Developing An NRS Data System: Putting the Pieces Together

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Chapter 1. Getting Started

The National Reporting System (NRS), the accountability system for the adult education program, requires states to report on measures of student outcomes, demographics, and program attendance and participation. While the NRS requires that local adult education programs in each state use individual student record systems to maintain their data for reporting, there are no further specifications or requirements for the system. Each state has had to develop its own approach toward the design and implementation of its data system. Consequently, several different types of data systems have arisen, and there is great variation among the states in the level of resources they have invested in the development and maintenance of their management information systems. After several years of experience using data systems, and with the rapidly changing pace of technology, many states are now revising their NRS data systems.

As a decision-maker within a statewide adult education organization, you may be faced with the prospect of assessing the data system needs and playing a role in the selection of an appropriate solution. This task requires that you carefully consider your system's goals, be familiar with the needs of all users, understand your operating environment, and assess which system choices are most appropriate.

This guide is designed to help state and local adult education staff who make informed decisions on the design and development of a data system. It outlines a process for identifying requirements that reflects the range of needs from functional and operational perspectives. Through a careful requirements analysis and effective communication, you can minimize implementation problems, and you and your staff can spend more time delivering services and analyzing data for quality improvement, rather than worrying about technical support and system maintenance. The guide is organized into three parts.

- **Exploring Your Needs.** By identifying your users, examining their needs, and understanding operating conditions, you learn what the system must be able to do. This approach will help you determine the system's requirements from the perspective of people who use the system. Technical considerations come later. Chapter 2, *Exploring Your Needs,* helps you focus primarily on functional and operational requirements. It will help you ask the right questions to uncover operational issues and assess the applicability of your organization's competencies to the new system.

- **Learning How Operational Needs Relate to Technology Needs.** Unless you have a technical background, it is unlikely that you have considered the properties of computer-based systems that make them effective in meeting the needs of users and the demands of their operating environment. However, making the link between nontechnical and technical needs is essential in understanding whether a proposed system is suitable for your needs. Chapter 3, *Learning How Operational Needs Relate to Technology Needs*, introduces some key characteristics of software-based systems and explains how they relate to the operational needs you have identified.

- **Putting the Pieces Together: Designing Your System.** To convey technical system requirements to venders or system developers, and to help sharpen your own

understanding, it is important to develop a requirements document. You can also use this document as a basis for comparing possible solutions. The process of preparing and using your requirements document will help replace the uncertainty and guesswork of implementing a new system with a process that facilitates success. Chapter 4, *Putting the Pieces Together: Designing Your System*, outlines the contents of a requirements document, introduces some common system designs you are likely to see, and answers frequently asked questions.

In addition, a glossary of terms that are used throughout the guide is available at the end of this document.

About Data Systems

Before discussing how to analyze requirements, we consider the nature of the system we wish to build. An adult education data system can be considered an essential tool that enables state and local adult education programs to assess the effectiveness of their programs and identify areas for improvement.

For its key users, the central features of a data system relate to the information that comes out of it, usually in the form of reports or graphs. Frequently used reports, such as NRS tables, may be built in for use by local, state, or Federal staff. Other kinds of reports may be produced on an occasional or ad hoc basis. Such a system might provide generalized reporting capabilities to provide more flexibility. In addition, the system might include a data export function to facilitate analysis using external tools such as MS Excel or SAS.

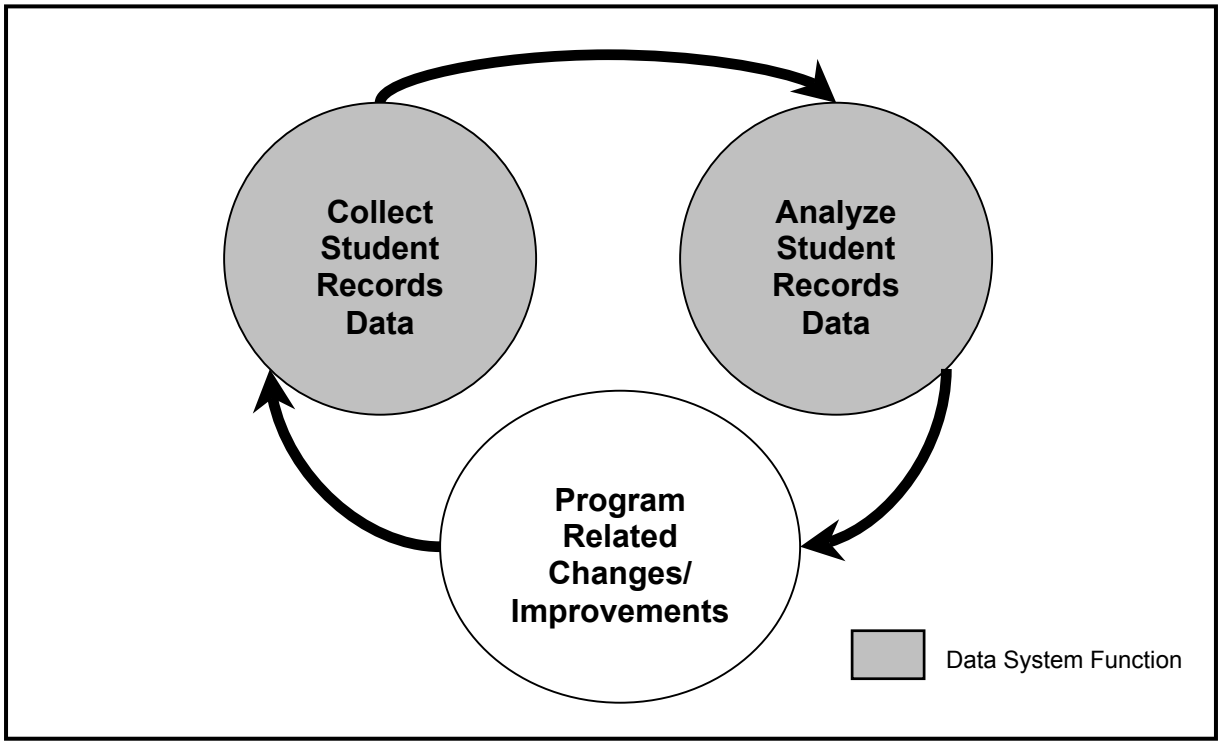
Data System *– An essential tool that enables the state and local adult education programs to assess the effectiveness of their programs and identify areas for improvement.*

To provide meaningful reports, graphs, or other analyses, an adult education data system needs timely and accurate student data. The most painless and reliable, way to obtain data is to generate it as a byproduct of everyday operations. By building a *student records component* that works with the *data analysis component*, quality data are consistently generated.

