Michael R. Descour, Ph.D., DMetrix, Inc., & University of Arizona
Lloyd J. LaComb, Jr., Ph.D., DMetrix, Inc.

DMETRIX'S (FUTURE) PERSPECTIVES ON DIGITAL IMAGING & DIGITAL PATHOLOGY SYSTEMS

Outline of presentation

- Thanks to Robert Michel and his excellent staff for putting on these outstanding meetings
- Thanks to distinguished audience for staying the extra day

- Digital pathology market and trends
- DMetrix background
- Digital imaging background and the paradigm of parallel imaging
- Laboratory workflow and implications for imaging instruments
- Data storage considerations
- Concluding remarks

Digital pathology market

- Same trend as transformed radiology over last 2 decades…

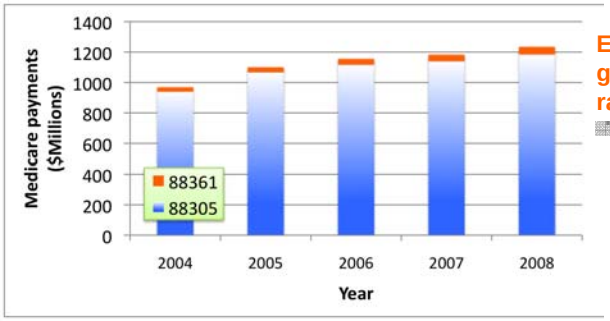
- Divided into **research** and **clinical** market sectors
- Adoption most advanced in research market
  - This market sector is very receptive to digital imaging already
  - Estimated 600-800+ systems installed world-wide

- Clinical market emergent
  - Estimated by GE Healthcare to eventually reach $2B
  - High throughput is essential
  - Adoption lagging research market

- Fundamental enabling technology: convert glass slides to digital images, a.k.a., **slide scanning**

Adoption of digital pathology

- Billing with 88305 and 88361, to estimate adoption of digital pathology among independent labs, hospitals, and pathology groups: **Adoption at ~2-3%**. Average global reimbursement is $62 vs. $91 per claim.

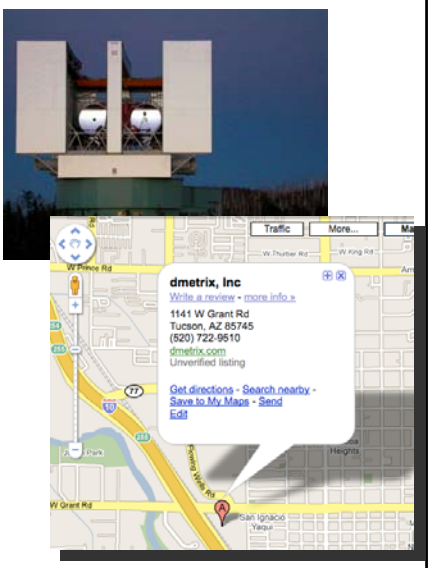


- Important developments: FDA clearances but very piecemeal
  - Receptor/antibody specific, reagent specific, instrument specific
  - Need more clearances with a broader scope
- Integration with information technology (LIS, PACS): In progress

Data sources: CMS, Laboratory Economics.

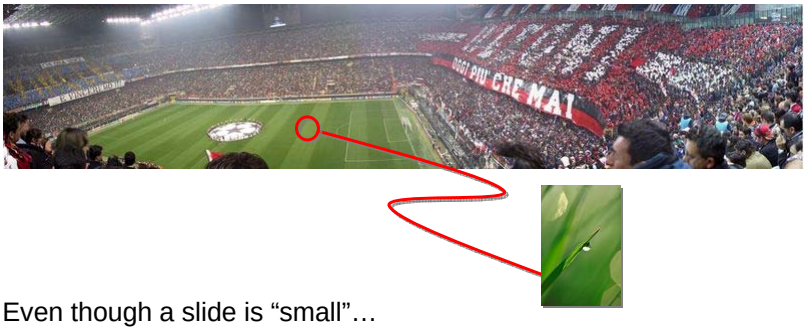
A few words about DMetrix

- Company spun out from world-renowned College of Optical Sciences and Telemedicine programs at University of Arizona
- Company founded by pathologists and engineers seven (7) years ago
- Continued advanced-microscopy work funded by the National Institutes of Health (5 funded SBIR grants)
- Multiple awards for innovation: 2 R&D 100 Awards, *Wall Street Journal* Runner Up, University of Arizona and AZ Governor's Awards
- Focus on innovation:
  - 18 issued US patents, 14 patents pending, 2 licensed patents



