An Analysis of the Value/Impact of Patents (emphasis on Material Patents) during the Invention-Innovation Life Cycle

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Invention and Innovation. Definition Not all inventions lead to Innovation.

- **Invention** – *(Technology and Intelligence- IP issues predominate).*
  - High notion of value. Small teams or individuals.
  - Eureka Moments, Discoveries, Unanticipated directions
    - 1um to 100nm to 10nm *(Nano technologies)* increased Properties
    - Some Inventions can be highly novel and potentially disruptive
      - The airplane, *nano technologies* but also Aluminum

- **Innovation** – *(Market Place Effectiveness - Cost and Profit issues predominate).* Notion of value tempered by notion of cost.
  - Most often large number production (larger teams)
  - Plus Reduced Defects
  - Plus Improved Properties. Continuous Improvement.
  - Plus better ROI against competing ventures

Some are seemingly stupid Inventions:
- A wind powered fan.
- A hydrogen fuel-cell to make hydrogen electrolytically
- A high density aluminum alloy

Alexander Graham Bell at the opening of the line from New York to Chicago, 1892
Source: Library of Congress
Invention and Innovation

- Inventions mostly are technical

- Innovations do not have to be - Note that one can have market innovations or business model innovations that need not involve new technology.
Invention and Innovation

- Inventions --- low risk (dime-a-dozen). Drafting attorneys get the gold
- Innovations -- huge risk (very few). Inventors and Companies get rich along with litigating attorneys (drafting attorneys keep doing OK).
- Different emphasis on the ROI’s in each stage...........(impacts management techniques).
Invention is necessary, but not sufficient for innovation to occur.

Innovation is multi-dimensional.
- Vision with the invention
- Market need, timing, technologies require convergence
- Marketing and finance issues are very important

Innovation requires an implementation strategy to succeed.
Life cycle notion: simple for a commercial product

Life cycles for materials, enabling technologies and businesses are quite different.
A typical activity life cycle for a material

Yeramalli and Sekhar Resources Policy 2006
Invention and Innovation.

C. Yerramilli and J. A. Sekhar: Resources Policy Volume 31, Issue 1, March 2006, Pages 27-36

\[ y = x^{2n} \left[ \alpha x^2 + \beta x \sin(\omega x) \right] \]

\[ \exp\left[ \frac{x - \mu}{v} \right] \exp\left[ - \exp\left[ \frac{x - \mu}{v} \right] \right] * \delta \]
Statistics reveal that patent licensing revenues shot up 700 percent from 1990 to 1998, from $15 billion to over $100 billion, and some experts claim that such revenues could surpass a half-trillion dollars by the middle of the next decade.


There are three methods (market, cost and income) used to valuate patent property and all do not apply perfectly to every patent, nor are any infallible. Valuation of patents is still an estimation.
Activity Curve- The same pattern in materials and energy….is it universal?
\[ y = x^n \cdot [\alpha x^2 + \beta x \sin(\omega x)] \]

Where \( \alpha, \beta, n, \omega \) are parameters.
As long as $\alpha > 0$ and $n > 0$ we get Innovation and Rapid Innovation. The rate of growth of activity is noted to be extremely sensitive to $\alpha$ and $n$.

Sekhar, Yeramilli and Dismukes 2006 First Congress on Ceramics John Wiley

**Radical Innovation is** $[\alpha * x^{(2+n)}]$ **dominated**

We are interested in the rate of growth

$(2+n)\alpha x^{(1+n)}$ must be positive

and

\[
d(\log (y=\text{activity})) \propto 2.3d((2+n)\log (x) + \log \alpha) \sim 10
\]

Very Difficult

<table>
<thead>
<tr>
<th>Parameters</th>
<th>$\alpha$</th>
<th>$\beta$</th>
<th>$\omega$</th>
<th>$\delta$</th>
<th>$n$</th>
<th>$\mu$</th>
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<tr>
<td>Aluminum</td>
<td>15</td>
<td>30</td>
<td>0.5</td>
<td>2.32e6</td>
<td>1.1</td>
<td>43</td>
</tr>
</tbody>
</table>

Normalized Year
Innovation and Rapid/Radical Growth

\[ y = x^n \times [\alpha \times x^2 + \beta \times x \sin(\omega x)] \]

