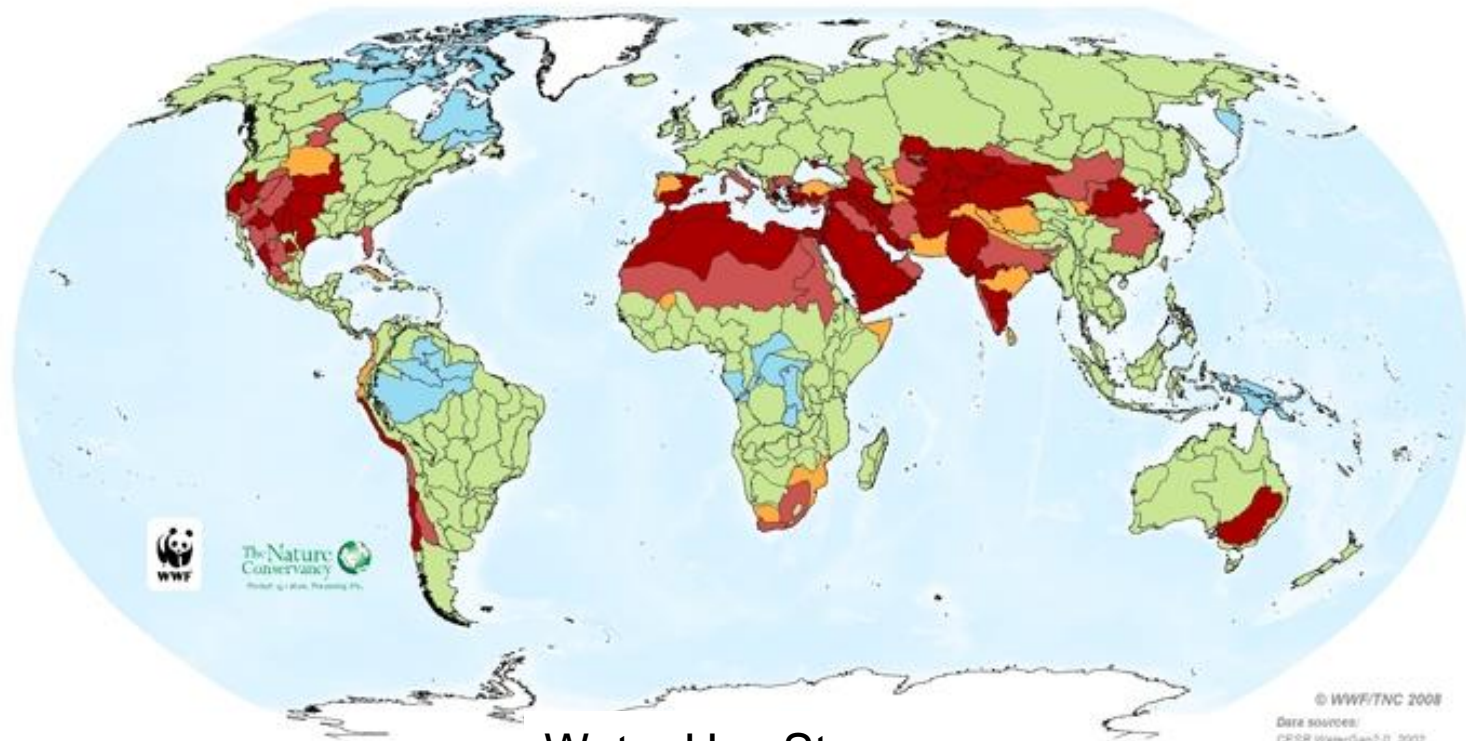
No Tailings



Our Next Big Challenges

Water Shortage

- “World War III will be fought over water”
- “The wars of the twenty first century will be fought over water”
 - Ismail Serageldin



