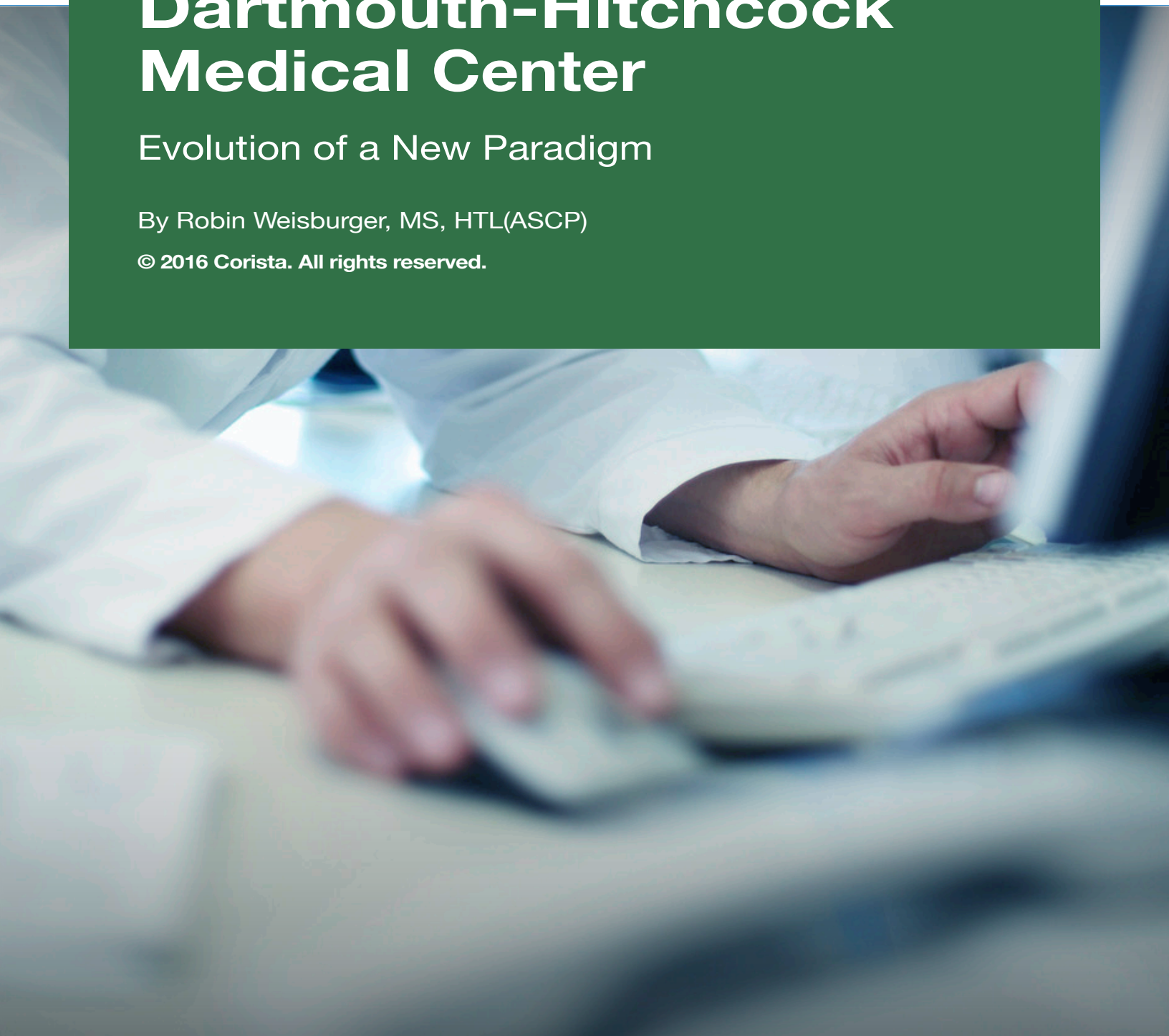
corista

Digital Pathology at Dartmouth-Hitchcock Medical Center

Evolution of a New Paradigm

By Robin Weisburger, MS, HTL(ASCP)



Part 1

Implementing a Digital Pathology Platform

Transitioning from Photomicroscopy to Whole Slide Imaging: Market Drivers and Requirements

Only our most senior pathologists recall the days when they would need to capture microscopic images on a shared scope outfitted with a special camera. After taking their pictures, the film was taken to a local developer to create 35 mm slides and print any photos needed for teaching or research.

