Innovations in medical imaging: research in academics and industry

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Outline

Impact of medical imaging (medical, economic)
Progress through innovation in diagnostic imaging
Vignettes during my time in industry
Vignettes from academia
Conclusions
**Economic impact**

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**Economic impact**

- ~75M CT and ~35M MRI procedures/yr in USA
- Medical imaging is ~$100B per year (US)
- Lots of people employed
- Many patients are impacted

Sources: Healthday, Organization for Economic Co-operation and Development
Medical impact

Pneumencephalography no longer used

(A) AP and (B) lateral pneumencephalography of patient with congenital toxoplasmosis with hydrocephalus.

Medical impact

modern imaging replaced most of exploratory surgery

Medical impact

patient with meningioma
How do innovations have impact?

- Publications and dissemination can alter research, and clinical use if changes don't require system mods or approvals
- Broad impact of technological changes requires commercialization

Progress through innovation

EMI Mark I
1973
Progress through innovation

Completely new product: commercialization is often by a new company

Improvement to existing product: commercialization is usually through existing company

Outline

Impact of medical imaging

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Improved calibration methods

new methods improved reliability and image quality and reduced manufacturing and service cost

http://emedicine.medscape.com/article/385012-overview
Quarter-detector offset


"Bone-detail" reconstruction


"Bone-detail" reconstruction

Images courtesy of Jiang Hsieh.
Observations

- Problems were important to the business
- There was an in-house expert and advocate (me)
- Relatively easy implementation
- Incorporated into the product quickly
- Innovations helped the customers and the company

Respiration artifacts in MRI

Conventional Acquisition

Result => ghosting

Respiratory Compensation

Result => reduced ghosting
Respiration artifacts in MRI

Conventional Acquisition

Respiratory Compensation

Observations

- Feature was important to the business
- There was an in-house expert and advocate (me)
- Complicated implementation: hardware, operator interface, scan software, pulse sequences, reconstruction, operator interface
- Incorporated into the product

Cardiac pulsation artifacts

- Potential solution: phase encoding order based on cardiac cycle
- Relatively simple adaptation of resp comp feature already in the product
- Stanford clinicians liked it
- Not incorporated in the product

Observations

- Moderately easy implementation
- Not incorporated into the product
- Lack of perceived market impact?
- No in-house expert/advocate?
- Needed resources were required elsewhere?

MRI near metal

Four common metal artifacts are shown…

- Signal Loss
- Distortion/Displacement
- Failed Fat Suppression
- Hyperintense signal "pile-up"

Often occur together, from multiple mechanisms

SEMAC

Slice Encoding for Metal Artifact Correction

Combination of techniques - longer scan time but more robust in the presence of metal

Developed at Stanford but GE was informed regularly

Lu, et al. MRM 2009

Stanford University Radiology
MAVRIC

Multislice Variable-resonance Image Combination

Developed independently by a scientist at GE (Kevin Koch)

Different combination of techniques, not slice selective

Koch, et al. MRM 2009

MAVRIC-SL

Kevin Koch and Brian Hargreaves knew and understood each other's techniques. Wide and open communications

SEMAC and MAVRIC have different strengths and weaknesses. One is superior in some cases; the other is others

A "hybrid of the two was created and implemented in GE product (MAVRIC-SL)

Methods published and licensed. Similar techniques implemented by other vendors

Observations

- Moderately complicated implementation
- Feature was important to customers
- There was an in-house expert and advocate
- Incorporated into the product
- Communication between the academic and industry groups, before and after commercialization decision, was critically important

Koch, et al. MRM 2009
Summary

- Medical imaging innovations have had a huge impact, clinically and economically. Medical physicists contributed greatly.
- Impact of innovations needs dissemination.
- Commercialization makes innovations widely available to the medical community and public.

Summary

- Physicists within companies play a great role - innovators - experts and advocates for innovations
  - internal innovations (including their own)
  - external advances
- Physicists in the community and academia are closer to the clinician and clinical needs.

Dissemination decisions

- Commercialization decisions are complex
  - Assessment of commercial opportunity
  - Needed resources? Are they available?
- Within companies: internal matter. Physicists should be engaged.
Dissemination decisions

- Commercialization/dissemination of academic innovations can be by several routes:
  - Place it in the public domain
  - Patent and license. Expectations must be realistic.
  - Starting a new company may be appropriate for completely new product
  - Working with existing company may be more effective for evolutionary advances

Academic - industry partnership

- "Evolutionary" advances accumulate to huge impact
- Collaboration and communication between academia and industry is essential
- New compliance policies and expectations of both sides can be a barrier
- Don't throw out the baby with the bathwater

Thank You