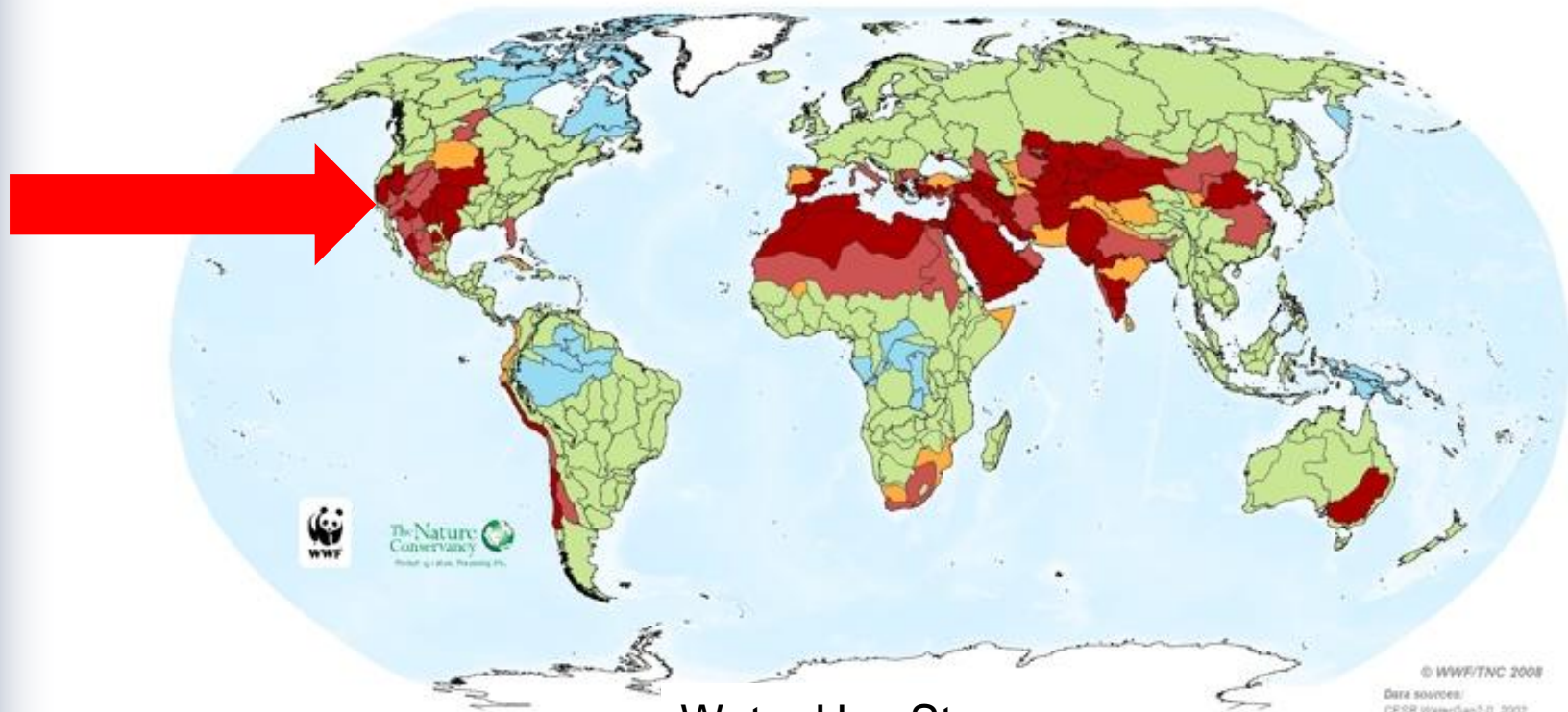
Water Use Stress



Our Next Big Challenges

Water Shortage

- “World War III will be fought over water”
- “The wars of the twenty first century will be fought over water”
 - Ismail Serageldin



Water Use Stress



© WWF/TNC 2008
 Data sources:
 CESR WaterGap2.0, 2002
 Abelt et al. 2008
 www.feww.org



Where Are We Going In This Hand Basket?

What Else Could Possibly Go Wrong?

Where are We Going In This Handbasket?



What Else Could Possibly Go Wrong?

Where are We Going In This Handbasket?



What Else Could Possibly Go Wrong?