When digital photography arrived on the scene, the technology was adopted to both capture images for later use as well as to project images in real time so that a larger number of viewers could attend multi-headed case discussions and teaching sessions. Even then, the glass slide was always the gold standard and a seat at the scope was preferred for prime viewing.

As pathologists transitioned from a film-based to a digital-based medium for capturing microscopic images, many were reluctant to change fearing that the "new" digital technology was not of as good quality as the familiar film. As we move into the Whole Slide Imaging era, we are seeing much of this same reluctance. How can a digital whole slide image possibly be as good as the glass slide on which diagnoses have been based for more than 100 years?

Why did we need digitized microscopic images?

Originally, digital microscopic images were obtained primarily for teaching and research. As the technology developed, their use expanded to teaching conferences and tumor boards. Cameras became "cheap" enough to allow each pathologist to have one on his or her scope. Digital video cameras allowed real time collaborative viewing, at first by projecting the images directly from the scope to a screen and later via a network to a colleague's computer at a remote location.

"As service areas expanded and pathologist staffing contracted, digital microscopic imaging technology became invaluable for assisted fine needle procedures, frozen sections and subspecialty expertise."

As the technology advanced, the application of digital microscopic images increased. Images could be shared for quality assurance purposes and intradepartmental consultations. For tumor board presentations, pathologists transitioned from the use of projection microscopes to projecting digital images prepared in advance. As image analysis techniques developed, digital images were also used for quantified analysis of immunohistochemical stains. As service areas expanded and pathologist staffing contracted, digital microscopic imaging technology became invaluable for assisted fine needle procedures, frozen sections and subspecialty expertise.

Centers utilizing digital technology could better meet the clinical needs of their patients and offer this new "tele-medicine" technology as part of their marketing strategy.

Why move to a Whole Slide Imaging Process?

Photomicroscopy is a simple technology, and most pathologists are familiar with the process. They can capture the image directly from their microscope and are not dependent upon anyone else to help. The cameras are relatively inexpensive at less than $10k per camera, and storage requirements are minimal. Most pathologists store their images on an external disk drive at their desktop. The familiarity and independence that photomicroscopy offers has historically fed the pathologists' resistance in changing this practice.

"Even under the best circumstances, photomicroscopy limits the user to capturing only discrete, representative images of an individual slide."

The quality of photomicrographs, however, is not always consistent, and is often dependent upon the user. Although storing images on a local external disk drive is convenient for the pathologist, it results in image archives being fractured throughout a department rather than maintained in a central location that is accessible to colleagues. Images are also subject to loss if an external drive becomes corrupt or damaged.

Even under the best circumstances, photomicroscopy limits the user to capturing only discrete, representative images of an individual slide. Workflow can be compromised as the pathologist must often go back to obtain additional images creating rework.

Over time, as new pathologists come on board, new generations of cameras are purchased, often by different manufacturers. Maintenance becomes difficult as driver and software updates become more frequent, and incompatibilities with the hospital operating systems drive obsolescence of the cameras themselves. Yes, photomicroscopy is becoming obsolete. Whole slide imaging is not just the future, it is here now.

Today, several manufacturers have developed high quality whole slide scanners that solve most of these issues. However, managing these images requires a platform that is compatible with any scanning device, robust enough to manage the different applications required to meet clinical, research and academic missions, and is simple to use.

Over the next series of articles, see how one medical center transitioned to whole slide imaging and implemented Corista's DP3™ system to manage their workflows for quality assurance, tumor boards and consultative services. Their journey from standard microscopy to the utilization of a digital platform is outlined below.

Evolution of Digital Pathology at Dartmouth-Hitchcock

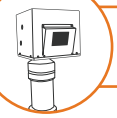
Pre-1990

Standard single-head microscopes are the norm. Multi-head scopes are usually available for the shared viewing of slides during intradepartmental consultations. Projection scopes are an expensive alternative for conferencing and lectures.

1990

Cameras are added to the microscope for taking static field-of-view images. Film is then sent to developer to make 35mm slides. Slides can be projected for teaching and conferences. Projection scopes are still widely used.

1993



Digital Cameras become available as attachments to the microscope. Images are previewed on a small screen and saved to a smart media card.

2003

Digital Cameras become more advanced and images can be viewed on a desktop computer. Images are saved to a smart media card and/or external drive.

2010

Pilot begins with Corista, LLC and Massachusetts General Hospital (MGH) to evaluate the use of digital pathology for remote viewing and interpretation of digital images provided by MGH.

1st generation whole slide scanner is acquired. Images are primarily used for teaching and research.