The *student records component* of a data system has the benefit of helping program staff and management to maintain the operational information needed to run their programs. If the system provides the necessary functionality and is easy to use, program staff will accept it as a benefit rather than a burden. As a result, accurate data needed for analysis will be available quickly.

A careful consideration of your program needs is clearly important as you develop the reporting and data analysis functions of your data system. To summarize, your data system provides two components of a three-part system for improving the quality of adult education shown in Exhibit 1–1. The third component, *program improvement*, is both the result of and leads to good data collection and analysis.

Exhibit 1–1
Adult Education Quality Improvement Process



Basic Data System Requirements

Starting from scratch, you would need to identify the data elements that must be in the system and a set of functions to support program operations. Table 1–1 lists the minimal data elements that are needed for the NRS and Table 1-2 identifies basic system functions.

The listings in these tables identify some basic components that you data system will need to have. To ensure that your data system provides for your specific needs and operates properly, you should consider them in the context of your state. To get a more complete picture of your requirements and provide adequate guidance for a system development team or outside vendor, you will first need to explore your needs.

Table 1–1
Basic Data Elements

STUDENT INFORMATION

- Name
- Address
- Phone
- E-mail
- Date of Birth
- Gender
- Ethnicity
- Functioning Levels
- Test Scores & Dates
- Program Type
  - ABE (Adult Basic Education)
  - ASE (Adult Secondary Education)
  - ESL (English-as-a-Second Language)
- Environment
  - Family literacy
  - Workplace literacy
  - Homeless
  - Work-based project learner (WBPL)
  - Correctional
- Secondary Status Measures
  - Low income
  - Displaced homemaker
  - Single parent
  - Displaced worker
  - Learning disabled
- Enrollment Date
- Teacher/class enrolled
- Separation Date
- Attendance Hours/Dates (weekly/monthly)

STUDENT INFORMATION (continued)

- Goals for Attending
- Core Achievements
  - Entered employment
  - Retained employment
  - Got GED
  - Placed in Postsecondary Education
- Secondary Achievements
  - Achieved WBPL Goal
  - Left public assistance
  - Achieved citizenship goals
  - Increased involvement in child's education
  - Increased involvement in child's literacy activities
  - Voted or registered to vote
  - Increased involvement in community affairs
- Disability Information
- Employment Status
- Public Assistance
- Community Type
  - Rural
  - Urban

STAFF INFORMATION

- Function
  - Teacher
  - Counselor
  - Paraprofessional
  - Local administrator
  - State-level administrator
- Status
  - Full time
  - Part time
  - Volunteer

Table 1–2
Basic Data System Functions

PROGRAM/SITE FUNCTIONS	DESCRIPTION
▪ Add Program	▪ Set up information for program
▪ Add Site	▪ Set up information for site associated with program
▪ Add Class	▪ Set up information for class associated with site
▪ Move Sites/Classes	▪ Ability to move one or more classes to a different site, or sites to a different program (merge)
▪ Class Attendance	▪ Enter attendance information for all students in class
STUDENT FUNCTIONS	
▪ Intake	▪ Enter demographics, needs, goals, etc., on intake
▪ Enrollment	▪ Enroll/drop student in class
▪ Attendance	▪ Maintain attendance information for student
▪ Assessment	▪ Enter student test scores
▪ Leveling	▪ Level student based upon test scores (automatic)
▪ Separation	▪ Enter separation information
STAFF FUNCTIONS	
▪ Staff Profile	▪ Maintain information about staff members
▪ Contact Hours	▪ Enter actual contact hours by week or month
REPORTING FUNCTIONS	
▪ NRS Tables	▪ Generate NRS tables
SYSTEM MANAGEMENT FUNCTIONS	
▪ Assessment/Leveling Information	▪ Maintain information about test scores and levels
▪ Goals/Achievements	▪ Maintain information about standardized goals/achievements

Chapter 2. Exploring Your Needs

In developing or procuring a student records system, you should begin by exploring your agency's goals, needs, and constraints. This process helps to ensure that your efforts meet the expectations for which the system is being designed and enables you to produce a specifications document that describes the defining characteristics of the system.

Factors That Affect Your Needs

Three factors are relevant to your effort to specify requirements for a new system:

- System Functionality
- Operational Considerations/Constraints
- Organizational Priorities/Constraints

Even if you already know what you want the system to do, this process of requirements analysis will help you gather input from others in your organization, think through your operational needs, understand existing capabilities, and compare needs with available solutions.

System Functionality

The previous section defined the term *data system* in a general way. As a starting point, it may give you an idea about how your system may be developed to meet the needs of your state. To make sure that you stay on the right track in gathering requirements, it is a good idea to decide, in broad terms, what you want the system to do. Possible system goals may include managing student records, maintaining data to support program improvement initiatives, assisting with monitoring of follow-up activities, and reporting to Federal agencies or other funding sources.

In determining specific functionality, you will need to identify who will use the system and learn about their needs. By meeting the needs of each group of users, you ensure that the goals of the system are attained. For example, the system must provide an easy way for program staff members to enter data. If this need is not met, it will be difficult to generate the reports and analyses that other users depend on.

Operational Considerations

To be used effectively, a student records system must do more than provide basic functionality. It must meet your operational needs as well. For example, the system must keep accurate and reliable records, or your data will not generate useful reports. If the system is not secure enough to protect data quality and student privacy, then your data may not be reliable. Operational qualities weigh heavily on the effectiveness of your system and can impact the amount of time and money you spend using and maintaining it.

Organizational Considerations

Your new NRS data system is almost certainly not the first computer system ever used by your agency. It will operate along side other information systems upon which you and others depend. Your organization may have developed expertise that would be useful in implementing the new system and coordinating it with existing, related systems.

To help ensure a new system's effectiveness, to control costs, and to get up and running quickly, you will find it helpful to consider organizational factors such as technology standards, staff expertise, plans for agency growth, and anticipated organizational changes. As you develop your system's requirements and research ideas about the best hardware/software/telecommunication solutions, important security features, planning for growth, and promoting flexibility, you may find that some of these factors have already been addressed in an existing system within your agency.

