Introduction

As one of the largest and fastest growing school boards in Ontario, The Dufferin Peel Catholic District School Board is responsible for over 82,000 students enrolled in 102 elementary and 18 secondary schools. The teachers in these schools, located in the municipalities of Mississauga, Brampton, Bolton, Caledon, and Orangeville, all need to use documents known as Curriculum Support Materials. These documents are used to help them teach according to the guidelines of the Board and the Ministry of Education.

Through earlier interviews with several key individuals at the Board, we were able to attain an understanding of how these materials get to the teachers that need them, the problems that exist with this system, and what is needs to be done about these problems (see Appendix 1: Interview 1, Appendix 2: Interview 2, and Appendix 3: Interview 3). Further discussions with various stakeholders resulted in alternatives to the current system, and finally a decision to proceed with the most cost-efficient and beneficial alternative system. This document outlines the analysis of the current system and the alternatives considered, the reasons for choosing the proposed system, and concludes with a requirements specification for the proposed system.

Analysis of the Current System

Curriculum Support Materials are either created by the Board's Program Department or sent to the Board by the Ministry of Education. They range from evaluation methods for standardized testing to ideas for enhancing a math lesson and are anywhere from 1 to 300 pages in size. All of the documents are stored in hard copy format among three locations in two different buildings; two at the Board office and one a few blocks away. There is no inventory kept of these documents. The Program Department distributes compulsory materials to whichever schools are required to have them. However, teachers and principals also request these documents from the Program Department when they need extra copies, or non-compulsory materials.

Figure 1: Context Data Flow Diagram for Ordering and Distributing Curriculum Support Materials
Distributing Curriculum Support Materials

When support documents are created by, or sent in to, the Program Department, the Assistants to the Program Coordinators have to figure out how many copies to send to each school. For example, if a document comes in for a Grade 3 English Program, they have to figure out how many Grade 3 teachers will need that document. Some schools may want one copy to share between all their Grade 3 teachers, while some may want one copy for each Grade 3 teacher.

The Assistants then have to fill out a Print Requisition Form (see Appendix 4: Print Requisition Form) for each school and take the form and the document to be copied over to Printing Services. This form contains such information as the quantity and format of the copies to be made (binding, tabs, color, etc.), the name and budget code of the school that requires the copies, and the date that the copies are required by. It is in a triple carbon format such that one copy stays with the Assistants, one copy goes to Printing Services, and one copy goes to Accounting to charge the printing job to the appropriate budget. In this case, the budget charged is the Program Department’s, so they receive a Debit Memo from Accounting for the cost of the copies.

Small Print Requests are packed by Printing Services and then shipped by the Board’s In-house Courier Service to the school.

For large printing requests, the Assistants have to count and pack the completed copies so that the Board’s In-house Courier Service can ship them to the schools. These large shipments occur mostly in August and September when the schools are preparing for the new school year. During this time the workload is so heavy for the Assistants, that a temp must be hired to help out.

Figure 2: Level 0 Data Flow Diagram for Distributing Curriculum Support Materials
**Ordering Curriculum Support Materials**

Typically, when a teacher needs support material they do not know what exact document they need or sometimes they do but they do not know the exact title. For example, a teacher may want one of the support documents for Grade 7 Math that they saw at a symposium earlier in the year, but they do not remember which document, which symposium, or what the title is. Or perhaps they do remember which document, but they do not remember the title.

To acquire this document, first a teacher may look around their school, checking with other teachers if they have the document they are looking for. If they do not find it, they then call the Board office. They do not always know who to speak to, so they have to call several people before they get to the Assistant to their appropriate Program Coordinator.

Another case is that the teacher simply wants a copy of a document that already exists at their school. In this case, they will call the Board office to request copies. Again they may not know exactly who to speak to. When they do reach an Assistant, the Assistant will tell them to make copies at their own school if it is a small document.

In either case, if the copies need to be printed at the Board, the Assistant fills out a Print Request Form for the teacher and takes it to Printing Services. Printing Services will then take the order and print the copies when they can. After they do print the copies, they send a copy of the Print Request Form to Accounting and Accounting sends a Debit Memo to the school for the cost of the copies. Finally, either the ordered copies will be shipped to the school by the In-house Courier, or the teacher that ordered them will come to the Board to pick them up.
The Problems with The Current System

The PIECES Framework for Identifying Problems provides a good outline of the nature and range of the problems associated with the current system.

**Performance – Does the proposed mode of operation provide adequate throughput and response time?**

No. It was estimated that only about 10% of teachers that search for Curriculum Support Materials will find them and that, if they are found and must be printed, it could take up to two days to actually arrive at their school.

**Information – Does the proposed mode provide end users and managers with timely, pertinent, accurate and usefully formatted information?**

No. Currently, teachers do not know what materials are available, the Program Coordinators have no way of knowing which schools have which materials, and the Assistants to the Program Coordinators have no way of knowing which documents are located among the three locations.