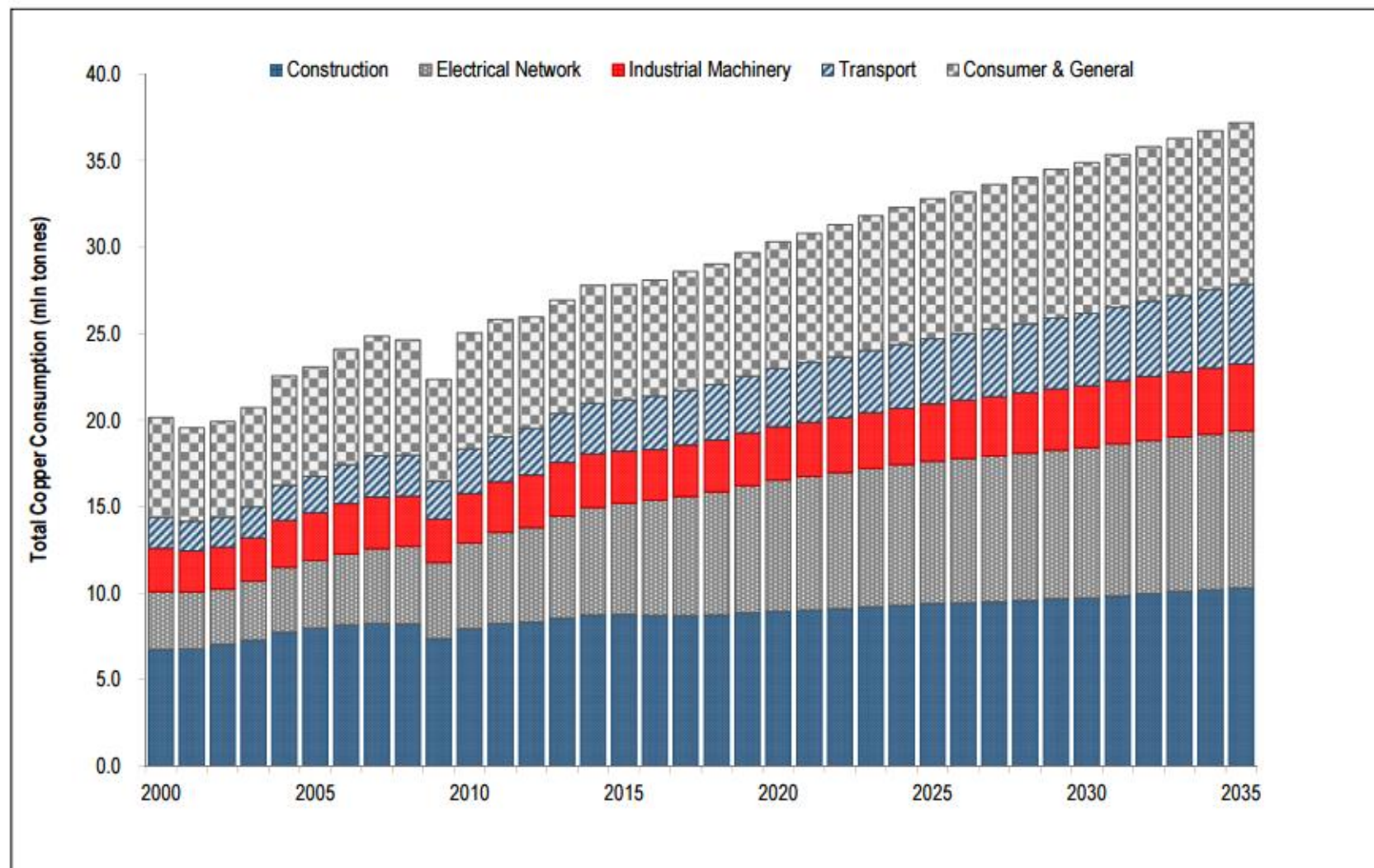
Where are We Going In This Handbasket?



The Upside

Metal Consumption Continues to Rise

Where are We Going In This Handbasket?