Learning About Your Needs

Putting together a profile of your user needs will help you to evaluate the appropriateness of prospective solutions.

How do you find out about your functional, operational, and organizational needs? Although you may have some of this information, nothing beats talking with prospective users and those who have a role in managing or maintaining the system.

Users and Uses

Users are individuals who operate and maintain the system or rely upon the information it provides. The insights of these individuals will help you learn about the needs and concerns the system will have to address. Program staff can tell you about their operational needs as well as positive or negative experiences they have had with similar systems. Other stakeholders can tell you about their information or reporting needs. You and other planners in your agency will then identify key features and functions and ensure that organizational priorities and constraints are considered.

The choice of individuals with whom you talk depends upon your goals for the system and where the responsibility lies for record keeping, reporting, management, and other functions. Potential users may include:

- *State Administrative Staff*. State administrative staff are responsible for adult education across the state. They may use the data system to assess the effectiveness of individual programs and of all programs taken together. They are responsible for producing NRS tables and submitting them to the Federal government. They may also support goal achievement and follow-up activities.

- *Program Administrative Staff*. Program administrative staff manage individual adult education programs. They may use the system to maintain student intake information, perform ongoing administrative activities, and enter student separation data. They may also use reports to assess the quality of their offerings, identify problem areas, and plan improvements for their programs.

- *Program Operations Staff*. Program operations staff are responsible for providing instruction, assessing student progress, and tracking attendance, test scores, and achievement of student-specified goals. They may wish to use the system to better understand the individual needs of their students.

- *Legislative Staff*. State legislators provide funding and direction for adult education consistent with Federal requirements. They may rely on information provided by the system to inform their approaches.

- *Other Agencies*. Administrators of agencies that provide funding for adult education may need to know how their resources are used. They may also want to know whether their contributions are having an impact on the success of adult education students.

- *The Public*. The public may be interested in the effectiveness of adult education, equity, and other issues. They may also wish to obtain information to help them determine which programs to recommend to a family member or friend.

Focusing on Functionality

To determine specifically what functions your system should provide, it may be helpful to conduct interviews, focus groups, or surveys. Existing system documentation may provide ideas or uncover pitfalls. Input both from *direct* and *indirect* system users will provide the basis both for functional and operational requirements.

Direct Users

Prospective hands-on system users will focus on administrative functions and ease-of-use issues. For example, program staff members who perform intakes may tell you what information they currently maintain, what is required, what is optional, and pitfalls to avoid, from their perspective. Others may tell you about difficulties they have had in following up on postseparation achievements with students who leave the program.

Detailed operational knowledge provided by hands-on users will enable you to develop a system that helps them work more effectively. For example, if you are told about the difficulties of retrieving records for individual students, you may identify features that would be helpful in retrieving records more easily. User input may inspire the creation of powerful new features or the elimination of others that are underutilized or unused. The information you obtain from direct system users may also serve to validate your understanding and ideas about how it should work.

Indirect Users

Prospective *indirect* users can tell you what kinds of reports, data, and other functions are useful to them. For example, the U.S. Department of Education would tell you that annual copies of the NRS tables are necessary for them to fund your program. Instructors might tell you that it would be helpful to see historical assessment and attendance information for their

students. State-level staff might want the system to produce metrics that support program improvement initiatives or simplify postseparation achievement follow-up activities. System outputs affect the types of information and operating rules that need to be embodied in the system.

About Operating Conditions

To be sure that your system is viable, you must understand the stresses, strains, and peculiarities of the environment in which the system will run. Therefore, operating conditions—such as number and location of users, available technologies, and intensity of use—should be appropriately reflected in the design of your system.

There are many operational questions that one might ask about a new system. Examples include:

- How easily can we produce NRS tables or reports when data are entered in locations scattered across the state?
- How long will it take for us to learn to maintain a system that employs technology we have never used before?
- Will our new software be able to run on the computers that our field users have?
- Do all users have access to the Internet, if that is necessary to use the new system?
- What kind of care is necessary to safeguard data?
- How do we prevent the system from becoming overloaded?
- What kinds of computer hardware and software are appropriate as a platform?

Operating conditions should be appropriately reflected in the design of your system.

To address these questions and other operational considerations, you will need to look at the characteristics of your operating environment that affect your technology choices, including the following:

- *Number of Users*. The number of users, along with other factors, affects the amount of work a system has to do. As more users access the system, your computer and communication network must work harder.
- *Location of Users*. The location of your users can affect the methods you choose for getting information to and from the system. Where will data entry of student records take place? Are you providing reports to legislators and their staffs? Which location will generate these reports? Which state-level staff will be accessing the system, and

from where? Will the public be invited to access the system to obtain copies of reports?

- *Amount of Data*. The amount of data you need to manage, initially and later, can affect how well your system runs. As your database gets bigger, the amount of disk space and computer processing time can increase dramatically. The potential for data integrity problems can also increase as the database grows.

- *Intensity/Frequency of Use*. The intensity and frequency of use can affect system performance. This can result in slower system performance during peak-usage times.

- *Technical Expertise in the Field and Headquarters*. Technical abilities of field staff and headquarters staff can affect your ability to install and manage the system. By matching the abilities of your staff with the technologies used, you can improve system reliability while reducing training and technical assistance costs.

- *Kind and Quality of Computer Equipment*. The availability of computer equipment, communication networks, and Internet connectivity in the field may serve as operational constraints. For example, if your state's largest participating adult education program, or any program, uses Apple computers rather than PCs, what is the feasibility of running a PC-based system there?

- *Availability of Communication Networks*. Systems that depend on the Internet or other communication networks require suitable communications equipment. If your state has many small adult education programs without Internet connectivity, or if your available bandwidth at the state level is limited, what impact might that have on the effectiveness of an Internet-based system?

- *Privacy Requirements*. With the advent of large-scale databases and the growth of technologies for sharing information, privacy is a growing concern for students and staff members. The level of privacy protection you wish to provide may require that particular kinds of security features be present in your system.

- *Data Integrity Issues*. To protect the quality of your data, you will need to provide adequate security. Considerations for physical, electronic, and data communication may be relevant in your operating environment.