Point of reference: What we are trying to accomplish

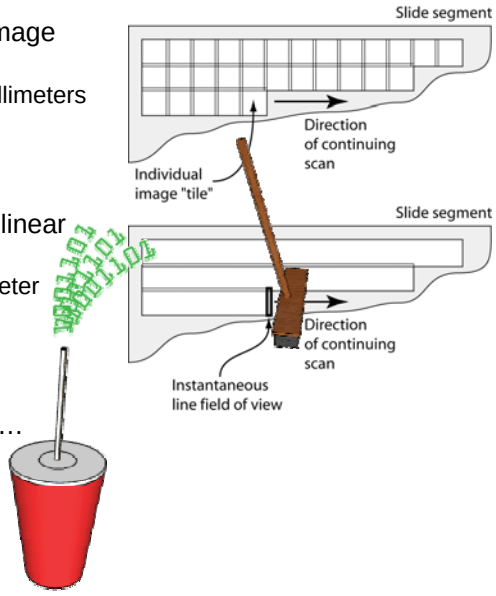
- How to think about the number of pixels in one glass-slide image?



- Even though a slide is "small"…
  - …imaging of biological specimens requires 100's of millions of pixels.

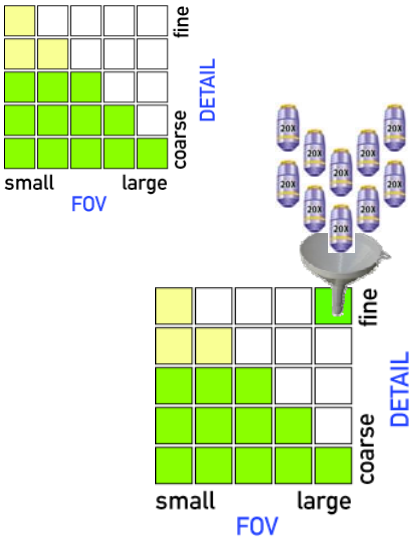
Conventional whole-slide scanning technologies

- **Step-and-repeat** approach ("image tiles")
  - Typical size of a tile is 0.75 millimeters on a side
- "**Pushbroom**" scanning with a linear detector array
  - Typical swath width is 1 millimeter
- Image capture through a straw…



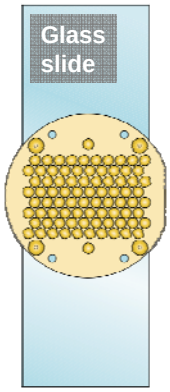
How to escape an uncomfortable trade-off?

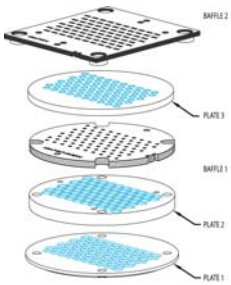
- Microscopy:
  - Trade off between image detail and field of view
- Every microscope objective obeys this trade-off
- **Solution**: Keep adding objectives
  - Move along top row
  - PARALLEL IMAGING
- **What does an "array microscope" actually look like?**



DMetrix's parallel imaging: the array microscope

- **Parallel-imaging concept**, exists now as a product in context of digital pathology (histology & cytology)
  - DX-40, EX-40, and multispectral imaging models
- 80 microscopes in one instrument
- Highest-throughput scanner on the market for the last 5 years





Benefits of DMetrix systems

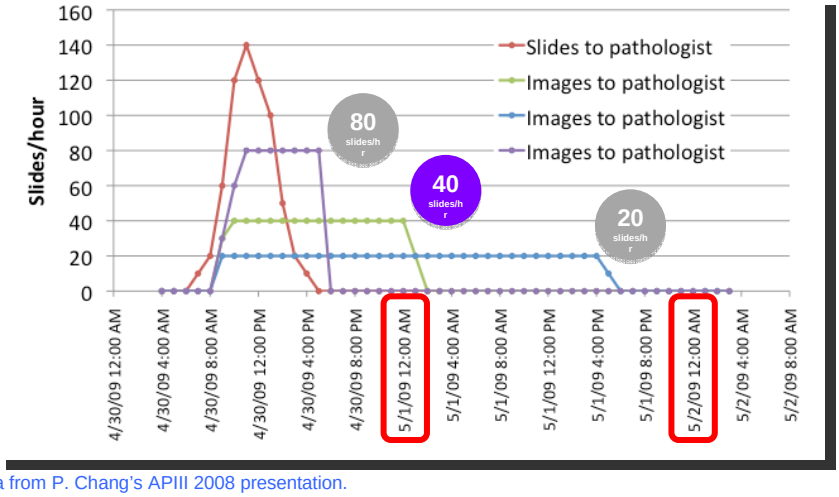
- Rapid image acquisition
  - High throughput, AND/OR
  - Increased information content at pace of others
    - Multiple colors; AND/OR
    - Multiple z-planes
- Fast and safe slide handling
  - Air-flow to move slides without touching
  - Gauntlet of sensors monitors slide positions
  - High sustained and unsupervised throughput
- Images output to various formats
  - JPEG, BigTIFF, DICOM*, custom formats
- Compatible with 3rd-party image analysis & image management software, including LIS software

