Use of the LIS Functionality Assessment Toolkit: A Methodology for Assessing LIS Functionality and Enabling Comparisons Among Competing Systems

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by

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This LIS functionality toolkit project was conceived during the Strategic Summit, a conference presented by the Association for Pathology Informatics (API) on June 8, 2012, in Pittsburgh. This event was planned and convened to discuss the future of laboratory information systems (LISs) and pathology informatics in an era when electronic health records (EHRs) seem to dominate the hospital IT landscape. The conference was generously underwritten primarily by four healthcare software vendors, SCC Soft, Sunquest, McKesson, Cerner plus additional contributions from ARUP Labs, General Data, Lifepoint Informatics, and PathCentral.

Following the Strategic Summit, a project was launched by the API leadership to address the critical issue of how pathologists and other lab professionals can assess the functionality of an LIS prior to its purchase. A key underlying assumption with regard to this project is that optimizing LIS functionality is a necessary goal in order to enhance the productivity and efficiency of pathology and the clinical labs as well as that of the health systems of which they are a part. This report, plus its three appendices, is the product of this initiative. It is our intention to also write an article discussing the future of the LIS for submission to the *Journal of Pathology Informatics*. We are deeply appreciative of the support of the companies that have underwritten this work as well as the products and services that they provide for the industry.

Executive Summary

Assessing the total functionality of a laboratory information system (LIS) prior to purchase is a critical first step for ensuring long-term satisfaction with the product and optimizing the work of pathology and the clinical laboratories. The advantages of working with an LIS with maximum functionality are numerous. First, the deployment of such an LIS will result in lower labor costs for the labs that, in turn, will result in a lower cost-per-test for the department of pathology. A second advantage is that a high quality LIS serves as a guide for optimized laboratory workflow which results in greater work efficiency and higher quality and lower costs. A third factor is the impending threat of a medical technologist shortage such that skilled laboratory personnel will be increasingly hard to recruit even if sufficient funds are available to hire them. Lab automation plus a highly functional LIS can serve as a substitute for labor.

The goal of this report is to provide lab professionals with a toolkit for assessing the functionality of the various LISs that may be under consideration by a pathology department during an LIS purchase cycle. We refer to this methodology and the tools provided here as a *LIS Functionality Assessment Toolkit*. The use of this methodology and tools makes it possible to identify functionality gaps in the LISs under consideration. These gaps need to then be filled in order to optimize LIS functionality.

The LIS Functionality Assessment Toolkit (LIS-FAT) consists of the following four components:

- This report that provides information about how to search for a new LIS among the systems available in the market and develop a request for proposal (RFP) which is commonly used to manage system selection. The report also provides guidance about how to plan live vendor demonstrations of those LISs with the highest ratings based on the responses to the RFP.
- A list of approximately 850 weighted functionality statements (FSs), some of which can be integrated into the RFP submitted to the competing LIS vendors as part of a system selection process. (Appendix I) Participating vendors are required to reference each of these FSs as to its availability in their LIS
- A list of suggestions for scripted scenarios derived from the functionality statements in Appendix I. (Appendix II) These scenarios can be used to guide the competing vendors during the on-site live demo's that are part of the LIS purchasing cycle.
- Worksheet guidelines that can be used to calculate the total cost of ownership (TCO) of an LIS or compare TCOs across several LISs. (Appendix III) Such calculations are important if it has been demonstrated that the LIS chosen for installation in a hospital lacks specific functionalities. In such a case, there will be initial capital costs required to fill the identified functionality gaps in the new LIS with software from other vendors. These additional costs need to be factored into the TCO of the primary LIS.

I. Introduction

Selecting a new laboratory information system (LIS) is one of the most important career tasks for most laboratory professionals. LISs are expensive and it can be a challenge to select one from all of the competing systems available in the market. Because LISs are complex and the learning curve steep after a system is selected and installed, the purchase of a new LIS usually signals a long-term relationship with that vendor. Put another way, the switching costs to de-install an LIS and install another one are so high that an LIS buying decision should never be taken lightly. Therefore, an extremely important criterion is to select an LIS vendor that will be an effective long-term partner of the laboratory. This can confirmed, in part, by talking with some of the current clients of that vendor selected from a complete list of the existing clients provided by the vendor.