If you have a system that stores records for all students in a facility operated at the state level, physical provisions (such as secured computer rooms) may already be in place to prevent unauthorized access and data integrity. But if records are stored on-site by each program, you may want to determine whether sufficient physical protections are in place to prevent unauthorized individuals from accessing data.

Data should be protected electronically as well. Different systems for storing data will provide various methods for making data inaccessible or unreadable by unauthorized individuals.

Data sent between computers can also be subject to unauthorized access. Just as there are different means of transporting the data, there are also different levels of security. For example,

data entered into a simple Web-browser form are sometimes sent as readable plain text or may be encrypted.

About Growth

Over the life of your system, operating conditions, organizational needs, or reporting requirements will almost certainly change. The ability of the system to adapt to these changes may affect system performance, reliability, and costs.

Also consider the possibility that the functionality of your student records system may need to change over time. NRS requirements are periodically reviewed, new kinds of assessment tools are developed, the needs of adult education students change, and new state requirements come into effect. Reflecting on past experiences or anticipating certain changes may enable you to identify parts of the student records system that could provide flexibility when such changes come about. Having a system that is easily modified in these areas of potential change can help you to implement new features more efficiently and less expensively.

Organizing Your Needs

To help provide a clear picture of your needs, consider putting together a profile for each user group as well as a table that enables you to compare your needs across user groups. You can collect information on a profile form, like the one illustrated in Table 2–1.

Table 2–1
User Group Profile

User Group:	State Program Administrators
Functional Needs:	• Produce NRS tables • Follow-up activities • Respond to lawmaker/public queries • Evaluate local program effectiveness
Amount of Data:	• Uses existing data • Minimal data entry
Location:	State Department of Postsecondary Education (HQ)
Size of User Group:	5
Frequency/Intensity:	• Light use weekly • Heavy use occasionally
Privacy/Security Issues:	• Protect data from unauthorized disclosure • En data integrity • Prevent disclosure of individual student information

Table 2–1
User Group Profile (Continued)

Tech Expertise:	• Intermediate end-user • Not able to manage/install software • In-house support for desktop applications
Equipment:	• Computers </= 3 years old • Operating platform: Windows 2000/XP mix • Available software: MS Word, Excel
Communication Network:	• Standard of the Art, Local Area Network (LAN) • T1 Internet connectivity

About Your Organization

As you begin to understand the breadth and depth of your requirements, you may discover that you are farther along toward completing your new system than you had imagined. That is because your organization already has communication networks, computers, database management systems, and technical know-how that may help you implement the system more quickly and cost-effectively. By learning more about your organization's capabilities, you can find out what it has to offer in providing a head start toward implementing your data system. Understanding the power of available resources and technical expertise, combined with an understanding of your system's operational needs, will help you determine which existing resources in your organization are beneficial to your effort and which are not.

Your organization may already have resources that will help you implement a new data system more quickly and cost-effectively.

The Case for Familiar Technologies

There are times when existing technology and expertise can give a boost to your new system implementation project. The computers and database management software that your agency uses for other purposes may have additional capacity that can be applied to the task of storing student records data. This means that you may be able to minimize, or even eliminate, additional costs for hardware and some software. By tapping into existing networks, you may be able receive data or disseminate it at minimal additional cost.

If it is feasible to use available technologies, the costs of training, technical support, and ongoing maintenance can be reduced. Further, experienced technical staff members are often more able to anticipate implementation pitfalls and fix problems quickly. Experience can yield better—and faster—results.

Available technologies may also facilitate more seamless sharing of data. For example, if your student records system uses the same technologies as your state's database of GED recipients, you may find it easy to match GED recipients with ABE participants having a goal of

obtaining their GED. Easy data sharing also makes new uses for data more accessible and worth trying, because the cost and effort required is reduced.

If your agency has technology standards, you may be required to use particular types of equipment or particular brands. If your Information Technology (IT) department is involved in the planning, setup, and maintenance of the system, its staff should be able to tell you what kinds of technologies they are most familiar and comfortable with. They should also know about any agency standards that apply.

When To Try New Technologies

Before you accept a set of available technology assets as firm requirements for the new system, you will need to make sure that their capabilities match up with functional and logistical needs that you have identified for all groups of system users. For example, if the existing infrastructure and expertise is designed to meet the needs of headquarters staff only, it may or may not be applicable for use in the field. In some cases you can utilize existing resources, but others may require a different solution. Also, if the available technology has not lived up to its promise, you may want to try something different. If you feel that either functional or operational differences between your data system and others within the agency might make a familiar approach unattractive, you should consider looking into alternatives.

Organizing Your Technology Assets

To keep track of your technology assets, you can you can use a worksheet like the sample illustrated in Table 2–2. When you compare current assets with needs, these will be listed in one place. Alternately, your agency may already have an outline of its technology standards for this purpose.

Table 2–2
Technology Preferences and Standards

Client Operating System	MS Windows
Server Operating System	MS Windows
Database Management System	Oracle
Programming Languages	ASP, C++, JavaScript
Other	Networking components must use only TCP/IP

Chapter 3. Learning How Operational Needs Relate to Technology Needs

So far, you have explored system requirements by collecting information from prospective users and others at state, local, and national levels. You also have become familiar with the technologies and expertise available within your organization. You now have the basic data from which to make some decisions about technology and other system-oriented needs.

Of key importance is functionality because it is at the core of your interest in building a new data system. You may also find functionality to be the most understandable because it pertains most directly to the work you do each day. However, a range of technical characteristics must also be considered to ensure your new system's success over the short and long term, such as the platform on which the system will operate and its accessibility, reliability, interoperability, and flexibility. These and other types of abilities determine how your system will operate and whether it will meet your needs. This section discusses these important system characteristics.

Functionality

Through your interviews with prospective users of the system, you have learned about the functions and kinds of information that are needed in your student records system. This functionality is at the core of your system requirements, as it addresses the reason the system is being built.

In specifying functional requirements, you may find it helpful to think in terms of *inputs*, *processing rules*, and *outputs*. Inputs refer to information that must be entered or obtained from an external source. Outputs are products that the system generates, such as reports, graphs, statistical analyses, Web pages, datasets, and more. Processing rules specify (1) how to determine whether inputs are valid, (2) how data are used and managed, and (3) how outputs are generated.

Think of functionality in terms of inputs, processing rules, and outputs.