Source: NBF Estimates, Wood Mackenzie

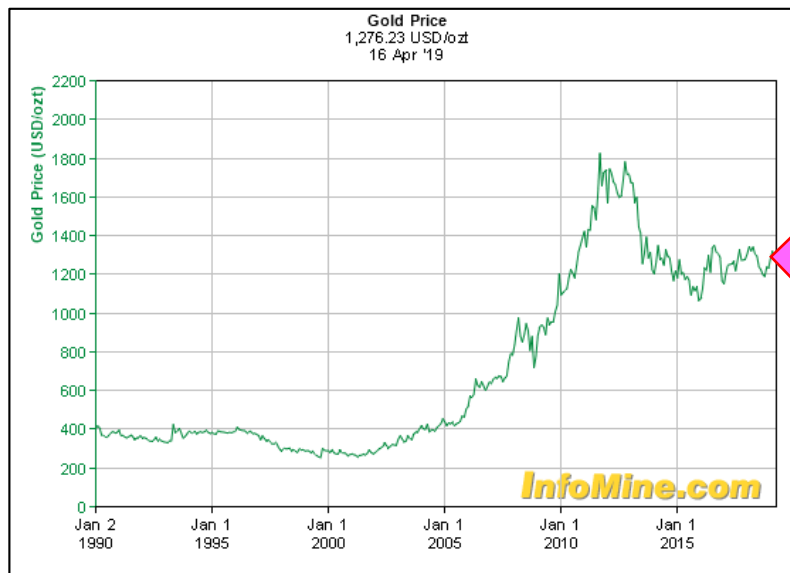


The Upside

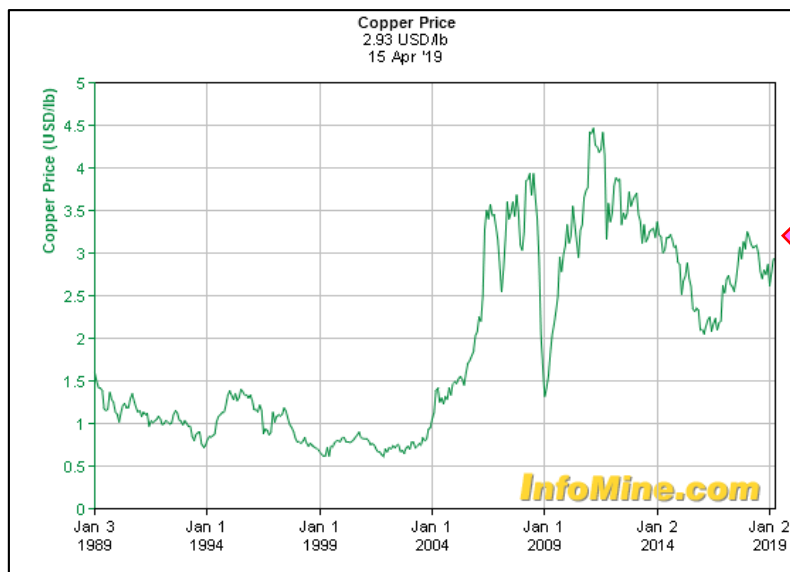
Metal Prices Rise Significantly

Where are We Going In This Handbasket?