2012

Networked cameras are implemented for remote pathologist evaluation (adequacy & preliminary diagnoses) of fine needle aspiration cases.

2013

Whole slide scanner upgraded to achieve improved performance & quality. Department leadership develops plan for full scale implementation of Corista's DP3™ image management system.

2014

Decision is made to no longer replace digital cameras as their software becomes incompatible with hospital operating systems.

2015

Corista DP3™'s Quality Assurance application is now in use as a key component of the Department's QA program.

2016

DP3™ use is projected to expand into tumor boards and external consultations.

Part 2

Implementing a Digital Pathology Platform

Whole Slide Imaging Is Here to Stay. Now What? A Project Management Approach to Digital Pathology Strategy

While photo-microscopy has been the standard of practice for nearly two decades, it no longer meets the needs of a practicing pathologist. Camera drivers and software need constant updates and often become incompatible with hospital operating systems. Users are limited to static discrete images whose quality is operator dependent. The quality and flexibility offered by a whole slide scanner trumps the familiar camera on top of the pathologist's microscope workstation. Now what? Here is how one academic medical center transitioned to a digital pathology platform that could support all of their whole slide image applications.

When Dartmouth Hitchcock Medical Center (DHMC) of Lebanon, NH decided to move forward into the realm of whole slide imaging, the intended use at the time was primarily for education, conferencing and research. Whole slide scanners were costly and budgets were tight. Considerations for choosing a scanner were limited to quality of image, ease of use and ease of hardware acquisition. After some negotiations both internally and with the vendor, DHMC's Anatomic Pathology (AP) Laboratory leased two scanners and justified their cost by committing to not purchasing microscope cameras in the future.

This initial transition to a whole slide imaging process was relatively smooth due to its limited scope. Use of the technology was voluntary as most pathologists already had a complete micro-photo workstation on their microscope. Only those who were interested in using the technology took advantage of it.

Over the next two years, the pathologists who used the slide scanners became dependent upon them. However, due to the limitations of the system, if images were needed on short notice, they would resort to standard digital photography. As the utilization increased, it became necessary to upgrade the lab's whole slide scanning platform.

It was clear that a thoughtful strategy was required if DHMC was to move forward in its use of digital pathology.

Key Quality Characteristics for Choosing a Whole Slide Imager

Now that the pathologists and technical staff had experience with using a whole slide imager, it was easier to determine the key quality characteristics of their next generation scanner.

First and foremost, the quality of the image produced by the scanner was critical. Clean, crisp images were required and the option of scanning at both 20x and 40x was preferred.

Throughput, including both speed of scanning a slide and the volume of slides that could be loaded were features to take into account. Features such as the ability to scan fluorescent slides or perform quantitative analysis also needed to be considered.

Finally, cost and service were important factors in the acquisition decision. The cost of obtaining the instruments would likely impact the timing of their acquisition. Ensuring that the vendor would provide excellent service and support was also an important consideration.

Weighing the value of each of these key quality characteristics was an important step in the decision-

making process. Some features such as speed might be compromised to allow for better quality of images or other features that might decrease slide throughput.

Process

Since DHMC already had experience with a whole slide imager, there was some familiarity with what was available on the market. During the final year of their lease with their original vendor, the AP Lab Manager and AP Section Chief spent time evaluating the options available via trade shows (ex. USCAP, APIII, TRICON, Visions & others), through literature reviews and by gathering recommendations from colleagues.

Based on their previous experience, the lab leadership identified their key selection criteria by considering what features held real value and what was perhaps perceived value by the end users. They identified the key stakeholders in both the implementation process and the end stage utilization of the new whole slide scanning devices. Finally, they scheduled a demo by the top ranked vendors.

In DHMC's case, they were fortunate in that their top choice was a vendor with whom they already had a strong relationship. This relationship offered them the opportunity for preferred pricing and the ability to incorporate their service agreement into an already existing agreement.

DHMC purchased their next generation scanner permitting the scanning of four slides in a run. They subsequently added a second scanner that automated the loading process by allowing up to 384 slides to be scanned in a single run. This set-up permitted routine slides to be loaded and scanned in an overnight process requiring little effort on the part of the technologist. Slides needing a quick turn-around-time, however, could be handled on an as needed basis throughout the workday.