Table 3–1 lists a sampling of some inputs, outputs, and processing rules that might be relevant to a student records system. Your listing of inputs, outputs, and processing rules might include some different items and will almost certainly be longer.

Table 3–1
Sample Inputs, Outputs, and Processing Rules

Inputs:	❑ Student-Related ▪ Contact information (student name, address, etc.) ▪ Student profile (demographics, goals, employment, etc.) ▪ Enrollment ▪ Assessment and leveling ▪ Achievements ❑ Staff-Related ▪ Contact information (name, address, etc.) ▪ Employment information (wages, etc.) ▪ Qualifications (education, years of experience, specialties, etc.) ▪ Operational (classes being taught, etc.) ❑ Program-Related ▪ Site information (site names, addresses, etc.) ▪ Calendar (instructional calendar, deadlines, etc.) ❑ Systemic ▪ Assessment (instruments, leveling information, etc.) ▪ Goals (standardized goals, etc.) ▪ Demographic categories (ages, ethnicities, etc., for reporting)
Processing Rules:	❑ Students must attend 12 hours before being counted in reports ❑ Students have completed intake before enrolling ❑ Students must be 16 years of age or older ❑ Instructors must have obtained college degree ❑ Only one instructor per class ❑ Students must be pretested ❑ Employment retention cannot be checked before 9 months past separation
Outputs:	❑ NRS Tables ❑ Student Attendance Report ❑ Student Achievement Report by funding source

Platform

A system's platform is the collection of technologies upon which it depends to operate. Examples of platform components include the computer operating system (e.g., Windows or Linux), database management system (e.g., SQL-Server or Oracle), programming language (e.g., Delphi, C++, Java, or ASP), and Web server on Web-based systems (e.g., IIS or Apache). The platform upon which a system runs can significantly affect how well it operates. A range of technical characteristics, characterize a system's usefulness for a particular purpose. These characteristics include accessibility, reliability, interoperability, extensibility, performance, scalability, compatibility with other systems, security, and training requirements for your system. These system characteristics are described below.

The platform upon which a system runs can affect how well your system operates.

Accessibility

All direct users of the system must be able to access its features. At the *local level*, program staff will need to enter intake information, test scores, attendance, advancement, and other information. Individual programs may also want to use system data to assess their strengths, identify areas for improvement, or project NRS figures that affect their grant. At the *state level,* staff may need access to program-level or statewide data to produce NRS tables, provide follow-up assistance, or support operational decisions that affect all programs. Different platform components may be better at providing the kinds of access you need. For example, some platforms are better at providing Web-based access than others.

Usability

Usability refers to the ease with which a system can be operated. The way a system's functions are organized, steps necessary to perform its functions, even screen layouts can affect ease of operation. Tech-savviness and other user characteristics are also important.

Usability is important because it can affect the productivity of your users and the accuracy of your data. Well-constructed entry screens can speed up data entry and make it easier to get results. Poorly constructed ones can slow users down, tire them out, and frustrate their attempts to use the system. Because usability is subjective, it is helpful to get input from individuals who will use the system.

Reliability

System reliability can be defined in terms of stability, database accuracy, and ease of recovery from problems. These characteristics are dependant upon the robustness of your platform, quality of system design, and care taken in development and testing. The database management system in particular will impact the system's reliability. Products like Oracle and Microsoft's SQL Server have features that make them less susceptible to failure than desktop systems such as Paradox or MS Access. More robust components, however, can be more complicated and may require greater technical expertise to install and maintain.

Interoperability

Interoperability is the ability of your data system to work together with other systems within or even outside your agency. From a practical perspective, it enables you to share data between databases. Interoperability may enable you to track—across information systems—the achievement of certain goals such as GED completion, job retention, and student enrollment in postsecondary institutions, or to provide more detailed cross-program coordination.

By considering the possibilities for synergy, you can maximize opportunities to analyze a range of data maintained by your organization for the benefit of adult education and other statewide education programs.

Extensibility/Flexibility

Extensibility refers to the ease with which the functionality of a system can be extended to meet other needs. The extent to which a system is extensible depends on both its platform and the methods by which it is constructed. System developers can create a program for a very specific purpose, encoding most of its functionality into the computer instructions from which it is built, or they can provide a level of flexibility by storing information about the system's data and operating rules in a database. The database management system in use can be more or less extensible as well. For example, extensible systems may enable you to change the structure of your data tables easily.

To assess whether a system is extensible enough, consider the nature of your most likely changes and then ask how easily the system can be modified to accommodate them. For example: How easily can a new assessment instrument be included? How easily can we accommodate a new type of adult education service (e.g., work-based project learners)? Will we be able to add an ability to match students with their GED scores from a different database?

Scalability and Performance

Scalability is a system's ability to perform given an increasing workload. When putting a new system in place, scalability is sometimes given less consideration in the face of other technical issues. In fact, scalability and performance may not be apparent issues until system usage grows or the capacity needs to be increased. If a system is not able to handle the load under which it is placed, users can suffer poor response times or database corruption. This may occur when a system is installed, or after months—or even years—of operation. As a result, the productivity of users can drop dramatically as they wait for the system to complete its work or spend significant amounts of time repairing broken databases. Many systems are built upon platforms that help to make them scalable.

An ability to add capacity (e.g., database servers and communication lines) as well as certain measures of flexibility (e.g., deployment methods) may indicate a measure of scalability. Other performance-related factors, such as a program's efficiency and other limitations, may not be as easy to determine. To get a sense about whether a system's performance is acceptable, you may wish to perform benchmark testing. It may also be helpful to talk with other users about their experiences.

Compatibility

Unless you are developing a system in-house, your platform choices are limited to what the vendor offers. Nevertheless, compatibility issues can be significant. For example, imagine what would happen if your new system runs beautifully, but exclusively, on PC-based computers. Programs in the field with Apple computers would not be able to use it.

By implementing technologies that are compatible with the background/expertise of your technical staff, your organization will be better prepared to take on the administration and maintenance of the new system. New systems that are compatible with available expertise and

existing systems have several advantages; they (1) enable you to leverage existing technology, (2) require less intensive training, and (3) open opportunities for data sharing and more effective program management. Each of these benefits represents lower costs and improved quality.