**Economy – Does the proposed mode of operation provide cost-effective information services to the business?**

No. Teachers waste a lot of time searching for materials, finding out if materials exist, and re-creating documents that already exist. These teachers make an average of $40/hr, so this is wasted money. Plus, the Assistants to the Program Coordinators spend a lot of time searching, counting, packing, and shipping documents and sometimes need a temp to help out. All of this is also costing money in unnecessary salary.

**Could there be a reduction in costs and/or an increase in benefits?**

Yes. Costs can be reduced by an improved system that somehow makes teachers aware of what materials are available and that makes it easier to locate and distribute documents. The major benefit of this would be an increase in the quality of education for the students, since their teachers would be able to use more of the support materials in classes. Also, any reduction in cost could help the Board to meet the budget provided by the Provincial Government, or reallocate the saved funds into other forms of resources for schools.

**Control – Does the proposed mode of operation offer effective controls to protect against fraud and to guarantee accuracy and security of data and information?**
Although the current system does provide good security in that only authorized personnel can access the documents that are being stored, it does not guarantee any accuracy of information in terms of which documents are stored where.

**Efficiency – Does the proposed mode of operation make maximum use of available resources, including people, time, flow of forms?**

No. In terms of people and time, as stated earlier, both teachers and the Assistants to the Program Coordinators have to waste time searching and a temp has to be hired to deal with the distribution workload. Furthermore, there may be technology already in place at the Board that could reduce the need for hard copies to even be printed. Therefore, space, time, and possibly the use of available technology are being wasted.

**Services – Does the proposed mode of operation provide reliable service?**

Although the delivery of documents by the in-house courier service is reliable, no one can rely on getting accurate information about what is sent or stored anywhere.

**Is it flexible and expandable?**

No. The amount of documents in the current system is constrained by the space available among the three locations.

Through this analysis, and after speaking with those that are affected by the system, we were able to summarize the problem as follows:

1. There is no formal inventory or tracking kept of the materials
2. There is limited space for these materials
3. The materials are not centralized in any one location

These problems result in the three main undesirable characteristics of the current system:

1. Teachers waste time trying to track down materials that they would like to use because they do not know what exists or how to search for what does exist unless they know exactly what they are looking for.
2. The Assistants have to waste time searching for materials that teachers request and the distribution workload for mandatory materials is so heavy that temps must be hired to help out.
3. There are materials that are not being used because teachers do not know that they exist or because they cannot be found.

There are several monetary costs associated with these problems. For example, suppose, in the course of one year, that 1,000 teachers spend 30 minutes looking for a support document. At an average rate of pay of $40/hour for teachers, that works out to 1,000 x 0.5 x $40 = $20,000 spent, just for teachers to search for the materials they need. In addition, there is the intangible cost of students not benefiting from the use of materials that teachers do not know exists.
Requirements Analysis

Objectives for New System

After determining what the problems were, we needed to discuss what the management and other users felt were the most important objectives for improving the system. In speaking with a representative of each user group, we were able to come up with a concise list of goals for a new system (see Appendix 2: Interview 2). The new system should:

- Allow management to know what materials were sent out to which schools
- Allow teachers to know what materials are available
- Make materials easy to locate for all users (i.e. no wasted time or money)
- Eliminate the need for a temp to help out with the distribution of materials
- Be easily updateable
- Free up as much space as possible

Scope of the Problem

Our analysis of the current system showed that there was a definite need for improvement. However, due to time and budget constraints, it was determined that any proposed system would only deal with the aspects of distributing and ordering with respect to the Program Department and the Schools. Therefore, the system would create little or no change in Accounting or Printing Services processes.

After we established the Scope of the problem we intended to provide a solution for, we carefully evaluated the alternative solutions to this problem.

Criteria for Evaluation of Alternatives

Before assessing the alternatives that we would be considering we established criteria for evaluating these alternatives. This evaluation criterion was based on the combination of the Board’s & the O.M.S design teams shared objectives. These objectives were the product of one of the initial meetings that took place. The defined criterions for evaluation are as follows:

1. **Search Time:** This refers to the time taken for a teacher or administration to find out whether their support material is available. It also determines the ease of use of the current system for administration and teachers.

2. **Physical Space:** This refers to the amount of storage space that is required to store support materials.

3. **System Awareness:** This refers to the awareness of teachers that support materials are available and accessible.

4. **Security & Control:** This refers to how much control administration has over the Support Materials. In other words, can they easily allow access to new teachers and remove past teachers off receiving materials. Also the system should only be accessible to administration and teachers.
5. **Waiting Time**: This refers to the period of time teachers must wait before they receive the Support Materials they request, or the time it takes a teacher to print off his or her own Support Materials and photocopy them manually if necessary.

6. **Costs (Developmental & Operational)**: This refers to the cost to create this system (development costs) and the continual costs of using and maintaining the system (Operational costs). This is primarily determined by the cost/benefit analysis given in detail in the *Analysis of Alternatives* below.

7. **Ease of Updates**: This refers to how easily it is to add new Support Materials to the system and remove unused, unnecessarily large documents from the system. It also includes any other types of updates that are necessary.