Gold
From 1990

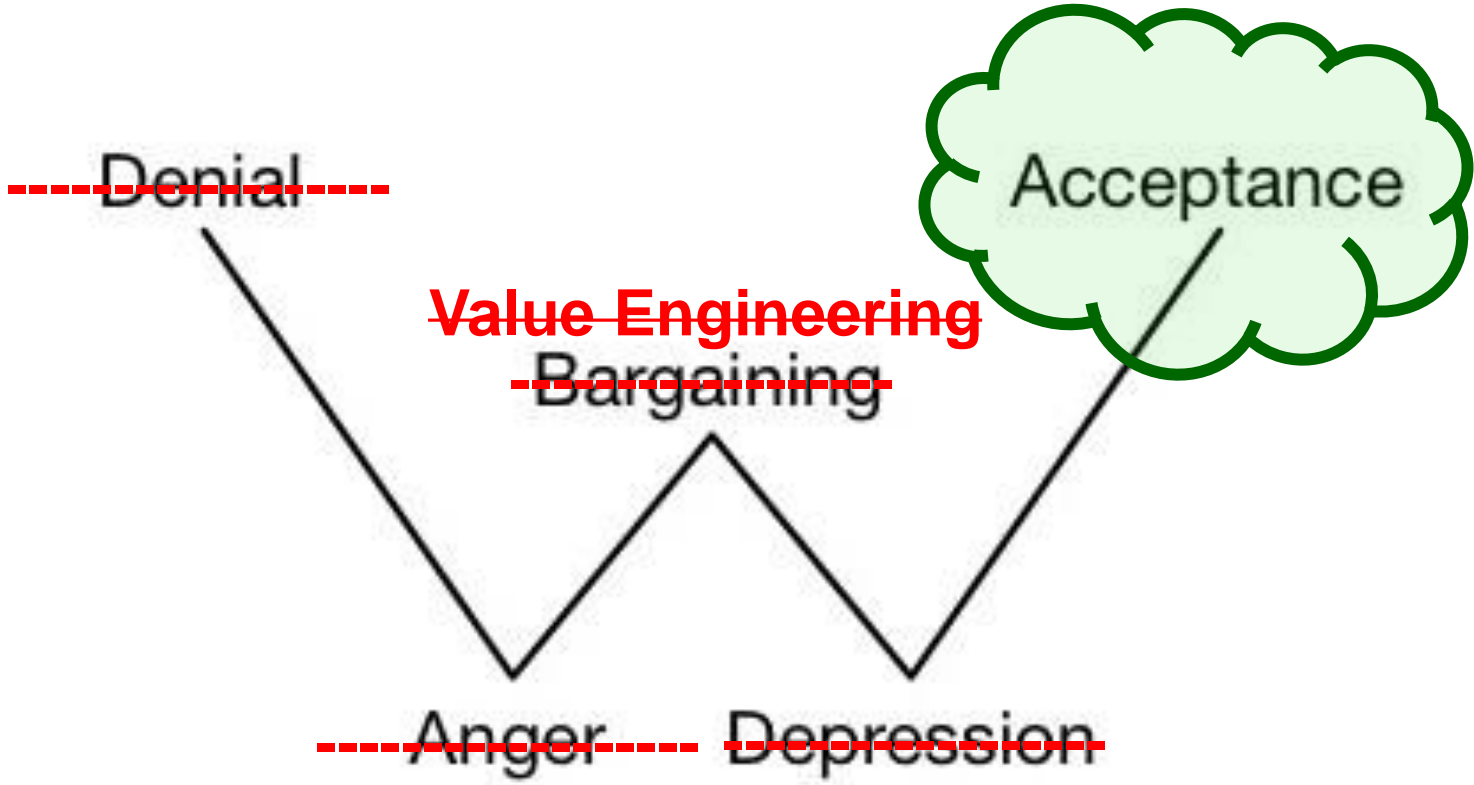


Copper
From 1990



What Else Could Possibly Go Wrong? Haubrich's "Market Heat" Driver Takes Over

Where are We Going In This Handbasket?



The Downside

History Repeats Itself (Rectal-Cranial Inversion)

Where are We Going In This Handbasket?



- Market Heat will drive the “GO” decision.
- Projects will be advanced too quickly.
- Schedules will be unrealistic.
- Important stage gate stages will be missed.
- Projects start-ups will likely miss the “Up” cycle.
- And we will try to do all of this with a shortage of qualified personnel.



Where Are We Going In This Hand Basket?

Where are We Going In This Handbasket?

Ending on a Positive Note



Embrace Innovation and Creativity But . . .

Not every new idea is a good idea.



Sometimes the answer is “No!”





What Do You Think?



Notes



Press Releases

The Facts

- The Facts:
 - On the back of a photograph of Remus Starr, showing him standing on the gallows, are the words:

"Remus Starr: Horse thief, sent to Montana Territorial Prison, 1885. Escaped 1887, robbed the Montana Flyer six times. Caught by Pinkerton detectives, convicted and hanged, 1889."



Press Releases

What the Reader Sees

The Facts:

On the back of a photograph of Remus Starr, showing him standing on the gallows, are the words:

"Remus Starr: Horse thief, sent to Montana Territorial Prison, 1885. Escaped 1887, robbed the Montana Flyer six times. Caught by Pinkerton detectives, convicted and hanged, 1889."

