Entrepreneurship in Medical Physics

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An entrepreneur (ˌontreprəˈnər/, loanword from French) is an individual who organizes and operates a business or businesses, taking on financial risk to do so.
1803: Jean-Baptiste: An entrepreneur is an economic agent who unites all means of production- land of one, the labor of another and the capital of yet another and thus produces a product. By selling the product in the market he pays rent of land, wages to labor, interest on capital and what remains is his profit.

1934: Schumpeter: Entrepreneurs are innovators who use a process of shattering the status quo of the existing products and services, to set up new products, new services.

1964: Peter Drucker: An entrepreneur searches for change, responds to it and exploits opportunities. Innovation is a specific tool of an entrepreneur hence an effective entrepreneur converts a source into a resource.

1975: Howard Stevenson: Entrepreneurship is "the pursuit of opportunity without regard to resources currently controlled."
Examples of Entrepreneurs

James Watt, (1736 - 1819) was a Scottish inventor and mechanical engineer whose improvements to the steam engine were fundamental to the changes brought by the Industrial Revolution in both his native Great Britain and the rest of the world.
Examples of Entrepreneurs

Thomas Alva Edison (1847 – 1931) An inventor and businessman. He developed many devices that greatly influenced life around the world, including the phonograph, the motion picture camera, and a long-lasting, practical electric light bulb. Dubbed "The Wizard of Menlo Park", he was one of the first inventors to apply the principles of mass production and large-scale teamwork to the process of invention, and because of that, he is often credited with the creation of the first industrial research laboratory.
Examples of Entrepreneurs

Steven Paul Jobs (1955 – 2011)

An entrepreneur and inventor, best known as the co-founder, chairman, and CEO of Apple Inc. Through Apple, he was widely recognized as a charismatic pioneer of the personal computer revolution and for his influential career in the computer and consumer electronics fields, transforming "one industry after another, from computers and smartphones to music and movies..."
Examples of Entrepreneurs

Thomas “Rock” Mackie, Ph.D., FAAPM, is a medical physicist. He is a primary inventor and algorithm designer of the helical tomotherapy concept. He was a founder of Geometrics Corporation (now owned by Philips Medical Systems) which developed the Pinnacle treatment planning system. He is also a founder and Chairman of the Board of TomoTherapy, Inc.

In 2002, Mackie was one of six winners of the Ernst & Young Entrepreneur of the Year.
Entrepreneurship in Medical Physics

Aktina Medical Corp. (George Zacharopoulos)
Geometrics (Mackie et al)
Prowess, Inc. (Phil Heinz)
TomoTherapy, Inc. (Rock Mackie)
Nomos Corp. (Mark Carol, Bruce Curren, Ed Sternick)
Math Solutions (Dean Renner)
MGS Research, Inc. (Marek Maryanski)
D3 Radiation Planning (Mark Sontag, Ron Lelond)
Velocity Medical Solutions (Tim Fox)
Mevion Medical Systems, Inc. (Kenneth Gall)
ViewRay, Inc. (James Dempsey)
Xcision Medical Systems (Cedric Yu)
How Does It Work?

• Start with an idea: a means to fill a need
• Bounce the idea to access its commercial viability
• Picture the entire process and make a plan
• Schedule and budget and multiply by two
• Search for resources – partners, funds, …
• Take the plunge
• Learn to swim quickly or drawn
What is a commercially viable idea?

- Does the new product enhances cure or quality of life?
- Does the new product reduces cost?
- Does the new product increase hospital (and Physician’s) revenue?
- Does the potential revenue justify the needed time and money (investment)?
The idea
Simulation shows the possibility
Bouncing the idea

• 1996 NIH grant proposal: Sereotactic conformal therapy of breast cancer.
• My own research and continued interest in breast cancer – MammoSite, APBI, RF ablation, HIFU, Cryosurgery
• 2006 conversation with Dr. William Regine
Successes of Radioablation

Gamma Knife (right)

SBRT of NSLC 98%
LC in 3yrs
Heat or cold is no different from surgery – tumor gone or remaining

Still invasive

Radiation Ablation causes both cell death and senescence – ablate the tumor and sterilizing tumor bed at the same time

Truly non-invasive
7-field IMRT vs GammaPod™
Why is GammaPod a viable business idea?

• Does the new product enhances cure or quality of life?
  1) Potential to replace BCS+33 fractions of RT with BCS + 2-5 fractions of APBI
  2) Potential to replace BCS+RT with 1-3 fractions of SBRT alone

• Does the new product reduces cost?
  • External beam 33 fx: ~$25k, HDR or LDR brachy: ~$16.8k
  • SBRT 5 fx: ~$16k

• Does the new product increase hospital (and Physician’s) revenue?
  200 days x 30 txs / day =6000/33fx = 182 patients/year x $25k = $4.5M/yr
  200 days x 10 txs /day = 2000/5fx = 400 patients/year x $16k = $6.4M/yr

• Does the potential revenue justify the needed time and money (investment)?
  – Answer with careful market analyses and budgeting
Time and Money Needed

- Estimate how long it will take:
  - I estimated 4 years for GammaPod
- How many people are needed:
  15: 3 software on TPS, 2 software on control consol, 3 mechanical, 1 electrical, CEO and 3 VPs, 1 Accounting, 1 assistant
- Estimated best scenario: $9M
  \[15 \times 100k \times 1.5 \times 4 = 9M\]
- More realistic budget: 8 years and $18M
  \[15 \times 100k \times 1.5 \times 4 \times 2 = 18M\]

Always multiply by 2!