Where \( \alpha, \beta, n, \omega \) are parameters

<table>
<thead>
<tr>
<th>Material</th>
<th>( \alpha )</th>
<th>( \beta )</th>
<th>( \omega )</th>
<th>( \delta )</th>
<th>( n )</th>
<th>( \mu )</th>
<th>( \nu )</th>
<th>( X_0 )</th>
<th>( R^2 )</th>
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<tr>
<td>Aluminium</td>
<td>1.7</td>
<td>30</td>
<td>0.5</td>
<td>2.32e6</td>
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<td>43</td>
<td>0.5</td>
<td>1900</td>
<td>0.9728</td>
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<td>Copper</td>
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<td>10</td>
<td>0.5</td>
<td>2.32e6</td>
<td>1.1</td>
<td>116</td>
<td>2</td>
<td>1801</td>
<td>0.9225</td>
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<tr>
<td>Lead</td>
<td>0.0015\times x^2 + 0.3093\times x</td>
<td>5</td>
<td>0.5</td>
<td>2e6</td>
<td>0.45</td>
<td>90</td>
<td>0.4</td>
<td>1822</td>
<td>0.9065</td>
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<tr>
<td>Molybdenum</td>
<td>-0.0005\times x^2 + 0.0619\times x</td>
<td>0.5</td>
<td>1.0</td>
<td>2.32e3</td>
<td>0.5</td>
<td>15</td>
<td>1.0</td>
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<td>0.9568</td>
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<tr>
<td>Tungsten</td>
<td>-1.97e-5\times x^2 + 0.002</td>
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<td>0.4</td>
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<td>1.2</td>
<td>13</td>
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<td>0.5225</td>
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</table>

Ref: Chinmaya and Sekhar. RP 2006

Radical Innovation is \([\alpha \times x^{(2+n)}]\) dominated
Aluminum Production/Sales

Aluminum Production and Fitted Curve

- $b = 30$
- $c = 0.5$
- $u = 43$
- $v = 0.5$
- const $= 2.32 \times 10^6$

Origin = 1900

- $a = 15$
- $n = 1.1$
- $R^2 = 0.9729$

Years

$10^7 	imes$ Activity
\( \alpha \) can go negative after some time. Stage IV. See below real example for Pb.

Radical innovation is influenced by time so try hard for \( \alpha \) to remain positive.
Aluminum Patents

EPO Worldwide Patents with Aluminum or Al or Aluminium in Title or Abstract by Date of Publication

- b=30
- c=0.5
- u=43
- const=2.32e6
- v=0.5
- Origin=1913

Activity

- a=15
- n=1.1
- R2=9.666-0.0000i

Years


Actual
Aluminum Activity and Patent Fitted Curves

- Actual
- Origin=1900
  - R2=.9729
- Origin=1913
  - R2=.9666-.0000i

Activity

Years:
- 1900
- 1910
- 1920
- 1930
- 1940
- 1950
- 1960
- 1970
- 1980
- 1990
- 2000

Parameters:
- \( b = 30 \)
- \( c = 0.5 \)
- \( \text{const} = 2.32e6 \)
- \( u = 43 \)
- \( v = 0.5 \)
- \( a = 15 \)
- \( n = 1.1 \)
Interesting Result - When dip in activity occurs that is when the patent kicks-in

<table>
<thead>
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<td>R2</td>
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<td>0.9483</td>
<td>0.9666</td>
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<tr>
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<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>b</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>u</td>
<td>43</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>v</td>
<td>0.5</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>const</td>
<td>2.32E+06</td>
<td>1.00E+06</td>
<td>2.32E+06</td>
</tr>
<tr>
<td>w (omega)</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>x0</td>
<td>1900</td>
<td>1900</td>
<td>1913</td>
</tr>
<tr>
<td>n</td>
<td>1.1</td>
<td>1</td>
<td>1.1</td>
</tr>
</tbody>
</table>
Sensitivity analysis

R² (best fit)

Years shifted
Results to date

- A 13 year displacement matches alpha and n for production and patent
- Production dip appears to be offset by technology every 13 years. (Schumpeterian concept of technological innovation)
- Positive alpha and n are conditioned by a 13 year out variable
The value of Patents - Must recover about $5000 (1X)-$15000(3X) per patent over its life

Since 1955 the number of utility patents that have issued has grown steadily and substantially. In 1955 the number of issued utility patents was 30,479, in 1965 the number was 62,864, in 1985 it was 71,741, in 1995 the number jumped to 102,299 and in 2005 the number of issued utility patents was 165,015.(10)

- Therefore, in 2005, for 165,015 persons or organizations, the patent rights available for their inventions were valuable enough, to them, to spend, disregarding attorney fees, at least $395 in filing fees and $700 in issuance fees.

- At least $1095 is spent to obtain every patent issued today.(10) This cost will be more if other patent office actions are needed. To maintain patent protection for the twenty year life of the patent, the owner must pay at least an additional $3500 in periodic maintenance fees.(10)

- In short, the patent must be worth at least $1095, in some manner, to the holder of the patent rights or it does not make fiscal sense to apply for a patent and have the patent issued.

- Over 160,000 entities in 2005 thought their patent rights were worth these costs, which totaled up to $180,691,425 for just these fees for just utility patents. To maintain the patent for its entire twenty-year life would cost a total of $4595 per patent. Other fees typical to patent prosecution and attorney fees would make this total significantly larger.

- The possible value of a patent can be at least compared to these numbers and if it is obvious that the future patent would not pay this amount back in some way, it would be unwise to patent it.
on-going work.. Cu and Mo

EPO Worldwide Patents with Molybdenum or Mo in Title or Abstract by Year of Publication

Actual


Years