Maintainability

Maintainability refers to the ease with which a system can be updated or fixed. In practical terms, it represents the ease with which your technical staff, a contractor, or vendor can make changes. This is dependent upon an ability to access the system's *source code*, configuration files, databases, and related components. It also relies upon the skill level of individuals who are tasked to make necessary changes.

Security

Security is an important issue both for protecting the integrity of your data and the privacy of your students. There are a range of ways that your data need to be protected. From a physical perspective, security may simply mean keeping computers with sensitive data protected under lock and key. From an electronic perspective, security may require multiple measures as there are a number of ways that data can be electronically tapped, perhaps without your knowledge. Responsibility for electronic data security is usually shared among the components of your system.

Perhaps the most well-known security measures are access controls, which allow only those with a valid user name and password to use the system. Although they provide a level of protection, other system characteristics can severely diminish the effectiveness of access controls. For example, some database management systems store data in a form that is easily decipherable with software tools as simple as a word processor. Other systems may utilize a method that is more complicated and difficult to read outside your data system. Still others may store data in an encrypted format for even stronger protection. Similarly, different methods of transmitting data from computer to computer (commonly required in Internet-based systems) provide varying levels of protection.

Training and Technical Support

Training and technical support are hidden costs in deploying a new system. They are significant because they can be ongoing and often outstrip the cost of the software itself. Such costs can be minimized by focusing on ease of use and reliability, and by leveraging technologies already used by your agency. When users quickly understand how to operate a new system, they do not need as much training. Technical staff members experience a shorter learning curve when they are using familiar technologies. Since reliable systems break down less frequently, less technical support may be necessary. You can also reduce training and support costs by implementing a system that shifts responsibilities for system installation, maintenance, and troubleshooting from less technical field staff to trained technical staff at the state level.

Chapter 4. Putting the Pieces Together: Designing Your System

A discussion of functionality, along with the technical system characteristics explained above, are essential parts of a specification document that describes the kind of system you wish to buy or build. Putting together these requirements is simply a matter of assembling a functional description of the system and identifying the technical characteristics that are important to you. Sections of your requirements document may include a functional description, explanation of the operating environment, and technology preferences.

The functional description outlines what the system does, both overall and on a function-by-function basis. Be sure to identify (1) inputs, (2) processing rules, and (3) outputs. Indicate areas in which the system might need to be flexible. For example, if you need to accommodate new kinds of assessment instruments or flexible reporting capabilities, be sure to make this part of the specifications. Your functional description should also indicate which parts of the system are related and explain how and when they are used. These considerations may be important for ease of use, providing adequate access, security, and more.

The explanation of the operating environment describes your user groups, where they are geographically, and what parts of the system they will access. You might also want to indicate the users' level of technical savvy or other considerations that would need to be considered in providing either enhanced flexibility or simplicity to their parts of the system's user interface. You should also identify other considerations such as system load, growth, security, and extensibility.

The technology preferences section should discuss platform requirements and other needs. For example, if your users have Apple computers but no PCs, the system must be accessible using an Apple computer. If data security is an issue and you think the system will be Internet-based, then you might indicate that certain functions send data in an encrypted format (using a technology such as SSL). Overall organization standards/preferences should also be identified. For example, you might indicate that the system should use an Oracle database if that is your agency's IT requirement.

The requirements document that you assemble should describe essential functional and technical characteristics of your data system. It should be detailed enough to allow an internal software development group to develop a technical system design that meets your requirements. You should be able to use it as a guide in determining the how well a vendor's offerings meet your needs.

System Architectures

Once you have identified your functional and technical needs, developed an understanding of the characteristics of systems that will help you meet them, and put together a specifications document that describes your requirements, it is time to match your

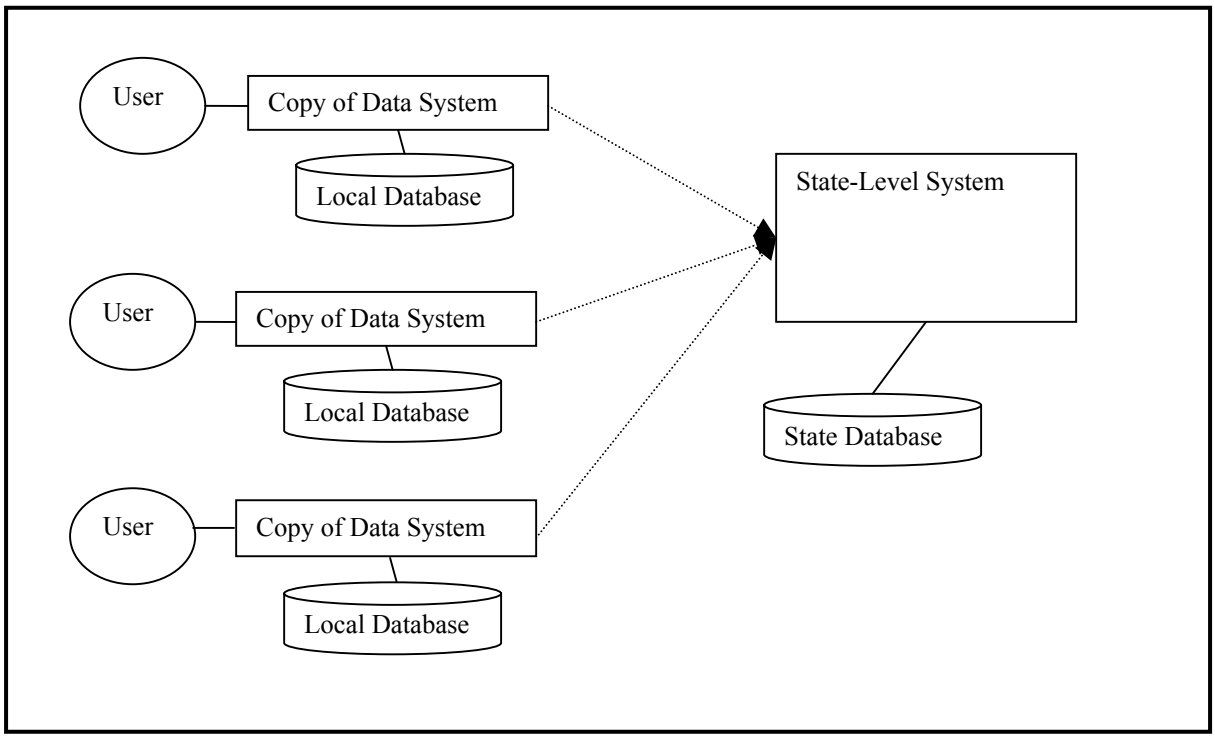
Standard-of-the-art offers two types of systems: Onsite Systems and Web-based Systems.

needs with possible data systems. The current standard in systems designs offers two options to planners. You are likely to see one or both approaches as you look at possible system solutions, whether designed by your internal system development staff or proposed by an outside vendor. Each approach has advantages and disadvantages.