8. **Records**: This refers to whether the system keeps accurate records on which schools have requested and received which materials, what materials have been distributed to which schools, and all the costs involved.

**Determining Alternatives**

Based on the above criteria our design team together with representatives from the Board brainstormed and came up with a few good alternative systems (see Appendix 5: *Group Meeting 4 – Determining Alternatives*). We made sure that the alternatives took into consideration the objectives of management determined earlier. We then used the constraints established earlier to help us narrow down our list to the following three alternatives, all of which proved to be an improvement over the current system:

**Alternative #1: “Media CD Catalogue System”**

The first alternative involves:

1. Gathering all the paper Support Materials from the present three storage locations
2. Digitizing these paper documents
3. Storing the Digital documents as well as each of the document’s attributes on a database.
4. Developing a software application that allows the database to be searched according to the document’s attributes.
5. Storing this database as well as the software application on CD format of which each school will receive its own copy.

**A More Defined Look at the Systems Processes/Capabilities**

This CD catalogue system will allow the user to find the Curriculum Support Materials they need using keyword searches or searching by field. All the documents will be stored in digitized format along with the application on a CD. This CD will be provided to each school and an updated CD will be sent out to each school every month. Once a required document is located the teacher will be able to view the document in PDF format with a free PDF viewer (Adobe Acrobat Reader). These viewers are already accessible at all schools. In addition to just viewing a document, teachers will be able to print the required documents or specific pages from a document on one of the school’s printers.
Alternative #2: “Phone-In Order Database System”

The second system involves:

1. Gathering all the Support Materials from the present three storage locations
2. Digitizing these paper documents
3. Storing the Digital documents as well as each of the document’s attributes on a database
4. Developing an In-house database software application that allows the database to be searched according to the document’s attributes

A More Defined Look at the Systems Processes/Capabilities

This system is similar to alternative 1 in that all information is digitized and stored on a searchable database. However the database is housed on a dedicated server at the Board instead of on a CD format. Users can find the Curriculum Support Materials they need using keyword searches or searching by field. Since the database & application for the digitized support material will be setup at the Board office, it will only be accessible by the Board’s administration, ensuring the security and proper distribution of Support Materials.

In order for teachers to request Support Materials, they will have to call the Board office (on a special telephone number known to all administration and teachers) and request the telephone-op to send the required materials. The teacher will be required to verbally disclose the schools budget code as well as the documents that are required. The operator will then need to search the database for the required support material. Once the operator finds the document they will request the required amount of copies from Printing Services electronically. Printing Services will receive this request in the form of an email form, that they can print off and use to fill the order with. In addition to this the system will electronically notify accounting to debit the schools account which is specified by the school’s budget code. Records of both these transactions will be documented on a relational database. Finally the ordered document will be shipped to the teacher. Should an order need to be cancelled, the teacher will be responsible to call the telephone-op and verbally cancel the order. The cancellation request will be manually entered into system and adjusted by Printing Services and accounting.

Alternative #3: “Internet Database Order System”

The third system involves:

1. Gathering all the Support Materials from the present three storage locations,
2. Digitizing these paper documents
3. Storing the Digital documents as well as each document’s attributes on a database
4. Developing an Online database web application that allows the database to be searched according to the document’s attributes from the Board as well as remote sites.
Requirements Analysis

A More Defined Look at the Systems Processes/Capabilities

The creation of an online web site will permit the user to search by field or use a keyword search on this database. The database will be consistently maintained, by adding new Support Materials when needed. A security login will be in place to allow proper access to materials by only administration and teachers, with certain materials only accessible by administration. Teachers can simply view and/or print off the Support Materials using existing hardware/software (Adobe Acrobat, etc…) at home or office. They will also have the option to fill out an on-line form to request multiple copies of large Support Materials. Printing Services will receive these email requests and a copy will be sent to the Accounting department.

After the documents have been produced and mailed out a production fee will be charged to the schools account. For an on-line request to Printing Services concerning a large document the budget code for the school as well as the principal’s password will be required. This will ensure a safe/authorized transaction. Should an order need to be cancelled the teacher who requested the curriculum supply documents will be required to make a cancellation call directly to Printing Services. The Printing Services department will then cancel the order and notify accounting not to debit the schools account. All ordering transactions will be recorded along with all pertinent information on the database. This database will be accessible to the administration of the Program Department to see what schools have requested and all costs involved.

Analysis of Alternatives

The criterion that we established above of 1) Search Time 2) Physical Space 3) System Awareness 4) Security & Control 5) Waiting Time 6) Cost 7) Ease of Updates and 8) History Records are used further in analysis and evaluation of the alternative systems. Of the criteria mentioned above, the system cost has the most initial significant importance. The system cost is the actual monetary cost of developing and operating the system. We will begin by looking at the cost of the current system as our first alternative.