Installing an LIS with the maximum total LIS functionality (T-LISF) will generally result in lower labor costs for the laboratories which, in turn, will lower the cost-per-test. Systems with high functionality will also serve as a guide for achieving optimum workflow within the laboratories which results in greater efficiency. A final factor to take into consideration in the search for an LIS with maximum functionality is the impending medical technologist shortage. Skilled laboratory labor will be increasingly hard to recruit even if there are funds available to hire them. IT functionality can thus be viewed as an substitute for labor.

Although this report focuses on the criticality of LIS functionality and the use of the provided toolkit for assessing the functionality in an LIS under consideration, we would be remiss in not saying that functionality is only one factor, albeit an important one, in the efficiency and effectiveness of LIS operations. Two other key factors are, the professional competence of the pathology and hospital central IT personnel who manage the system. A second key factor is vendor support for their LIS. These latter two factors are so important that they can provide an explanation of why older systems that may be considered outdated or inadequate can sometimes provide good performance. Alternatively, new systems can sometimes fail on the basis of poor vendor support or a poorly organized laboratory support staff.

Selecting a LIS in the current environment has been made even more difficult by the emphasis on electronic health records (EHRs) in hospitals. It is to these systems that LISs are interfaced and to which the LISs replicate all test results from the hospital laboratories. Modern EHRs provide clinicians and other healthcare professionals with a single system to which they can turn for the record of all clinical information for a patient over time and sometimes from other hospitals that may be a part of a multi-hospital system. Increasingly, patients can also gain access to their personal and family health records via the EHR using patient portals, also known as personal health records (PHRs).

Despite the dominance of the EHR as the overarching clinical data repository, the LIS remains a vital source-of-truth (i.e., system of record) for all laboratory test results. Laboratorians must ensure that an accurate copy of all lab data is available in both the EHR and PHRs as well as in other key hospital information systems such as data warehouses. This can be a daunting task because lab test results formatted on the LIS side of the interface are translated into HL7 as a first step in replicating them via interfaces to the EHR. The subsequent reformatting of these lab test results on the EHR side can introduce significant errors. Hence, special efforts must be taken on the part of lab professionals to prevent the introduction of such errors into the EHR database.

The leading EHR vendors generally offer a wide selection of specialized or departmental systems, including an LIS, in their product lines. There may thus be pressure, or even a requirement, placed on lab professionals by hospital executives to select the LIS offering of an EHR vendor as part of a purchased EHR software suite. This approach to the selection of a hospital HER, including additional modules supplied by the same vendor, is often referred to as an *enterprise wide solution* (EWS). This is in contrast to a best-of-breed hospital IT strategy in which multiple systems, each of which provides optimal functionality, are purchased from multiple vendors. This best-of-breed strategy tends to result in a diversity of systems but higher functionality of individual systems. An EWS strategy may be favored by hospital executive officers because they prefer to work with a small number of vendors and also because of the EWS vendor may claim that it can provide an integrated package of core and departmental systems with all of the necessary functionality. In this latter case, it falls to lab professionals to

assess whether this vendor claim is true as it relates to the LIS supplied as a component of an EWS strategy.

An EWS strategy can be justified as long as the LIS provided as part of the software suite by the EHR vendor provides sufficient functionality for pathology and the clinical labs to operate efficiently and effectively. In other words, it must be demonstrated that the LIS provided as part of an EWS suite is the equivalent of a best-of-breed LIS from another company and the EWS vendor provides ongoing, focused support for the laboratory. This is no easy task because of the complexity of the best-of-breed LISs available in the U.S. market. Because an understanding of what is meant by *LIS functionality* is so important, it is to this topic that we will now turn. However, before launching this discussion, we present a short glossary of the most important terms and acronyms used in this report.