Does the potential revenue justify the needed time and money (investment)?
– look the market
## Stage Distribution Over Time

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<thead>
<tr>
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<tbody>
<tr>
<td><strong>Localized</strong></td>
<td>48%</td>
<td>63%</td>
</tr>
<tr>
<td><strong>Regional</strong></td>
<td>41%</td>
<td>29%</td>
</tr>
<tr>
<td><strong>Metastatic</strong></td>
<td>7%</td>
<td>6%</td>
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83% are Early Stage
(NCI Cancer Trend Progress Report - 2008)

NIH Consensus Statement. Treatment of early-stage breast cancer; 1990 18–21 (Establish BCT as std care)
Market Estimate

~180,000 early stage patients, mostly BCT eligible
20% eventually choose GammaPod = 30,000 patients/year
Each GammaPod handle 300 patients/year = 100 needed in the US

Refresh every 10 years, 10 systems per year. $30M revenue in US alone, $60M worldwide. 10% net profit.

⇒ Return on investment of $18M is 30% per year.
   – not a bad investment.
Manage Conflict of Interests

• Who owns the idea?
  • Does my employer has rights to the idea?
• Can I use my students and postdocs to do some of the work?
  • Does it matter is my employer has rights?
• Can I use my own research time to work on the idea?
  • No. Must try to create maximum separation
How to finance it?

- SBIR Grants
  - Xcision received ~$4M from NIH
- State government grants and incentives
  - $100k MIPS grant, investors got $1.1M in tax credits.
- Owner financing
- Sweat equity – executives and employees take a lower pay for shares
- Minimization of the accounts payable – use my house
- Delaying payment
- Minimizing inventory
- Personal debt – refinance house
How to finance it?

Outside Financing:


2. Venture capital investors
   • Predatory practice, spoiled by a bad business culture
   • Exit strategy – short-term nature
   • Relinquish control (preferred voting rights & payout)
   • Personal guaranty

3. Crowd funding

4. Hedge funds

5. Bank business line of credit

6. Collateralized loans – POs can serve as collateral
Where we are?

- 5+ years in development
- Finished prototyping 2010
- Started pilot production, first unit installed 2012
- Formed a clinical consortium
- No FDA clearance
- 3 Publications


GammaPod™ system does not yet have a certificate of conformity and is not presently available for commercial distribution in the U.S.
1. Stereotactic Image Guidance

Concept has passed proof-of-principle

- Inner cup to hold breast.
- Outer cup to contain vacuum and define stereotaxtic coordinate system

- Preliminary clinical test completed on 15 women
- New design defined
GammaPod™ system does not yet have a certificate of conformity and is not presently available for commercial distribution in the U.S.
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Images from two separate scans

Clip location differ by less than 2mm between scans (n=48 clips)
New reproducibility trial at UMD w/ new Cups and Couch

internal markers differed by $1.2 \pm 1.0$ mm
external marker differed by $0.9 \pm 0.9$ mm
Dose Distribution Measurement

Dose Distribution for Static Shots - xy plane
Patient Plan Verification
Partial Breast Irradiation
(5.5cm target)
Prescribe 8Gy to CTV

V50 <15%! Only 42% of normal breast gets >2Gy
Dose Distributions

High dose gradient
Partial Breast Irradiation: 8cm CTV
Dose Distributions
DVH: Prescription Dose 8.5Gy

95% of the 8cm CTV gets 8.5Gy
V50 = 26.5%  (versus 35-45% in EBRT APBI)
SRS + APBI: 3.5cm GTV

3.5cmGTV + 3mm = 4.1cm CTV1 to receive 18Gy
CTV1 + 1cm = 6.1cm CTV2 to be covered by 10Gy
Achieved dosimetric goals of 18Gy to 4.1cm CTV1 & 10Gy to 6.1cm CTV2

$V_{5\text{Gy}} = 21\%$
3.5cm Tumor+3mm gets 18Gy
6.1 cm Tumor bed gets 10Gy
No need for surgery
No need for 5-7 weeks of radiation
2-3 irradiation is enough

3.5cm Tumor+3mm gets 18Gy
6.1 cm Tumor bed gets 10Gy
Figure 13: 2D dose distributions in the central transverse plane (left column) and central sagittal plane (right column). (A) MS 4.5 cm balloon, no trimming of the PTV_EVAL. (B) CMLB 4.5 cm balloon, no trimming of the PTV_EVAL. (C) SAVI applicator 6-1, no trimming of the PTV_EVAL.

Compare with Balloons
Figure 12: Cumulative DVH for a BT-target with no trimming and centrally placed target in GP. Balloon size 4.5 cm for MS and CMLB, SAVI 6-1 and target diameter 6.5 cm for GP.
Compare with balloons – 6cm target

Dose fall-off comparison for 6cm centrally placed target

Relative dose (% of PD)

Chest Direction (cm) Skin Direction (cm)
Benefits of Starting a Business

• Exciting and enjoyable (mostly)
• Being the boss – you set the directions, inspire and motivate your employees. Total freedom.
• Sense of contribution to society – improve breast cancer care
• Sense of achievement – seeing the progress, from nothing to something real
• Stretch all your skills and knowledge
• You learn a lot of new things quickly – in technological fields, management, legal, regulatory, and financial
• Potential financial rewards
Tribulations of Startup Life

- Constant Financial Pressure – Cash flow
- Loss work/life balance
- Employee turnover and misunderstanding
- Regulatory hurdles
- Loss academic productivity
- Loss respect from “pure academicians”
- High risks of failure: potential personal financial wrack, potential of hurting your employees, loss trust
Key to Stay Afloat

• Strong will and stay focused on the mission
• Strong bonds of trust with your people
• Consistently inspire and empower coworkers to stay motivated
• Be surrounded by people with experience and wisdom in business, and listen to their advice
• Being frugal, even with other people’s money
• Conservatively budget spending and aggressively seek funding from all sources