Cost/Benefit Analysis of the Alternatives

Operational Cost of the Current System:

If we compare the current system to the possible alternative systems it is easy to see, from the cost analysis data below (see Table 1: Cost Analysis of the Current System), that staying with the current system comes with a high cost. The operational costs alone for the current system stands at approximately $27,267 per year (see Appendix 6: Detailed Monetary Cost Analysis of the Current System). This dollar amount includes the cost of time spent by teachers to find Curriculum Support Materials. It includes the cost to process orders for Curriculum Support Materials requested by the schools, the cost to process distribution of mandatory Curriculum Support Materials by the Board to its schools, and lastly the cost for production and shipping of these documents.
Operational & Development Costs of Alternative Systems vs. Current System:

We have already valued the operational costs of the current system at $27,267 for the year. The proposed alternative systems that we have chosen to consider include:

- Media CD Catalogue System
- Phone-In order Database System
- Internet Database Order System

For each of the above systems, a detailed cost analysis was carried out (see Appendices 7 – 9: Detailed Cost Analyses). The results helped us to gain an understanding of the costs involved in developing and maintaining all the proposed alternative systems and gave conclusive evidence that a more efficient and less costly solution is available in comparison to the current system. In our cost analysis we calculated the approximate monetary amount needed to develop and operate each of the proposed systems for the initial year as well as the continued operational costs for subsequent years. The following table (see Table 2: Minimal Cost Associated with Each Alternative System) shows the total amount of funds that are required to develop and operate each of the proposed systems for an entire year. The difference in savings to the current system is also noted in the table and represents the monetary benefits (i.e. reduction in costs) that are possible if one of these new systems is implemented.

<table>
<thead>
<tr>
<th>System Type</th>
<th>Development Cost</th>
<th>Operational Cost</th>
<th>Total Cost</th>
<th>Cost Difference from Current System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current system</td>
<td>$0</td>
<td>$27,267</td>
<td>$27,267</td>
<td>N/A</td>
</tr>
<tr>
<td>Media CD Catalogue System</td>
<td>$7,040</td>
<td>$12,900</td>
<td>$19,940</td>
<td>$7,327 less</td>
</tr>
<tr>
<td>Phone-In DB Order System</td>
<td>$5,660</td>
<td>$14,930</td>
<td>$20,590</td>
<td>$6,677 less</td>
</tr>
<tr>
<td>Internet DB Order System</td>
<td>$8,040</td>
<td>$10,100</td>
<td>$18,140</td>
<td>$9,127 less</td>
</tr>
</tbody>
</table>

It is very easy to see that the total cost for development and operations for all alternative systems are considerably less than the operational costs of the current system. Therefore, from a cost analysis view, the Board would stand to save money by choosing an alternative system. These savings are enough to justify going with a new system. However, in choosing one of the new systems, cost may not be the only deciding factor. For this reason our team also looked at the possible benefits for each new system, compared to their respective costs (see Table 3: Monetary, Tangible & Intangible Benefits for Alternatives).
### Requirements Analysis

#### More Detailed Analysis of the Alternatives Using Criteria for Comparison

Once we identified the costs and benefits for each alternative and the current system we used this in addition to our criteria of comparison to further evaluate the alternatives in more detail. We did this in the table below (see Table 4: Analyzing the Alternatives Using Criteria for Comparison) by listing alternatives across rows and evaluation criteria across columns. All criteria were rated on a scale from 1-5, one (1) being the worst rating and five (5) being the best rating. For example, if we gave Search Time a rating of 1, it would mean that it takes the most amount of time to find Support Materials teachers need. If we gave Physical Space a rating of 5, it would mean that this system takes up no space to store Support Material. We also agreed that the TOTAL would constitute the deciding factor as to which alternative would be the best one.

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Media CD Catalogue System</th>
<th>Phone-In DB Order System</th>
<th>Internet DB Order System</th>
</tr>
</thead>
</table>
| Monetary | • **Costs**: $19,940  
• **Rank**: 2<sup>nd</sup> highest cost  
• **Payback Analysis**: system paid for in one year + $7,327 savings  
• **Operational Costs After First Year**: $12,900 | • **Costs**: $20,590  
• **Rank**: Highest cost  
• **Payback Analysis**: system paid for in one year + $6,677 savings  
• **Operational Costs After First Year**: $14,930 | • **Costs**: $18,140  
• **Rank**: Cheapest cost  
• **Payback Analysis**: system paid for in one year + $9,127 savings  
• **Operational Costs After First Year**: $10,100 |
| Tangible | • Reduces search time because not through a remote network  
• Eliminates need for storage space  
• Reduces waiting time  
• Saves paper since only desired pages needed to be printed | • Reduces Search time  
• Eliminates need for storage space  
• Database updated within seconds  
• Increased security determined by administration | • Reduces search time  
• Reduces waiting time to receive documents  
• Database updated within Seconds  
• Eliminates need for storage space  
• Saves paper since only desired pages needed to be printed  
• Increased security with password access |
| In-tangible | • More portable  
• Board Secretary can focus on her job as opposed filling orders and debit memos  
• Increases quality of education for students by reallocating saved funds | • If you cannot locate a document you can actually speak to someone who will help you  
• Easier to order  
• Increases quality of education for students by reallocating saved funds | • Easily accessible to teachers & Board employees  
• Easy to keep track of who orders what  
• Reduces frustration for administration searching and retrieving documents  
• Board Secretary can focus on her job as opposed filling orders and debit memos  
• Increases quality of education for students by reallocating saved funds |