II. Glossary of Terms

Best-of-breed LIS: A mature, market-tested LIS that performs at least as well or better than all, or most, competing systems in all of the major lab specialty areas (e.g., general labs, microbiology, blood bank, anatomic pathology).

Enterprise-wide-solution (EWS): The provision by an EHR vendor of a broad set of departmental or specialty software modules that interoperate efficiently, allowing hospital executives to work primarily with this one vendor and avoid the complexity of system interfaces and integration across systems from multiple IT vendors. Such EWS modules may be referred to by various names the most important of which as LISs, RISs, and pharmacy information systems.

Functionality statements (FSs): Short declarative statements, each of which describes an LIS function that is desirable or necessary based on the priority or weight assigned to it varying from 1-4. The higher the weight, the more necessary and important the functionality. Such functionality statements are often included in an RFP, requiring the vendor to respond as to whether the specified functionality is present in the product.

Laboratory workflow*;* The sequence of processes that are linked together in order to operate efficiently and generate test results from a patient sample. The general

assumption regarding workflow is that wasted effort needs to be eliminated to achieve an optimized, efficient set of linked work processes.

Live LIS demonstration: A process by which an LIS vendor competes with other vendors for a contract by demonstrating in real-time the various components of the system. Such a “demo” is performed in a hospital setting so that lab personnel can judge workflow, ease of use, and confirm that all of the promised vendor-described functionalities are actually present in the system.

LIS supplementation: If it has been proved that an LIS about to be purchased lacks important functionalities that are present in other LISs or LIS modules, they must be purchased from other vendors in order to achieve the optimum, total LIS functionality from the final set of lab support systems.

Reference telephone calls: This is one of the most important steps in the selection of the best LIS for a laboratory. The process begins by obtaining a complete list of all of the current clients from the vendor. If the vendor is unwilling to provide such a list, the question must be asked what the company is trying to hide. Then, lab personnel select a number of sites, calls them, and asks relevant questions about the performance of their LIS.

Request for proposal (RFP): A formal request to an LIS vendor to submit a detailed proposal for a new LIS or LIS module based on the characteristics of the hospital laboratories and the hospital in which it will be installed. If the requesting laboratory includes a set of functionality statements in the RFP, the vendor must respond to each individually as to whether the specific task can be handled by the system. These responses become part of the final contract if the vendor’s proposal is accepted and the provision of the functionality then becomes legally binding.

Scenario-scripted live demo: A process by which hospital lab personnel develop and submit to a LIS vendor a set of scenarios that are used to guide vendor personnel during a live demo of their system. These scripts, which can be based on the functionality statements provided in this report in Appendix I or the scenarios in Appendix II, are designed to better understand the workflow of the LIS under

consideration and also uncover potential weaknesses of the system not previously identified.

Total cost of ownership (TCO): A worksheet designed to help lab and hospital leadership make a more informed decision about a LIS purchase. Rather than just looking at the licensing and installation fees of a system under consideration, a TCO worksheet takes into account the total cost of the system from the time of purchase until decommissioning. It adds to the initial purchase price other costs that will be incurred during the life of the product such maintenance fees, repairs, additional hardware, and the cost of additional software modules to fill the functionality gaps (LIS supplementation) of the primary LIS. An important addition is the incremental staffing costs that would be necessitated by use of this system versus baseline performance. For example, if the suboptimal efficiency of a particular LIS will result in a 20% loss in productivity, the cost of hiring staff to make up for deficiency will be part of TCO. Appendix III contains suggestions about the various categories of expenses that should be included in a TCO worksheet.

Total LIS functionality (T-LISF): The functionality or theoretical work potential of an LIS or a primary LIS plus additional systems or modules. Lab professionals who purchase a new system should select the one with the highest T-LISF plus a vendor with an established record of support in order to reduce lab manpower requirements and reduce cost-per-test.