Onsite Systems

An onsite system, as illustrated in Exhibit 4–1, provides separate copies of your software at each location. Data from individual programs or sites are entered locally. All functions are available locally, including reports. Information from each program or site can be packaged and sent to the state where they are used for generating NRS tables, producing other reports, or other functions.

Exhibit 4–1
Onsite System Architecture



Onsite systems allow individual programs to manage and maintain student records and other data that are critical to their operation. They usually provide ready-to-use reports, and may also provide more latitude for program staff to explore and analyze their own data. They may also eliminate personally identifiable information from exported data, providing enhanced confidentiality for students whose data are sent to nonlocal places.

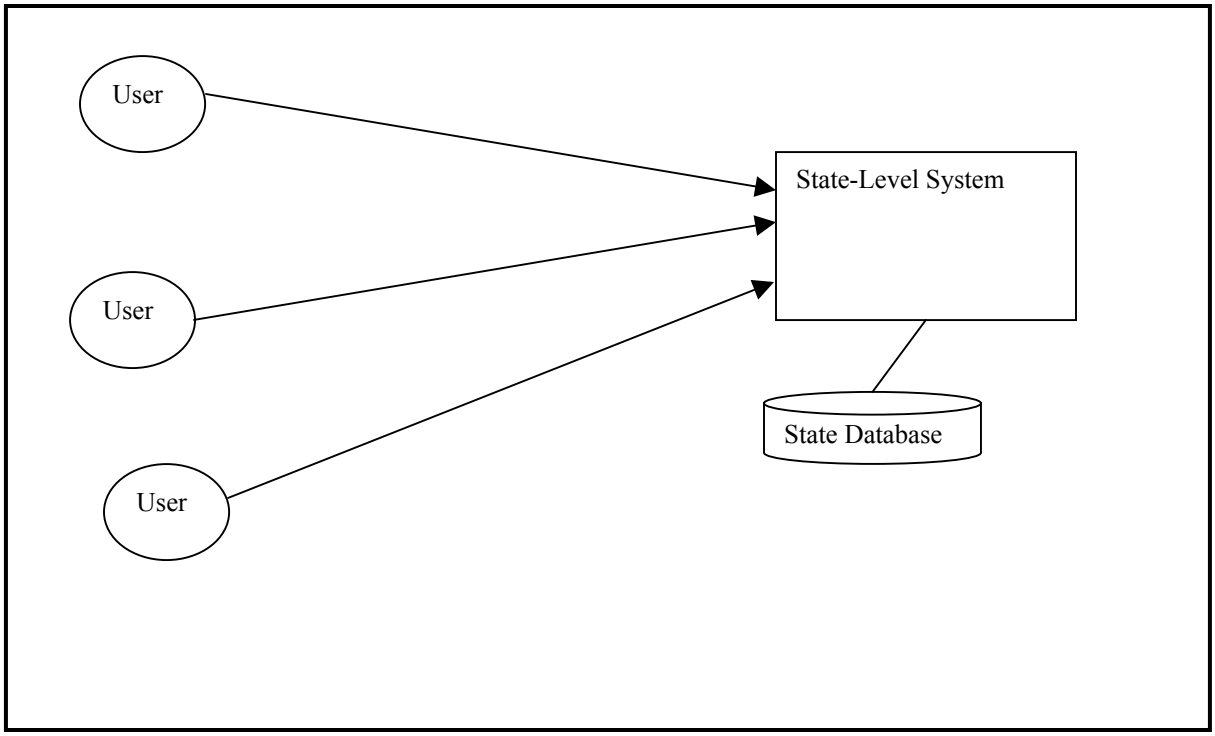
However, onsite systems have some drawbacks. For example, they are often built on less robust platforms and are therefore more susceptible to reliability problems. Since they are typically maintained and handled by inexperienced computer users, they have a tendency toward database integrity problems and data loss due to mishap. Simple problems are sometimes

compounded when field-based staff lacks sufficient technology expertise to install, maintain, perform data backups, and troubleshoot. Training and technical support is costly because a larger number of staff needs assistance, and local staff often requires much more assistance. In addition, access to onsite systems is limited to those having the software and relevant student records data installed on their computer.

Web-based Systems

A Web-based systems, as illustrated in Exhibit 4–2, provides access to a single software system over the Internet for users wherever they are located. The system can be used by anyone with an Internet connection, a Web browser, possibly a small piece of software called an "applet," and a valid user name/password.

Exhibit 4–2
Web-based System Architecture



You can provide access to individual programs, state agency staff, administrators of funding sources, legislators, and even the public if you wish. Levels of access may determine available functions for each individual. Because system administration is provided at the state level, setup requires little effort on the part of each program. Local programs spend less time managing their computers, leaving more time for them to manage their programs. Training is simplified. Statewide data are always up to date because programs submit data records directly to the state. Also, data quality may be improved with state IT professionals performing system maintenance and backups.

However, Web-based systems are often more complicated and require more technical expertise to install and maintain than traditional desktop systems. They often require more advanced infrastructure and can be more costly. For example, all of your users must have a sufficiently fast, reliable connection to the Internet to use Web-based systems. In addition, extra care must be taken to protect the privacy of students whose personal information is stored in a large statewide database.

Frequently Asked Questions (and Answers)

Earlier in this guide, we discussed how to identify your requirements and assess how suitably a system's technical characteristics meet your needs. This section answers some frequently asked questions and offers suggestions for putting your system together.

Q: Should I care what kind of database my system uses?

A: Most software does not run as a completely independent entity. Rather, it relies heavily on the building blocks used in its construction. Among these is the database management software that stores and retrieves information from the computer's disk. Without this capability, your system would not function properly. The technical characteristics of the database manager are essentially inherited by your application, so it is important to understand how well it meshes with your reliability, performance, security, extensibility, and other requirements.