Table 3: Monetary, Tangible & Intangible Benefits for Alternatives
### Summary of Findings

**Current System:**

We have evaluated the current system already, however, summarizing the data in Table 4, we find that searching takes a long time and that there is a lot of physical space being taken up. The waiting period for teachers to receive materials is also very long and the costs involved in maintaining the system are unacceptably high. The system awareness and ease of updates is worse than that of any other alternative system. Record maintenance is average in comparison to other systems but could be better and the only pleasing feature of this system is its security of materials.

**Alternative #1: “Media CD Catalogue System”**

This alternative uses miniscule amounts of physical space. In addition to this teachers will have a good idea that the system exists (system awareness) because we have included a training package to show them how to use the CD system (included in development costs). Other benefits for this system include a short waiting time and search time to obtain the required document. Search time is quick, however when new support material is received by administration at the Board, this material cannot be distributed until the CD is updated. This means some teachers may search and not find newly published material until a new update CD is sent. Another downside to the CD system is that there is a high cost associated with building the database and maintaining it on a monthly basis. The Media CD system has other shortcomings that include the fact that there is no method to keep track of how many Media CDs were sent, who has access to the CDs and how often the CDs are used.

**Alternative #2: “Phone-In Order Database System”**

This alternative has the maximum reduced search time for teachers and administration. It also takes up no physical space and will enable perfect security and control by administration since they distribute all information. Another positive factor is the fact the database is located at the Board.
Requirements Analysis

This makes it very accessible and it can be updated instantly. The database will allow administration to keep records as to who receives what, when an order was sent, how much it cost, etc. A downside to this system is that teachers may not know whether it exists (little system awareness), or where to call to get Support Materials. If they do order materials there may be a long waiting period of up to two days since the materials will have to be shipped to them. This long waiting period stands as a major obstacle in the implementation of this system. Adding to this downside is the fact that it costs more to setup and maintain this system than Alternative #1 and Alternative #3.

Alternative #3: “Internet Database Order System”

This alternative has the highest total out of all proposed alternatives and the current system. Its search time has been drastically reduced since all teachers and administration have access to the web and can find what they’re looking for via the web application searching tools. This system will take up no physical space since all Support Materials will be digitized over the Internet database. Teachers and administration using passwords and multi-level access security features will maintain security and control over the documents. In this way administration has ultimate control as to who has access to what. Updating will be instant since the web database can be updated with new materials at any time allowing teachers to gather the most recent Support Materials without delay. The system will record statistics for administration such as who accessed what documents, when they ordered, how often and what they order etc. If a teacher requires an order to be cancelled they will have to call Printing Services and it will be manually cancelled. Information on documents ordered will be maintained on an account screen for the teacher to view. Awareness of the system will be increased through the training given to teachers/principals. Waiting time is also very short good since most individuals can print off materials they need directly off the web. At times they may require documents in large quantities and will need to fill out an electronic request form. Due to this there may be a short waiting period. The cost of setup and maintenance is the lowest but not free which is why it does not receive a perfect rating.

The Best Alternative

From the evaluation done above, the numbers show that Alternative #3: “Internet Database Order System” is by far the best choice off all three alternatives. In comparison to Alternatives #1 and #2 it ranked over 11 points higher. Across the board physical space is reduced for all the Alternatives. However, Alternative #3 offers the most cost effect solution (see Table 2: Minimal Cost Associated with Each Alternative System) and addresses all the concerns that the Board needs solved by a new proposed system. It is easy to see that no matter which Alternative is selected, they are all far superior to the current system. Yet the best-computerized solution for a new method in storing and distributing Curriculum Support Materials to teachers and principals would have to be Alternative #3: “Internet Database Order System”.

Verification Using PIECES

In order to verify that Alternative #3: “Internet Database Order System” is the best solution among the other Alternatives and the current system we used the PIECES framework in order to identify any problems:
Requirements Analysis

**Performance – Does the proposed mode of operation provide adequate throughput and response time?**

Yes. Materials can be found fast and printed off immediately unless they are too large to print. Even in this case, Printing Services and Accounting is notified automatically by e-mail, making wait time almost nothing.

**Information – Does the proposed mode provide end users and managers with timely, pertinent, accurate and usefully formatted information?**

Yes. The number of times a document is printed and by which schools can be recorded and entered automatically as it is being done. This provides management with an accurate account of who is using what materials. Also, printing requests for larger documents are automatically stored in the database, so the Program Department administration, Printing Services and the teachers can keep track of orders.