III. An LIS with a Single Database Versus Integrated Applications Versus Fractionated Modules

As an extension of the previous glossary section, there is one additional set of terms that need to be understood. When purchasing a new LIS, it is important to differentiate between a *single database LIS*, *an integrated LIS*, and a *fractionated module LIS.* In today's LIS market, these three different LIS *platforms* are available. CIOs and lab directors should understand the characteristics of each of them in order to make an educated decision about the LIS purchase. We use the term *platform* in reference to the type of database associated with the LIS. The platform of a *single database LIS* is obvious. In case of an *integrated LIS*, there are more than one

databases supporting the system but they are integrated and can interoperate and transfer data among them. In the *fractionated module LIS*, each of the modules comprising the total LIS is served by a separate database.

The benefit of having a single database LIS needs to be emphasized. Such an architecture enables all applications and system users to work with the entire laboratory record of a single patient. All of the various applications comprising the LIS have access to this single database and can launch rules utilizing all test data. This single database, usually with a relational or multidimensional architecture, allows all modules within the LIS to write and read from the same database and reduces the duplication seen with the older indexed file databases. Such databases utilize a single patient record that all applications can access. The same result and order records can be utilized by all of the applications comprising the LIS.

The architecture of the *integrated LIS* is characterized by different databases but also provides the ability for them to interoperate. For example, ADT data can be exchanged between the main or primary LIS plus the specialized modules included with the system such as anatomic pathology or blood bank. The results generated in these specialized systems are then interfaced back to the main LIS and then transferred to the EHR for physician reporting.

The major problem encountered with an *integrated LIS* is that it's not possible to have real-time, proactive rules that can trigger various actions to improve patient safety or launch additional follow-up (i.e., reflexive) testing across the different modules. For example if a microbiology result is positive and lab personnel then want to "reflex" additional general lab or anatomic pathology tests, such a scenario cannot be achieved with rules when working with an integrated LIS.

Another advantage of both single database LISs and integrated LISs over a fractionated LIS is that the patient charts and reports contain all of the test results generated for a particular patient. This *single view patient chart* is highly valued by all clinicians because it allows them to work with a complete picture of a patient.

Fractionated LISs are the least integrated of all three types of LISs and do not support data transfer among the various modules comprising the LIS. The ability of a pathologist or medical technologist to view test results from one laboratory and react to,

or utilize them when working in another module is not possible with such a system. Depending on the architecture of these fractionated systems, the general laboratories, microbiology, and blood bank/ transfusion modules may have been developed by one vendor and the anatomic pathology, HLA, genetics, blood bank donor, and lab outreach modules provided by a second company. Fractionated LISs limit the capability for rules development and alerts across the disparate systems installed in the labs. Fractionated LISs thus present the same issues and challenges encountered with the HIS/EHRs of the past when trying to compile and analyze data from all clinical systems.

We are beginning to see some LIS vendors transition from a single database LIS to an integrated or even a fractionated one. The cause of these transitions may be related to the increasing technological and scientific advances within the various lab specialties and the need for additional features and functions to support these changes. The larger EHR vendors with an LIS product may find themselves unable to support all of these changes in the various fields and are then forced to prioritize between EHR/CPOE enhancements rather than providing broader LIS functionality. The good news is that there are a small number of specialized LIS vendors persisting in the market that are able focus primarily on the lab industry IT requirements and keep abreast of new technology and science.

There is a relatively quick litmus test that can be used to distinguish between a *single database LIS,* an *integrated LIS,* and an *LIS composed of fractionated modules.* As noted above, only a single database LIS has the ability to develop and fire rules involving test results generated in any laboratory in the hospital. Also and as noted above, the ability to utilize such rules will become increasingly important in the future as the clinical labs are required to perform tests cheaper, faster, and better. One of the most important ways in which this goal can be achieved is by using lab rules to order tests reflexively and shorten the lab testing cycles, enabling patients to be discharged faster from the hospital.