Additional Costs

In addition to the cost of the scanners, other costs had to be factored into the implementation process. A server of substantial capacity was needed to store the images. The AP Laboratory initially purchased ten terabytes of storage for their image archives. However, each whole slide image could vary in size from 300 megabytes to several gigabytes depending upon the scanning magnification. Adequate storage and a viable strategy for protecting the images became critical elements of the project as the image storage could become too big to back up by traditional methods.

"This relationship was a key element in the success of establishing their digital pathology program."

The AP Lab and their Ancillary IT Department worked closely together to calculate their storage needs by multiplying the number of slides which they anticipated scanning by an average image size to project their requirements for the next 2-3 years. Working together they were able to accommodate these needs.

The AP Lab also partnered with their Ancillary IT Department who gave them outstanding support in terms of providing a framework for transferring images from the scanners to the image server. This relationship was a key element in the success of establishing their digital pathology program.

A final consideration was the cost of the technical staff to support the whole slide scanning operation. Time to load the scanner, evaluate the quality of the images, and manage the overall process was overseen by an experienced histotechnologist with the necessary skills for ensuring the smooth operation of the digital pathology program. Additional support was provided by other histotechnologists, support staff and a volunteer student. When the whole slide imaging service had been fully

implemented, it required the support of approximately 0.75 FTE depending upon the volume of slides being scanned on a routine basis.

Adopting the Technology: A few bumps along the way

As DHMC already had experience with scanning glass slides for whole slide images, it was thought that the staff needed only to acquire the training necessary for the new instrumentation. It was felt that the basic knowledge and understanding of the process had already been established. Staff at all levels including the AP Section Chief, the AP Manager, the Imaging Specialist (a histotechnologist) and their student volunteer were trained accordingly.

As it turned out, the training needs for staff were underestimated. Due to the complexities of the new system and the varying skill levels of the trainees, more than one training round was required. Subsequent to the initial training, the vendor provided a senior expert who arrived with a defined program customized for the different levels of training required. This experience emphasized the need for a discussion of the training expectations and the training schedule prior to the trainer arriving on site despite the perceived experience of the staff.

Gaining the confidence of the attending pathologist staff was critical to the success of this project. Several pathologists were considered early adopters within the department, but there were also staff members whose comfort with their individual micro-photography set-ups made them hesitant to move forward to a fully digital platform for their image needs. But, by the end of 2013, the lab was scanning nearly 1000 slides per month to support the clinical, educational & research activities of their anatomic pathologists. In 2014, more than 19,000 slides were scanned for these purposes. By mid-2015, DHMC's repository contained more than 50,000 whole slide images.

A more robust platform was needed to facilitate the utilization and sharing of the current and archival images. DHMC had partnered with Corista, LLC, to pilot their DP3™ software for use in quality assurance activities and potentially to enhance their consultation service.

In our next section, we will follow DHMC's strategy for implementing a robust platform to manage their emerging digital pathology service.

Why Should a Pathology Lab Implement Whole Slide Imaging Technology?

PROS

1. Whole slide image scanners can capture an entire micro-slide at multiple magnifications.
2. Digital images have the ability to be more interactive.
3. Current literature reports that with modern scanner resolution, there is good diagnostic correlation between WSI and glass slides.[1]
4. Sharing of images between network users allows for easy internal and external consultations.
5. Depending upon the software, it is easy to annotate whole slide images.
6. Less hands-on prep time [2]
   - Pathologists spend up to 15% of their time managing their slides and associated paper work (reports, etc) for their various responsibilities.
7. A digital workflow allows for a more comprehensive management of cases and the opportunity to integrate with the laboratory's information system.
8. Whole slide images can improve workflow while reducing the handling of glass slides.
9. A digital workflow permits a standardized process for creating slide images and bodes well for automation in a pathologist's workflow.
10. Less handling of glass slides = less breakage and fewer lost slides.
11. By networking with a pathology service that accepts whole slide images for consultation, your own cases that are sent out for consultation can be interpreted more quickly and at potentially less cost.
12. Improved access to pathology cases and their related whole slide images creates opportunities for increased revenue by enhancing your own expert consultative services.
13. The College of American Pathologists has published guidelines for self-validation, facilitating the use of WSI for clinical purposes.[3]

CONS

1. Start-up costs can be high. Scanning devices typically range in cost from $25k - $500k. It helps to consider different funding sources (i.e. small capital vs. large capital funding, lease options or special funding)
2. Storage requirements must be considered. Images range from 300 MB to several gigabytes, although the ability to manage files of this size is constantly improving.
3. A lab must consider its current infrastructure limitations both in technology support & technical support.
4. Technical and/or support staff is required to manage the scanning process.
5. IT staff is required to support image storage & accessibility.
6. Pathologists new to whole slide imaging technology may lack confidence in the quality of the images.
7. A change in current workflow may initially take more time & effort before gains in efficiency can be realized.
8. Resistance to change!