The Press Release:

"Remus Starr was a famous cowboy in the Montana Territory. His business empire grew to include acquisition of valuable equestrian assets and intimate dealings with the Montana railroad. Beginning in 1885, he devoted several years of his life to service at a government facility, finally taking leave to resume his dealings with the railroad. In 1887, he was a key player in a vital investigation run by the renowned Pinkerton Detective Agency. In 1889, Remus passed away during an important civic function held in his honor when the platform upon which he was standing collapsed."

Danger: Your own people may start believing the press release.



Risk Assessment

Re-Risking & Due Diligence

- Select excellent people
- Build the right team
- Make sure they will tell you “No.”
- Listen to their advice
- Act on their recommendations



Grumpy



Grumpy



Grumpy



Dopey



Happy



Doc



**Number
Cruncher**



Skills Required Man and Machine

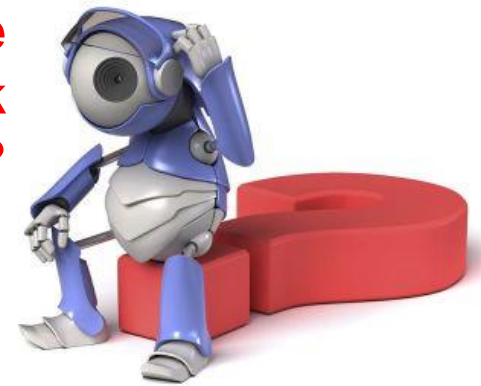
Ten skills needed for the current revolution:

- Complex problem solving
- Critical Thinking
- Creativity
- People management
- Coordinating with others
- Emotional intelligence
- Judgement & decision making
- Service orientation
- Negotiating
- Cognitive flexibility

Five things machines will not be able to do:

- Problem solving
- Adaptability
- Leadership
- Creativity & innovation
- Emotional intelligence

What will the machines think about THAT?



How Have We Done?

Feasibility Studies & Capital Performance

Where are We Going In This Handbasket?

No association or weak association with percentage capital cost overruns

- ✘ Financing
- ✘ Company size
- ✘ Project size
- ✘ Mining method
- ✘ Infrastructure requirements
- ✘ Power requirements
- ✘ Project location
- ✘ Primary commodity
- ✘ Processing method
- ✘ Project history

Strong association with percentage capital cost overruns

- ✔ Commodity market “heat” at beginning of construction
- ✔ Integrated design/build teams
- ✔ Project “quality” (IRR, NPV)



How Have We Done?

Feasibility Studies & Capital Performance

- Strong association between capital cost overruns and the following project characteristics:
 - ✓ **Commodity market “heat” at beginning of construction** (as measured by a ratio of trailing commodity basket prices)
 - Hotter markets = larger overruns
 - Cooler markets = smaller overruns
 - ✓ **Integrated design/build teams**
 - Feasibility author same as build (EPCM) team = smaller overruns
 - Feasibility author independent from build (EPCM) team = larger overruns
 - ✓ **Project “quality”** (as measured by feasibility IRR or NPV:CAPEX ratio)
 - Marginal projects = larger overruns
 - Stronger projects = smaller overruns



Innovation

To gauge the significance of an innovation, try to picture your project or operation without it:

- Cone crushers
- Froth flotation
- Cyanidation for gold ores
- Large trucks
- High explosives
- Internal combustion engines