IV. Defining LIS Functionality; Weighted Functionality Statements

The mission of the clinical labs is to translate biological samples from patients into actionable information in support of the clinicians providing direct patient care. Total LIS functionality (T-LIS) is the *total amount of work that is achieved, or can be achieved,*

by an LIS. In other words and like all computer systems, the value of an LIS lies in the extent to which it can perform many of the tasks that, in the aggregate, constitute the daily work of the clinical labs

Absent an LIS, all laboratory work would be performed in a non-automated fashion by lab personnel. However and for the majority of information-related lab functions, the LIS can perform this work faster, better, and less expensively than humans. The greater the T-LIS of any given LIS, the greater the number of tasks it can perform efficiently and the less the cost-per-test. The same claim can be made for the automated analyzers that are the backbone of the high-volume clinical labs like biochemistry and hematology. One of the most common metrics that is used to assess the performance of the clinical labs is the cost-per-test compared to those in comparable hospitals. Reduced labor cost drives the cost-per-test down significantly, because labor is the single most expensive component of the budget in the clinical laboratories. From all of this it follows that lab professionals need to deploy an LIS with maximum LIS functionality (T-LISF).

The need to replace skilled human labor with LIS functionality is doubly important currently because of the impending shortage of medical technologists. This shortage is due to the fact that this group of key lab professionals is aging faster than they can be replaced. The number of medical technologists being trained also falls short of the number required fro replacement. Therefore, some lab tasks and functions, given the impending medical technology shortage, may not be available at any price. Increasing lab automation is the general solution for this impending medical technology shortage. It is impossible to discuss the need for increased lab automation without reference to T-LISF.

V. Using Weighted Task Statements to Assess Functionality of LISs

Because LISs are so complicated, the best way to understand and assess LIS functionality is to divide and organize all laboratory work into what we refer to in this report as functionality statements (FSs). A similar approach was used by Sepulveda and Young in their article describing the “ideal laboratory information system.”[1]

Appendix I a list of approximately 850 FSs encompassing all lab work. The document is divided into nine sections or tabs that are labeled in the following way:

- Weights
- Core (System Wide)
- Specimen Procurement – Sendouts
- General Laboratory
- Microbiology
- Blood Bank
- Anatomic Pathology
- Quality Control
- Security
- Interfaces
- Molecular & Genetics

The initial tab of the spreadsheet, labeled Weights is quite short. It states that each of the subsequent approximately 850 FSs is assigned a weight or importance on a scale of 1-4 with 4 being the most important and 1 being the least. Weight 4 FSs are critical for most lab daily operations, weight 3 functions are required by most labs to perform optimally, weight 2 functions are not critical for operations but deemed important by most labs, and weight 1 functions constitute a wish list of desirable functions for many labs. All of this should be taken to mean that most labs, particularly the larger and more complex ones, will should seek to select a best-of-breed LISs that provides all or most of the 2-4 weighted tasks and certainly all of the weight 3's and 4's. Clearly, the emphasis on any particular FS will vary somewhat based on the size of the lab and type of testing performed.

The second tab labeled "Core (System Wide) FSs" encompasses those lab functions that are mandatory within all of the LIS applications listed in the subsequent tabs. These are listed under this second tab so that they do not need to be repeated in

all the subsequent ones. Note that all of the items listed under this second tab have 3 and 4 weights. They should thus be considered as critical functions and careful attention must be paid to them to make sure that they are present in any LIS under consideration. Readers of this report may want to review the FSs in all of the subsequent tabs to ensure they are familiar with them and the sometimes specialized vocabulary that crops up in the various labs and specialized LIS functions such as security and interfaces.

VI. Developing a Request for Proposal (RFP)

Because the selection of an LIS is so critical in terms of achieving maximum laboratory functionality and also because these systems are so complicated, a standard methodology called the Request for Proposal (RFP) is frequently used to manage the process. Frequently included in an RFP that is sent to all vendors with a system deemed desirable is a list of FSs very similar in content and format to those listed in Appendix I but generally fewer in number. It is quite possible that some departments will develop some FSs that are not present in Appendix I due to their special needs and requirements. We invite lab professionals to utilize the FSs in Appendix I in any way that they see fit in their own RFP processes and in their search for the most highly functional LIS for their laboratories.