**Economy – Does the proposed mode of operation provide cost-effective information services to the business?**

Yes. It has already been shown in the cost analysis that the proposed system will save a considerable amount of money by significantly reducing time that teachers spend searching for materials, time spent by Assistants to the Program Coordinators, and space used by the documents, all of which costs money.

**Could there be a reduction in costs and/or an increase in benefits?**

Yes. It has been shown in the cost/benefit analysis that the proposed system will reduce costs and increase benefits such as the quality of education for the students of the Board.

**Control – Does the proposed mode of operation offer effective controls to protect against fraud and to guarantee accuracy and security of data and information?**

Yes. The proposed system can incorporate multilevel security access depending on who the user is, thereby restricting access to those that are not permitted to view certain information, or print off materials. As well only a selected few will have ultimate veto power over all system functions. This will insure protection of all information and security of data.

**Efficiency – Does the proposed mode of operation make maximum use of available resources, including people, time, flow of forms?**

Yes. The proposed system makes use of all the technology available so as to eliminate as much space used and time wasted as possible.
It eliminated the need for Assistants to the Program Coordinators to have to search for materials, and the need for them to send forms to Printing and Accounting so that they can focus on handling the distribution of mandatory materials. In addition, it allows teachers to make the most of the available support materials by making them easily searchable.

**Services – Does the proposed mode of operation provide reliable service?**

Yes. All activity is documented electronically and can be backed up so that no paper work can be lost or duplicated unnecessarily. Plus, the proposed system will run 24 hours a day, 7 days a week, meaning that teachers will not have to wait to the business day to get the support materials they need.

**Is it flexible and expandable?**

Yes. Since the same procedure is used for secondary schools and for English as a Second Language, French Immersion, and Religion Support Materials, the system can be expanded by simply adding the schools and the appropriate documents to the database. Furthermore, adding more materials does not mean using more physical space anymore.

**Our Recommendation**

Through our evaluations of the alternatives we showed that the obvious third alternative, the “Internet Database Order System”, is the best choice to replace the current system for the ordering and distribution of Curriculum Support Materials.

We have showed that the proposed system:

- Allows administration/management to know what materials were sent out to which schools
- Allows teachers/administration to know what materials are available
- Makes materials easy to locate for all users
- Eliminates the need for any temporary employees to help out with the distribution of materials
- Is easily updateable
- Frees up as much space as possible
- Saves money for the Board/schools/teachers and administration

In other words, not only is it feasible, but the proposed system (Alternative #3) also meets all the objectives determined by management, further proving that it is the best solution to problem. Therefore, we recommended that the current system be replaced by the “Internet Database Order System”.

In order to determine what needed to be done to implement our recommended solution, we performed the detailed Requirements Specification, outlined below.
Requirements Analysis

Requirements Specification

System Decomposition

System decomposition involves the breaking up of the system into its individual interfaces. These include the external interface and the inter-subsystem interface.

![System Decomposition Diagram]

External Interfaces

The external interface is actually composed of three interfaces. The first external interface is the school interface, which will use the School Application (S.A.) web page. The second external interface is the interface that the Program Department will use. This interface will run of the Program Department Application (P.D.A.) web page. Both the S.A and P.D.A. are web applications which perform similar functions however the P.D.A. web program allows expert users more access to static data on transactions in the system. The third and final external interface is the standard email interface that Printing Services will use. It will run the Printing Services Application (P.S.A.) interface. This is just a standard Microsoft Outlook email application that will be incorporated to run with our order system.

![External Interfaces for the New System Diagram]
System Functional Requirements

Our earlier discussions with teacher representatives and Program Department administration helped us to establish functional requirements for the new system. A basic understanding of this system can be drawn from the Data Flow Diagrams shown below.

The functional requirements for the S.A. are as follows (see Figure 7: Level 0 DFD for Searching for and Ordering Curriculum Support Materials and Figure 8: Level 0 DFD for Viewing Orders):

- Teachers will be able to search for Curriculum Support Materials. The system will locate all documents pertaining to the criteria they requested.
- Teachers will be able to print small documents at their school.
- Teachers will have the capability to view all documents at their school.
- Teachers must be able to order hardcopy format of larger documents online.
- Teachers must have the capability to view all orders made by their school for large documents.
- Teachers must have the capability of canceling any orders that they do not require.

The Inter Subsystem Interface for order transactions and database maintenance is used at the Board office. This Inter Subsystem has two interfaces:

1) P.D.A. interface. (Program Department's Application)
2) P.S.A. interface (Printing Services Application)

Below we have broken up the functional requirements of both the P.D.A interface and P.S.A interface. These requirements have been established from earlier meetings.
Figure 7: Level 0 Data Flow Diagram for Searching for and Ordering Curriculum Support Materials

Figure 8: Level 0 Data Flow Diagram for Viewing Orders for Curriculum Support Materials
The **P.D.A. interface functional requirements** are as follows (See Figure 9: **Level 0 DFD for Distributing Curriculum Support Materials**).