1. Farahani N, Parwani AV, Pantanowitz L. Whole slide imaging in pathology: advantages, limitations, and emerging perspectives. Pathology and Laboratory Medicine International. 2015;7.
2. Ghaznavi G, Evans A, Madabhushi A, Feldman, M. 2013. Digital imaging in pathology: whole-slide imaging and beyond. Retrieved from http://www.annualreviews.org/doi/abs/10.1146/annurev-pathol-011811-120902.
3. Pantanowitz L, Sinard JH, Henricks WH, et al. Validating whole slide imaging for diagnostic purposes in pathology. Guideline from the College of American Pathologists Pathology and Laboratory Quality Center. Archives of Pathology and Laboratory Medicine. 2013;137(12):1710-1722.

Part 3

Implementing a Digital Pathology Platform

Implementation Using a Project Management Strategy

Dartmouth's New "Current" State

As of 2013, Dartmouth-Hitchcock Medical Center's (DHMC) Anatomic Pathology (AP) Laboratory was using whole-slide imaging (WSI) to support many of its routine activities. Pathologists had become more comfortable with the WSI platform, and the second generation of whole-slide scanners being used provided the level of quality and throughput needed for their clinical, research and educational applications.

Maintaining Images from Multiple Scanner Platforms

As DHMC's Pathology Imaging Service evolved and the laboratory implemented its second-generation scanner, it became necessary to access and manage the archived images from both scanning systems. With the opportunities that WSI offered for regional practices, the lab also needed to consider how to support images it might receive from its remote pathologists and external clients regardless of the scanning device used. The AP lab was hoping to use digital pathology to support a robust Quality Assurance (QA) system for "second" reads on its own positive cancer diagnoses and a telepathology system to support a consultative service with external facilities.

Starting in 2009, the DHMC AP laboratory, in collaboration with Massachusetts General Hospital, was also partnering with Corista, LLC to pilot their DP3™ System. Corista's DP3™ is a network solution for sharing digital whole slide microscopic images of pathology specimens for clinical interpretation, quality assurance, tumor board presentations, consultations and telepathology. The hypothesis of the pilot proposed, "Microscopic slide scanner and pathology image viewing software will enable pathologists to remotely interpret digital microscopic images via a secure internet transmission, providing a basis for the development of telepathology."

Subsequent to the successful completion of this pilot in 2012, DHMC also evaluated Corista's DP3™ as a tool for their internal quality assurance program. The second pilot resulted in:

- Facilitation of internal consultations by the participating pathologists
- Improvement in quality and accuracy of pathology reports by promoting second-reads on all positive cancer diagnoses for the participating service(s)

The success of the pilot supported the AP lab's acquisition of Corista's DP3™. Once in place, the platform would help align the department with the strategic direction of the organization providing a key component of Pathology's QA program to support patient safety initiatives through error reduction. It would also support organizational initiatives in telemedicine by promoting remote hospital support, expert consultative opinions and support of regional health initiatives.

Implementation of DP3™: A Project Management Strategy

Implementing a project of this scope required careful planning and coordination between multiple hospital departments as well as the vendor. To that end, the

implementation was set up as a formal project with the support of DHMC's Project Management Office. A Project Manager from the Project Management Office was assigned to work with the Project Leader and the Project Sponsor(s) in the planning process and first phase of implementation.

Requirements of a Successful Project Implementation

Support and Commitment of Leadership

At DHMC, the medical leadership of the department sponsored the project. The AP Section Chief and the Department Chair were the co-sponsors, and they had developed a core group of users during the pilot project. The AP Manager was the Project Leader/Operational Owner and worked closely with the Project Sponsors and the Project Manager to define the scope of the project and its timeline.

The Team used a Project Charter to clearly define the implementation process for the DP3™. The Charter included the following components:

- Start & end dates of the Project
- Description of the Project

Datmouth-Hitchcock's Implementation Strategy: A Project Management Approach

- Brief summary of the Project's business case
- Description of "In Scope" milestones and their timeframes
- Identification of "Out of Scope" items

By using this tool to define the Project, all team members would be clear on the project parameters and would work together to prevent "scope creep".