It should be noted here that some lab professionals and consultants may choose to avoid the RFP process, finding it too demanding of time and effort. Some of them may advocate a highly formal process based on assessment of vendor performance in support of existing clients. Others may advocate a less formalized approach to the LIS selection process. Although we cannot deny that such other approaches may have value, we personally believe that a comprehensive RFP is the most useful approach to an LIS selection. In fact, opposition to the use of an LIS RFP may be a strategy used by some to *avoid* uncovering the problems of a particular LIS that may be favored in some circles.

It would be theoretically possible to incorporate all of the FSs listed in Appendix I into an RFP that a LIS selection task force was developing. However, we offer a note of caution here about such an approach. Responding to an RFP, particularly a lengthy one, is an arduous task for a vendor. Therefore, it is frequently the best course of action

to incorporate into an RFP only those FSs that are deemed very important or critical by the system selection team such as the 3 and 4 weighted statements in Appendix I. In other words, it's not a good idea to suppress possible responses to an RFP from vendors who are deemed to be contenders for the contract. A larger number of companies responding to an RFP leads to a more competitive process.

When vendors respond to the FSs included in the RFP, they will usually reply with four possible answers: The stated functionality is (1) included in the current version of the product; (2) to be included in the next version of the product; (3) under development; and (4) there are no current plans to include the feature in the product. RFPs generally yield a large percentage of "standard and in the system" answers from vendors. After a lab has selected a favored vendor from among all of the others responding to an RFP and is negotiating a contract with that vendor, the vendor responses to the FSs should be included in the contract as an appendix. The vendor is then legally held for their responses in terms of the final performance of the system.

It should be cautioned at this point that vendors prefer to respond affirmatively to all of the FSs included in an RFP so that they can continue to be considered in the running for the purchase. Also note that there may be room for interpretation about the exact definition of the functions presented in the total list of TFSs. In other words, a particular function may be performed by a particular LIS but in an inelegant way that will waste time and effort. This leads us to a discussion of lab workflow and scripted scenarios that are addressed in the next section of this report and that are part of the selection process for a new LIS.

VII. Lab Workflow, Scripted Scenarios, and Live Vendor Demo's

Part of the knowledge that is baked into a modern LISs is an optimization of workflow for all of the various clinical labs that operate in a modern hospital. Recall that lab workflow has been previously defined as the sequence of processes that are linked together in order to most efficiently and effectively obtain a test result from a patient sample. Therefore, achieving the T-LISF for the various modules in an LIS that have previously been discussed is only one part of the story. Implicit in the architecture of a well-designed LIS is that the various functions required to generate a result are

arranged and available in an optimized and flexible workflow with the necessary screen branching arranged in an efficient manner.

The functionalities that are sought using the FSs provided in Appendix I thus provide a necessary but insufficient assessment of an LIS under evaluation prior to purchase. Reference calls to selected existing vendor clients should also have been made. It is also necessary to assess the LIS functionalities within the framework of lab workflow. One of the most important ways that this can be determined for an LIS under consideration is through hospital site visits to existing customers of the LIS. The visiting lab team members will sit alongside the medical technologists and pathologists at the host hospital and watch them navigate through their daily tasks. It should soon become apparent how many mouse-clicks are necessary to perform daily work and whether there are wasted steps in the various processes.

In order to understand the value of scripted scenarios, it is also necessary to discuss live vendors demonstrations (or “demo’s” as they are frequently called). The end of the RFP phase in the search for an LIS is signaled by the selection of a small number of favored vendors who are then invited to participate in the second phase of the selection process, commonly referred to as system demo’s. The vendors invited to participate in this second phase have emerged from the RFP phase as favorites on the basis of high functionality as demonstrated by their responses to the FSs included in the RFP as well as other factors such as reputation in the market, favorable reviews from other hospital labs running the same or similar LISs, a history of favorable client education and support, and cost.