Desktop database management systems, such as Paradox and dBase, are easier to deploy in the field but can be susceptible to reliability problems. They can also corrupt data when a program crashes or inexperienced users turn off their computers without properly shutting down. Systems such as Oracle or MS SQL Server require more technical expertise to manage and can be more expensive, but they are also more robust.

Q: Why is the operating environment important?

A: Your operating environment poses significant challenges that must be considered if you want your new system to work effectively because it is a factor about which you may have less than optimal control. The computers your users have, available communication networks, and agency IT standards are constraints within which the system must work. For example, if field staff has slow, unreliable, or nonexistent Internet connectivity, you may find implementation of a Web-based system difficult. If you want to be able to accommodate users with Apple computers, or other non-Windows systems, you must find a solution that addresses this constraint. If your agency's Internet connection tends to become overburdened with traffic, you may need to increase capacity as part of your system procurement or provide a non-Internet method of access.

Q: How do I know a system is well built?

A: Characteristics of a system's design and implementation can affect its effectiveness from stability to usability and beyond. Unfortunately, quality can be difficult to assess because it may require the analysis of a range of components that are both technical and often hidden from view. The best way to assess a program's effectiveness is to consider scenarios under which the system must work, and then do some benchmark testing or talk with others about their experience with the system.

Q: Do I really need to plan for system changes?

A: Over time—often not much time—your student record-keeping needs will change. Sometimes a change necessitates a revision of the software, which can be costly and time consuming. However, certain kinds of changes can be anticipated and addressed smoothly with the help of a little foresight. For example, handling new assessment instruments should be as easy as entering new scoring levels into a database, rather than having to make a more intensive code change. If you have a feel for the kinds of things that may change and consider how your system will need to change in response, you may well prevent an unpleasant surprise.

Q: Is it better to maintain summary data or detailed data?

A: A system that maintains detailed information is more flexible than one that stores only summary information. From detailed attendance, assessment, enrollment, and other information, you can answer a wider range of questions than you can with summary data alone. For example, systems that track monthly, rather than total, attendance hours provide a way to examine attendance patterns over time. This, in turn, can help you find periods of lagging attendance, which may show how well your instructional calendar meets student needs or suggest cost-saving operational changes. You can also use detailed attendance data to find out when certain groups of students tend to drop out. This kind of knowledge may help you to fine-tune follow-up efforts. Use individual assessment scores to look at levels of student achievement statewide, by program, or even by individual instructor. Counts alone may not enable you to find the answers you need.

Q: Can you name some "must-have" features?

A: You may want to consider some of the following specific features when putting together a system to help make your system more flexible without adding much in the way of cost.

- **Report Options.** *Canned* reports are helpful in answering important or commonly recurring questions about your program. Which populations do you serve? Are your students advancing? At a minimum, your system should meet NRS reporting requirements. However, you can respond to a wider range of analytical needs and data management issues by adding an ability to run specific, pre-programmed reports on subsets of data.

  For example, you can add a filtering option to print a modified version of NRS Table 4 that reports achievement for students by age and ethnicity. This may enable you to

look at student achievement of a particular at-risk group. A different report filter would let you compare student advancement rates for city dwellers with those who live in the suburbs. Adding relevant *report filters* provides a powerful, easy-to-use way of helping you understand your students and their adult education programs. This kind of capability is generally not expensive to include as an add-on to your system.

- **Data Export.** A data export function can help you to run reports using external tools, prepare reports using external data, or share information between state information systems. For example, exported goals and advancement information could be cross-checked with state GED records to accurately determine how many students have met their high school graduation goal, without having to follow up with each individual. Similarly, you could match students who have a goal of attending a postsecondary institution with community college or state university records. You could also compare enrollment patterns with external demographic data to identify the neediest locations.

- **Filtering/Archiving.** Detailed data are helpful because they open a wide range of possibilities for analysis. However, they can also take up a considerable amount of space in your database, take quite a bit of time for your computer to process, and may be cumbersome for your users to handle. Furthermore, data for students that have met their goals or dropped out are not regularly used. To alleviate these issues, consider a data filtering or archiving function. A data filtering function hides data that are not used frequently. For example, a system might hide the names and records of inactive students. An archive feature may move unused data to another location from which they can be recalled when a student re-enrolls, or if it they are needed for reporting or analysis.

Glossary

Accessibility	The means by which users will access a system
Bandwidth	The amount of data that can be transmitted in a fixed amount of time by a network connection or interface. Bandwidth represents the capacity of the connection.
Benchmark testing	A means of measuring system performance by having it perform a set of well-defined tasks. May be used to compare performance between systems.
Canned reports	Predefined reports in the application's menu structure where end-users can access programs to generate reports. Information in the reports can be used to answer important or commonly recurring questions.
Compatibility	The degree to which capabilities or needs of technologies work coincide with other technologies or in-house expertise.
Exported data	Data contained in onsite systems that are sent to another location.
Extensibility	The ease with which the functionality of a system can be extended or modified to meet growing needs.
Functionality	The functions of a system.
Inputs	Information that must be entered or obtained from an external source.
Interoperability	The ability of a data system to work with other systems within or outside an organization.
Maintainability	Ease with which software can be updated or fixed by qualified technical staff.
Onsite System	System design in which separate copies of your software are installed in field locations. All functions are available locally, including reports.
Operating Conditions	The conditions under which a system will run. Examples include number of users, available technologies, intensity of use.
Outputs	Reports, data, graphs, and other information products that can be obtained from a system.
Platform	A collection of technologies a system needs to operate: the computer operating system (Window/Linux), database management system (e.g. Oracle), programming language, and a Web server on Web-based systems.

Glossary (Continued)

Processing Rules	Rules that specify how to determine whether inputs are valid, how data are used and managed, and how outputs are generated.
Reliability	A system's stability, database accuracy, and ease of recovery from problems.
Requirements Document	A specification that contains a functional description of the system and important technical characteristics.
Scalability	A system's ability to perform, given an increasing workload.
Usability	Degree to which a system is easy to operate by its users.
User interface	The aspects of a computer system that can be perceived by the human user, and the commands and mechanisms used to control its operation and input data.
Web-based System	Provides access to a single software system over the Internet for users wherever they are using a Web-browser.
Web-browser	Software program that allows you to access Web pages on the Internet (e.g., Microsoft Internet Explorer, Netscape Navigator).