The Team Leadership met with the Project Manager prior to the kick-off of the project to write the project charter and identify the team members. It was clear from the start that to be successful the team membership needed representation from the Laboratory Information System (LIS) Team, DHMC's Ancillary Network Team, and the laboratory staff who would be responsible for managing the work and the Corista platform.

The Project Manager and the Project Leader worked closely together to define the Project Plan, expanding upon the elements of the Project Charter and providing a more detailed timeline for the execution of each step in the implementation process. An important component of the Project Plan was the Communication Plan. The Communication Plan ensured that not only were the team members kept informed, but key stakeholders were kept informed as to the progress of the project. This communication process helped build accountability for achieving each milestone in the project.

Similarly, the Project Leadership determined that bi-weekly meetings would be scheduled to update all team members as to the project's progress. Agendas of the meetings were scheduled to be sent out two business days prior to each meeting with the responsibilities for each action item clearly outlined. These meetings helped the team stay on track for the project despite juggling multiple priorities for other aspects of their jobs. Meeting notes were distributed to the team membership and the Project Sponsors after each meeting. Updates were also sent to key stakeholders as milestones were achieved.

Implementation Timeline

January 2014: Project Kick-off

The "Corista Project" at DHMC officially kicked off in January 2014. The Project Charter was completed and a Project Plan was drafted, both to be shared at the first meeting. Along with Corista's CEO, the AP Section Chief shared with the Project Team his vision for the project so that the team had an understanding of the "current" versus the "desired" state for the Digital Pathology Service.

Each segment of the project was described and responsibility for its completion was assigned:

The *Ancillary Team* would take responsibility for addressing server and storage needs with the anticipation of eventual storage needs of approximately 1000 slides per month or approximately 10% of the clinical slides produced in the histology lab. Corista would provide the specifications required for the DP3™ Platform and work with the team on installation of the hardware and software for the system.

The *Project Leader* would work with Corista and the hospital administration to ensure that network agreements, licensing agreements, business associate agreements and purchase orders were completed and processed.

The *Laboratory Team* would develop workflows, validate the system and write the standard operational procedures (SOPs) that would be used to manage the system once in place.

Corista would provide support and training, and they would work with the Project Team members to ensure each step of the process was successful.

February 2014

During the second month of the project, the team was focused on understanding the system infrastructure, finalizing contracts and devising a storage strategy. At the bi-weekly meetings, the Project Plan was reviewed and the task list revised to accommodate any new tasks or

changes. A Gantt chart was created to keep track of the various tasks and their deadlines, noting any issues as they arose.

March 2014

By the third month of the project, contracts and agreements had been signed, the Corista Team and the Ancillary Team were working on configurations of the servers and discussions began about adding a first "Spoke" to the network, a small rural hospital affiliated with DHMC whose pathologist had a strong interest in digital pathology and its potential for facilitating workflow.

April/May 2014

This time period saw significant progress on the technical aspects of the DP3™ implementation. Servers were installed and the storage framework was finalized. The Corista software was installed and workflow discussions had begun.

June 2014

With the installation of DP3™ completed, key pathologists were trained, and this core group of "experts" worked with the Laboratory Team to validate the system and finalize the digital pathology workflow. During the summer months, due to schedules and new residents in training, the focus of the project was on the core group of pathologists becoming familiar and comfortable with using the platform for the management of their digital images rather than expanding the training to the full faculty staff.

September/October 2014

The fall months saw a slightly different change in focus for the use of DP3™. A pathologist working remotely at an affiliated hospital wanted to take advantage of the system to support his QA activities. The work with the "spoke" hospital was put on hold while the team worked to establish a robust connection and workflow for the remote pathologist. DP3™ became the foundation upon which the remote pathologist built his QA process. Subsequently, the DHMC Lab leadership implemented DP3™ as a key component of the Department's QA program.

In our next section, we will look more specifically at the lab's implementation process in terms of installation, validation and managing this new workflow.

Part 4

Implementing a Digital Pathology Platform

Platform Implementation

Dartmouth's Implementation

Implementing Dartmouth-Hitchcock Medical Center's (DHMC) Digital Pathology platform was a formidable undertaking. The project would engage partners from multiple departments and eventually, multiple facilities.

Pathology's Laboratory Information System (LIS) Team, DHMC's Ancillary Information Technology (IT) Team and Corista's Engineering Team all partnered with the Anatomic Pathology (AP) Team to ensure success of the project. Having a clear understanding of the vision for the Digital Pathology Service, the various components of the project and how each part fit together was essential for their success.