- Program Department administrators will be able to search for Curriculum Support Materials online. The system will show all documents that meet their search criteria.
- They will be able to place an online order for large & small documents to Printing Services. The system will electronically send the order.
- They will be able to retrieve statistics on which documents have been received/accessed by which teachers and the costs that were paid for the documents.

![Level 0 Data Flow Diagram for Distributing Curriculum Support Materials](image-url)

*Figure 9: Level 0 Data Flow Diagram for Distributing Curriculum Support Materials*
Requirements Analysis

Since Printing Services is also responsible for printing and copying for the rest of the Board office, our system only has a minimal effect on their current process of handling print requests. Therefore, there is only one functional requirement for the aspect of the system that involves Printing Services.

The **P.S.A. interface functional requirements** encompass the following area (Figure 10: Level 1 DFD for Processing and Sending a Print Request):

- The system will receive email orders from teachers & the Program Department for print requests. These requests will be handled by Printing Services.

![Figure 10: Level 1 DFD for Processing and Sending a Print Request](image)

In order to get a better understanding of the format of the data that is to be passed between the processes involved in each function, we spoke again to a Program Coordinator and their Assistant (Appendix 10: Interview 4). Based on the information we attained from this meeting and previous meetings, we were able to construct an Entity Relationship Diagram of the proposed Ordering and Distributing System and perform a detailed outline of the required data for each function (see Figure 11: Entity Relationship Diagram for Ordering and Distributing Curriculum Support Materials).

**Software Requirements for a Subsystem**

Figure 12 defines the inputs and outputs for each function of the P.D.A and S.A. subsystems. The P.D.A. subsystem has the same functions as the S.A. subsystem, except for the Generate Report function. Once again, this function will only be accessible by Program Department Administrators.

**Data Requirements**

For every function in the subsystems, there are inputs. The details of these inputs and their composition is explained as follows:
Figure 11: Entity Relationship Diagram for Ordering and Distributing Curriculum Support Materials
Figure 12: Software Requirements for the P.D.A. and S.A. Subsystems
System Access Data Inputs

Name: Input_School_Password, School_Name
Description: Display message prompting Teacher/Principal to enter their password.
Composition: This information is composed of 1 school name in alpha format of maximum
20 characters & 1 school password in alphanumeric format of 20 characters.
This information will be sent to Board’s server for password verification.

Name: Re_enter_Password
Description: Display message prompting Teacher/Principal to re-enter their school name
and password if it is not entered correctly.
Composition: This information is composed of 1 school name in alpha format of maximum
20 characters & 1 school password in alphanumeric format of 20 characters.
This information will be sent to Board’s server for password verification.

Document Search Data Inputs

Name: Enter_Search_Criteria
Description: The search DB application will allow the Teacher to search based on
Program Area, Strand, Topic, Target, Grade, Publication Date and Title. This
information will be used to query the DB.
Composition: This information will have a 20 character alphanumeric format. Users will be
allowed to enter 1 or the entire above search criteria. This information’s
destination will be the Board’s server where the DB and Web applications are
housed.

Print Document Data Inputs

Name: Select_Document_to_be_Printed
Description: The selected document to be printed will allow the user to chose from
numerous documents that are the result of a search.
Composition: The document to be printed will be selected by clicking on a hyper link of the
file name (standard pdf file name format) which opens up the document
automatically in a PDF viewer. This information’s destination will be the
Board’s server where the DB and Web applications are housed.

On-line Order Data Inputs

Name: Select_Document_to_be_Ordered
Description: The selected document to be ordered will allow the user to chose from
numerous documents that are the result of a search.
Composition: The document to be ordered will be selected by clicking on a hyper link that
refers to the document file name.

Name: Select_Document_Pages_to_be_Ordered
Description: The user can pick to print the whole document or a selected range of pages.
Composition: The composition of this data will involve entering numeric input of the number
of the pages in a certain range required to be printed. The user could also
just click on a hyperlink that selects all pages to be printed. The destination
of this electronic data will be the Printing Services at the Board.
Requirements Analysis

Name: Administration_Password&_Budget_code
Description: As a security feature the principal will have to enter his/her password. This will ensure all charges to the school account will pass through the Principal of the school.
Composition: The composition of this data will involve a 9 digit numeric input for the Budget Code as well a 20 character alphanumeric Administration password. The destination of this electronic data will be the Web applications that verify the correctness of the information. These applications are located on the Board’s servers.

View Orders Data Inputs

Name: Enter_Date_Range
Description: Shows all orders that were requested by a school between a certain date range.
Composition: This data will be composed of 2 date fields. These are the start and end dates respectively. Each date will be in the form of an 8 digit numeric number spaced as follows, dd/mm/yyyy. The destination of this data will be the Board’s servers where this info will be further processed.

Generate Report Data Inputs

Name: Enter_Report_Generation_Criteria
Description: The DB application will allow Program Department to generate reports based on Grade, Teacher, Topic, Publication Date, Title, # of Pages, Order Date, Order #, Order Destination. This information will be used to query the DB and return a printout of the results.
Composition: This information will have a 20 character alphanumeric format. Users will be allowed to enter 1 or the entire above search criteria. This criteria information’s destination will be the Board’s server where the DB and Web applications are housed.