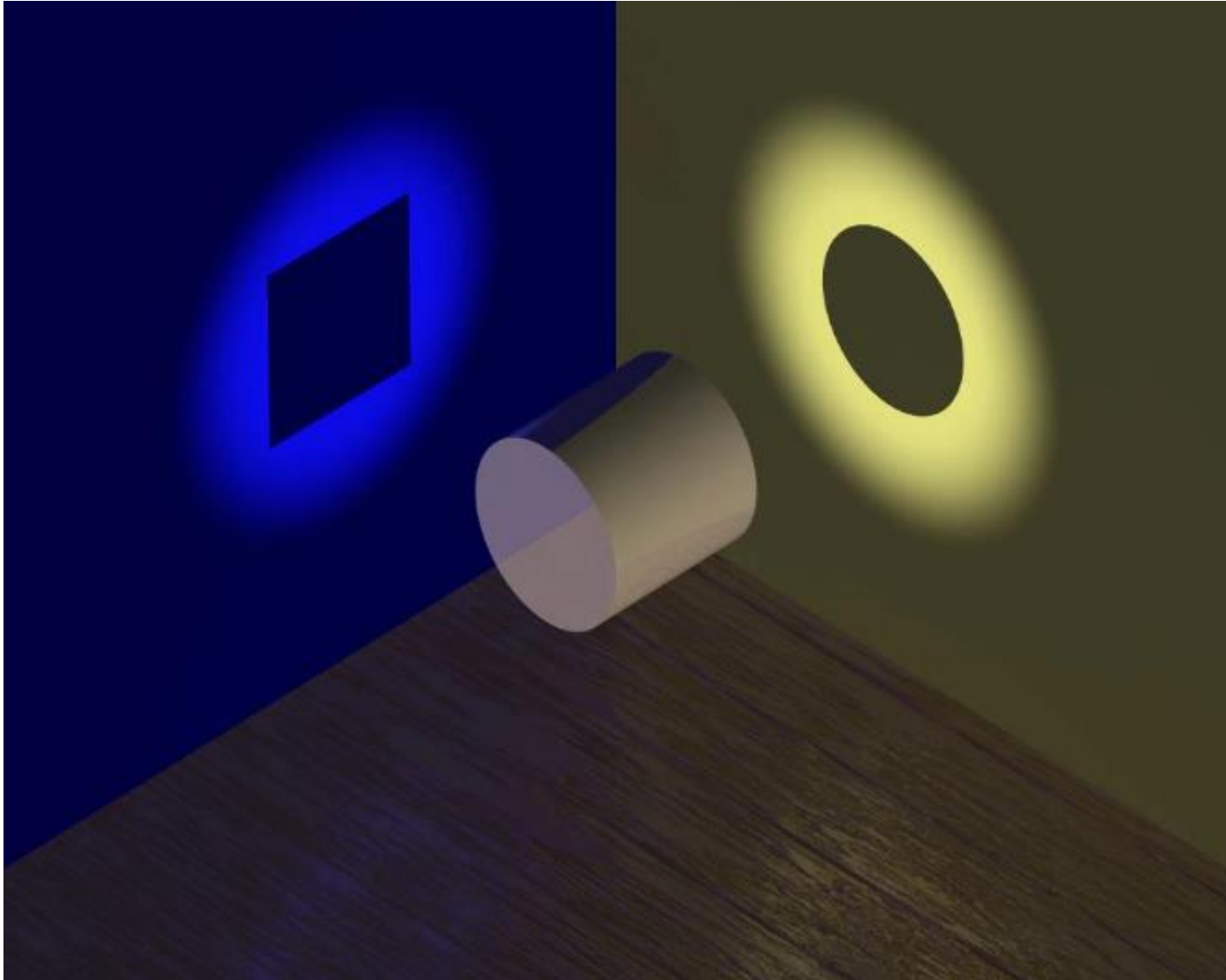
- Electricity



Think Outside The Box

Square Peg Round Hole

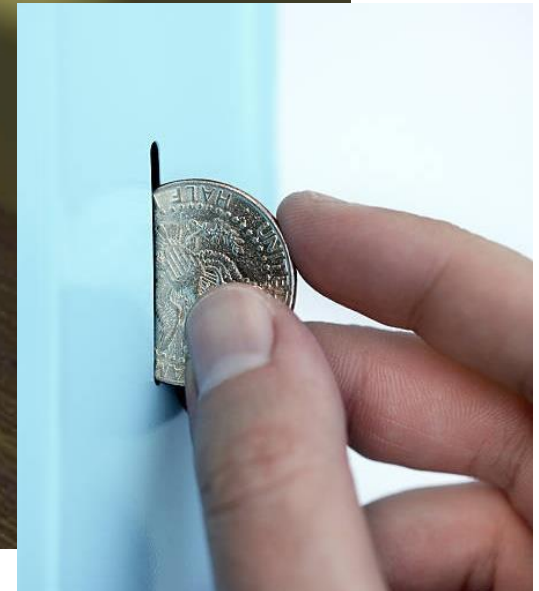
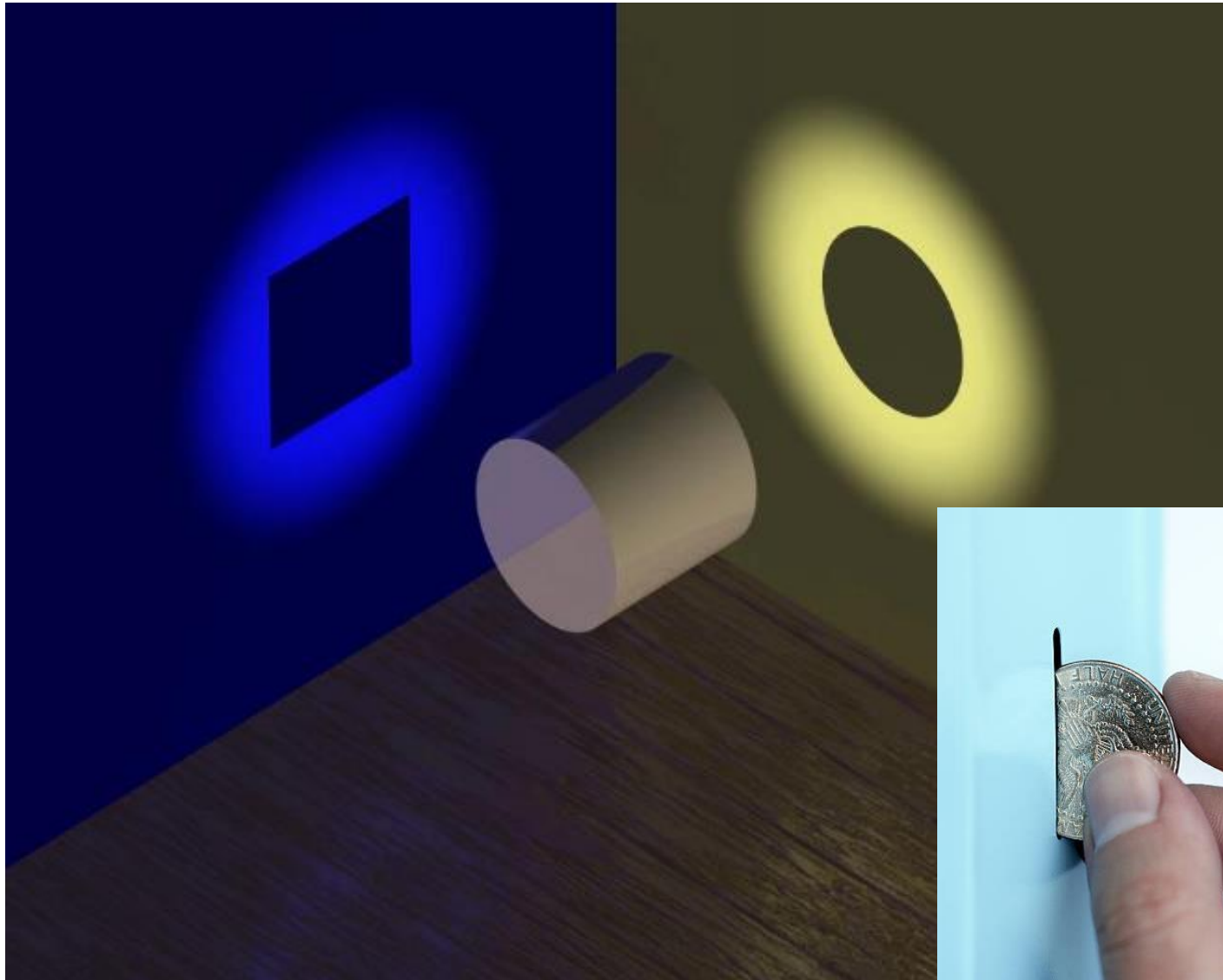
Where are We Going In This Handbasket?



Think Outside The Box

Square Peg Round Hole

Where are We Going In This Handbasket?



Thinking Outside The Box

Anything In The Box Should Not Be Considered?

THINK
OUTSIDE
THE BOX

X O X

O O X

O X O

Where are We Going In This Handbasket?