In the earliest months of the project, time was invested to provide all team members with an architectural overview of the system and an understanding of how each of them would interact with the system in their role as a pathologist, technologist, vendor or technical support. The Project Team Leadership identified short term and long term goals and then defined the milestones and timeframes expected to achieve them. They then assigned responsibilities for achieving these milestones to the appropriate project team members.

Installation of Software and Hardware

Corista provided an architectural overview diagram of their DP3™ with which the project team was able to better understand the infrastructure requirements. Although Dartmouth-Hitchcock Medical Center (DHMC) had servers supporting the whole slide images already being captured and maintained, consideration had to be given to the need for possibly replacing or upgrading the servers to support the new platform.

Support from the DHMC's Ancillary IT Department proved to be invaluable during the platform installation. With their assistance, the project team was better able to address not only the current needs of the system, but also to anticipate its future requirements.

Consideration was given to:

- Pathologists' workstations – Did they need upgrading to support this activity?
- Access - Remote internal users would use a virtual private network (VPN) connection and potential external clients would access the system via a portal server.
- Hardware & software needs – Corista's DP3™ supports any scanner's image format and can interface with any laboratory information system utilizing a middleware solution.
- Storage – current vs. future – How many whole slide images would need to be maintained and for how long?

Image storage

Storage soon became a major focus for the team. Whole slide images range from 300 megabytes to as much as several gigabytes each. Not only must the storage server be large enough to accommodate these files, but very

large volumes are difficult to back up. Appropriate access controls for the image repository were also required to prevent data from being inadvertently modified or deleted. The original storage model consisted of a drive mounted on the image repository server, a disk from a storage array requiring daily backups which took hours to perform. The laboratory migrated to an Isilon® platform which was better suited for high volume storage of the images and their associated metadata and which removed the need for daily backups.

DHMC and Corista's technical teams worked closely together to ensure that the installation was completed with minimal disruption to the imaging service already in place. The pathologists and technical staff were then trained on the system by Corista's senior leadership. On-site support from Corista and the Ancillary IT staff ensured a smooth installation and training process. Bi-weekly meetings throughout the process kept everyone on task.

System Validation

The digital pathology system needed to be validated on two levels. First, the whole slide images (WSI) needed to be evaluated for the quality of the image to ensure they were on a par with traditional glass slides. Secondly, Corista's DP3™ had to be validated to ensure it performed appropriately and did not compromise the quality of the images or their management.

"The resulting images were consistently of excellent quality by the time the pathologists received them in their queue."

To that end, 50 whole slide images of varying tissue types were compared to their original glass slides for image quality. This work was performed by senior pathologists with significant experience in the use of WSI for research and teaching. As a result, this process went quickly and with few issues. Technical staff were highly skilled in performing the scanning operation and with reviewing the slides for quality control purposes. The resulting images were consistently of excellent quality by the time the pathologists received them in their queue.

Further validation of the system involved the first phase of using DP3™ for Quality Assurance (QA) purposes involving a single pathologist stationed at a remote community hospital. This pathologist and a senior pathologist at DHMC independently reviewed 25 cases and compared results. When they completed their review, they were confident that DP3™ helped manage their QA workflow appropriately and maintained the integrity of the images and data associated with their cases.

Workflow Management

One of the most critical aspects of developing the Digital Pathology Service at DHMC was defining and managing the workflow, both at the technical and the faculty levels.

At the technical level, work processes for scanning slides, accessioning cases, triaging cases & system maintenance all had to be defined and documented. As the Digital Pathology Service became more integral to the daily work of the pathologists, these activities became scheduled as part of the lab's daily workflow with staff scheduled to be covering the Digital Pathology Service on a regular rotation.

Having staff assigned to the Digital Pathology Service ensured that the work became standardized. A senior level histotechnologist was assigned to oversee the service. This individual was responsible for documenting procedures, scheduling coverage and ensuring sound quality control measures were put into place.

At the faculty level, the Anatomic Pathology Section Chief took the lead on the development of the Digital

Pathology Service. He worked with the Histology Lab to develop processes for requesting scanning services and use of the scanned images. He then mandated that all pathologists who had not already migrated from digital microphotography to using the Imaging Service do so.

As pathologists became more accustomed to using the scanned images in their daily activities, utilization of Corista's DP3™ was incorporated into their workflow. Having already established baseline procedures with a remote pathologist, use of DP3™ was implemented on a service-by-service basis to help manage their Surgical Pathology Quality Assurance (QA) program for malignant biopsy cases.