Why is high throughput important?

- **Observation**: When our customers speak of digital pathology, they speak of using digital images, not taking them.
- The creation of digital images opens the gates to all sorts of value-adding processes.
  - **Examples** include:
    - sharing of digital data among professionals (2nd opinion),
    - automated image analysis (objective, quantitative, and reproducible), and
    - workflow-efficiency improvements.
  - To get there, glass slides have to be converted into digital files: No reason to delay that conversion.
- **We think that high *throughput* is essential.** We feel that it is the key factor needed to bring digital pathology to clinical practice.
  - Not time per slides but instead **slides/unit time**.

Work flow example

- Large batch process (**650** slides)
- What are implications for an imaging instrument's throughput?



Data from P. Chang's APIII 2008 presentation.

Saying "Sayonara" in many forms

- There is now a solution for every need
- Single slide scanners
- 5, 6, 7, 40, 80, 120, 300 slide capacity
- Throughput: 1, 10, up to 40 slides/hour

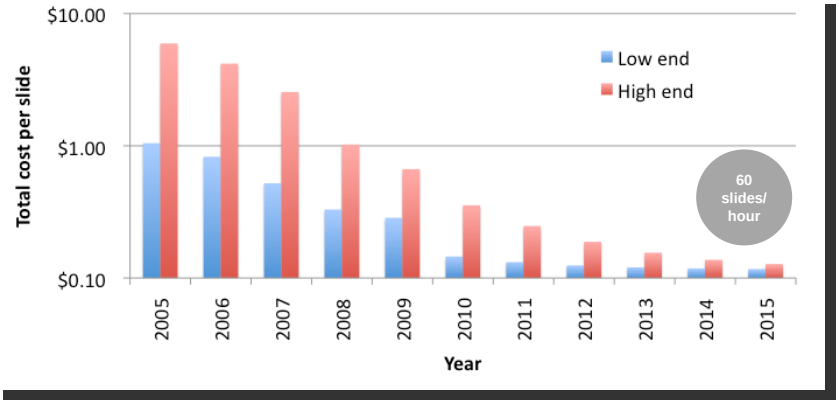
Workflow at the pathologist's desk

- Key requirement: Ultrafast image viewing/navigation
- **Standard**: viewing a glass slide moved by hand
  - To meet the standard, viewing may require a specialized workstation
- Software to aid pathologist in organizing/performing work
  - Rapid access to other information about case
  - Sort cases according to level of difficulty, per individual pathologist's preferences
  - Computer aided review

DMetrix's *Focus* software

Data storage costs

- **Since 1990, the price per gigabyte has decreased an average 47% per year**
  - **In October 2008, it reached $0.10, i.e., the cost of a slide + coverslip**
  - Today: $0.08/GB
- Circa 2011: Total cost of storing slide images expected to be dominated by capital costs (e.g., scanners, maintenance costs), not storage media



Conclusions

- Market adoption in the single percents, *significant opportunity remains*

- **Challenging existing standard** to match in terms of productivity
- To address this challenge in two fundamental ways, DMetrix has:
  - Developed parallel imaging to accelerate image capture in digital pathology
  - Highest throughput scanner product for the past five (5) years
    - Up to 40 slides/hour
  - Developed ultrafast image viewing to approximate microscope viewing

- **Paradigm shift:** Parallel imaging is a prerequisite for wide scale adoption of digital imaging and digital pathology

- Future: Opportunities for business models founded on image data
  - But this requires that imaging can affordably provide a data pipeline

Acknowledgments

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  - DMetrix staff
  - Our customers
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- You can reach me at:
  - descour@dmetrix.com
  - (520) 722 9510