The purpose of the vendor live demo’s is for vendor representatives to demonstrate the smooth and efficient workflow of their product in a simulated environment that closely mimics a real work environment. In other words, a medical technologist working in, say, the microbiology lab would be able to watch such a demo and envision the various work processes that would be required to complete an average shift’s workload in the lab. Typically and in the course of a set of one or two days of demos by a single vendor, lab personnel would be able to observe all general lab applications as well as those in specialized labs such as anatomic pathology, microbiology, blood bank, and molecular pathology.

Until about twenty years ago, the design of live vendor demo's was usually under the control of the vendor responsible for the demo. This approach was not inherently bad and such demonstrations were frequently instructive but did not always bring to light system weaknesses or inefficiencies. At this time, some lab personnel began to experiment with what will be referred to in this report as scripted scenarios. In such a process, lab personnel develop scripts that apply to and encompass various lab tasks such as test-ordering or result-reporting. In the case of a test order, for example, a scenario could be designed to assess whether the LIS could begin to process a patient specimen without a valid patient registration number or whether two separate test orders for the same patient could be merged into a single order.

Scripted scenarios are designed not only to assess workflow and the efficiency of rapidly shifting from one task to another but also to confirm and validate the vendor responses to the FSs in the RFP. However, it must be stated that these scripts can often be difficult and time-consuming to develop by lab personnel and are often disliked by vendors. Vendor demonstrators will develop fluidity during the demo's that they totally control and scripted scenarios tend to throw them "off their game." In fairness to vendors, the scripted demo's should be submitted to the vendors a number of weeks before the scheduled demo's so that they can prepare for them. Even then and to this day, some companies may not gracefully emerge from the process.

Appendix II presents a set of suggestions for the high-level scenarios that can requested during live vendor demo's separated by tab into core scenarios and those relevant for the major labs. They can be used in any way that readers of this report see fit to help them through this process. However and in order to extract the major value from them, they are best developed locally based on the culture and practices of the lab and the lab professionals working in the environment using the scenarios in Appendix II as a guide

VIII. Calculating Total of Ownership (TCO) of an LIS

There is one final consideration necessary when considering an LIS for purchase: calculating total cost of ownership (TCO) for an LIS under consideration. As stated in the glossary section above, "*a TCO worksheet takes into account the total cost of the system from the time of purchase until decommissioning*." On a very simple level,

the TCO for an LIS will always include the licensing fees for the system, the installation fees, and the yearly maintenance fees. The contract from the vendor may not include the installation of additional software modules from that vendor, available either at the time of purchase or at some later time. Of course, adding a new module from the same vendor involves adding functionality to the system.

If adding a module from the same LIS vendor adds functionality and cost to a system, the same logic applies if a module is added from another vendor. Recall from an earlier chapter that LIS's can be divided into three categories: (1) single database; (2) integrated applications; and (3) fractionated modules. Generally speaking, if an LIS vendor provides an integrated system, or one composed of fractionated modules, with some software developed and maintained by another company, those costs will be included in the quotation from the primary vendor.

There will obviously be a cost for purchasing new modules from other companies to supplement and enhance the functionality of the primary LIS. This process is referred to in the glossary above as *LIS supplementation*. The need for such modules should be made obvious by the inclusion of the FSs in this report. The cost of licensing these new modules should appear in TCO calculations in addition to the cost of installing them and interfacing them with the primary LIS. An important component of the TCO is the impact of a new LIS on laboratory productivity. If productivity is decreased relative to some baseline measurement, this represents cost of the system that must be recognized. Appendix III contains suggestions about the various categories of expenses that should be included in a TCO worksheet for the three types of LIS discussed above: single database, integrated, and fractionated. It can be used as a general guide for the development of such a TCO worksheet.

[1] Sepulveda JL, Young DS. The Ideal Laboratory Information System. Arch Pathol Lab Med. 2013;137(8):1129-1140.