DP3™ provided an improved QA workflow by enhancing the communication between pathologists and eliminating the movement of glass slides from pathologist to pathologist, office to office. In addition, DP3™ allowed documentation of these QA results to become centralized and offered a more effective tool for monthly review. The new QA process allowed the pathologists to develop familiarity and expertise with the system thereby increasing their comfort level as well.

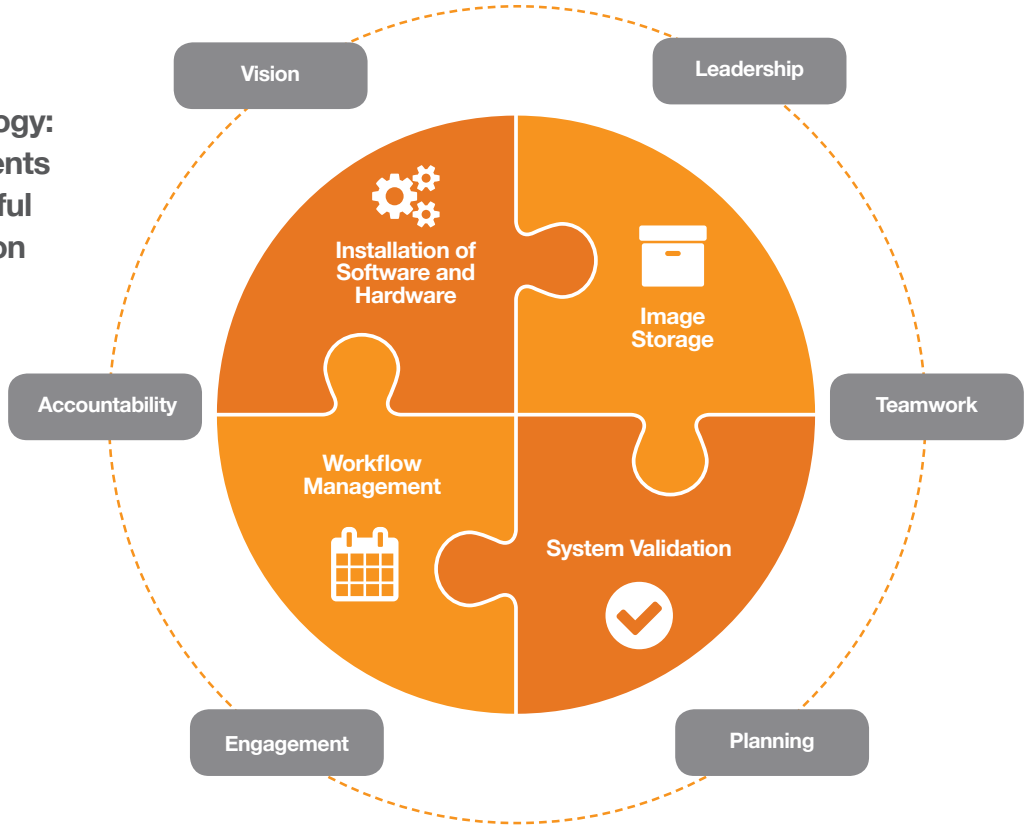
DHMC's focus on strong project planning and workflow design was key to their success in developing their Digital Pathology Service. Their vision for expanding their use of whole slide images in their daily work continues to grow. Their future plans include incorporating these tools for tumor board activities, consultation services and other clinical telepathology activities.

Key Requirements to Ensure Success

Most importantly, to ensure the success of your Digital Pathology program, you will need strong leadership, good planning and well-documented procedures. As you roll out your program, begin with users who are comfortable with this new way of working so that they can serve as coaches and support to their colleagues as the service expands.

Standardize your processes and provide support to new users as they come on board. By allowing an evolutionary process with strong support and standardization of processes and procedures, you will likely gain more buy-in for working in a digital environment. Soon, no one will be able to imagine going back to the "old way" of relying solely on glass slides for all of their daily workflow needs.

Digital Pathology: Key Components for a Successful Implementation



About Corista

Corista's DP3™ is advancing the speed and quality of digital pathology for physicians, scientists and researchers around the world. The only digital pathology software that natively reads every scanner's image format, DP3™ integrates universal image access with a full suite of workflow, collaboration, and search and analysis functionality. DP3™'s scalable and secure platform is accessible from any web-enabled device, putting the power of universal access, robust search and analysis, and integration with any LIS to work for pathology labs worldwide.

The industry's most comprehensive digital pathology platform, DP3™, was awarded Frost & Sullivan's Product Innovation Award in 2014.