Non-Functional Requirements

As with any system, in addition to the functional requirements, there are many non-functional requirements. In speaking with the Coordinator of Computers in Education and the Developer that is assigned to this project (See Appendix 11: Interview 5 and Appendix 12: Interview 6), we were able to determine many of the non-functional requirements found below.

Interface Requirements

The interface will need to be a web-based resource of curriculum support materials easily searchable for all types of users. The interface will be user-friendly to all levels of experience (from beginners to advanced users) using the system. It will have a general help screen for individuals seeking assistance. The system will act as an interface for the Programs Department, Printing Services and teachers, which will enable them to view, update, request and print support material documents.
Requirements Analysis

The interface must be viewable through any web browser (on MAC/PCs) with minimum requirements being Internet Explorer 2.0 or Netscape 2.0. Microsoft Outlook is the standard email program used at the board.

Therefore, this software will be required for all email transmissions made by this system (This is in regards to the order form in email format which is sent by teachers to printing services and accounting).

**Performance Requirements**

**Time/Space Bounds & Efficiency:**

The system will need to run 24 hours a day, 7 days a week. It will also be able to handle multiple users (Approx. 1000) at the same time, eliminating waiting time and response time. Especially since, there are at present only about 1000 requests for support materials each year. Of course response time will be dependent on connection speed of modems users have (Refer to Platform Requirements). Storage space is really not an issue since if need be extra storage facilities (hard drives) will be added, and this is relatively inexpensive.

**Reliability:**

Since the interface is online and updates/backups will be made to all system/database files regularly, the system will have great integrity for all information stored. The School Board presently has all computer components available to implement our proposed solution. Backup computer components are already in place if any of the primary components fail. This reduces the chances for services to be indefinitely taken off-line. Generally the system should have little if no downtime (Approx. 1% of its running time), excluding the first few months of initial setup and testing.

**Security:**

The system will have a high-level of security (Entry by password and user name), only allowing access to individuals who have permission. This includes administration and teachers, however administration will have the ability to adjust the database and limit the documents teachers can access. This means teachers will only be able to view and print off certain documents.

**Survivability:**

If any type of emergency occurred, the system will survive and keep running as long as the server does not go down. This of course allows the system to be broadcasted over the World Wide Web. However, a back-up of the system and server files, along with associative data (digitized support materials and other documents), will be on file at a remote safe location, so that in case a catastrophe occurs, it will not be a total information loss, just a delay in services. To ensure this, a back up of all system files must be saved to a remote location away from the School Board and its server, whenever a change has been made to the system. All support materials will also need to be backed up on a regular basis. This can be possibly done monthly or biweekly.
Operating Requirements

The system must run on a server connected to a database of files, (Which contains the curriculum support materials). The server and computer system must be protected against overheating, therefore environmental conditions (temperature, moisture, etc) must be set in order for the system to run without damaging any of its components. The server will also be located in a safe position within the office, which will not allow for accidental damage to the device.

To operate the system properly and efficiently, training is required. Mandatory training is required to update managers and administration that will use the system daily. Ideally, there will be a separate input system for new curriculum support materials to make updates relatively easy. This will require some training. All administration and teachers must have some computer knowledge to use the system to its fullest capability. Maintenance and updates will be easily accessible at the board, since all hardware/software needed to update the system are close at hand.

Availability of personnel is dependent on workload. For example, if there are a lot of documents that need to be digitized and added to the system right away, personnel may be needed to work extra hours. However, normally personnel are only required to update and manage the system during office hours. There are luckily no physical constraints on the system since all equipment is not large and therefore does not take up very much room. The description of Backup and Fallback requirements are already discussed in the Survivability section of Performance requirements.

Platform Requirements

Memory Requirements:

To insure a user can at least view a 100-page document in a reasonable amount of time it requires the computer to contain a minimum of 16 Megs of memory. However, printing services and updating managers may be required to view much larger documents, therefore in regards to their systems 64 Megs of memory is recommended.

Disk Space Requirements:

The School Boards system at present, is capable of almost unlimited disk space for data storage, therefore this section is irrelevant. Plus, teachers will be viewing files off the Boards server, which actually requires very little if no disk space.

Operating System Requirements:

Operating systems range though out the Board and its schools, therefore the system must be able to run on MAC O/S, Windows 95/98/NT/Novell.

CPU Requirements:

Since all computers at the Board and its schools have at least Pentium 75’s (or equivalent) and higher, the system must conformably run on these computers.
Requirements Analysis

Peripheral Requirements:

All printing must be done via Laser Printers for quality and speed. Since all schools have these printers this is not a costly expense. A second peripheral requirement is a digitizer unit. This unit will be used to convert documents from paper to PDF or Postscript format, so the documents are accessible over the web. The digitizer must be able to scan at least 60 pages per minute to be considered efficient.

Network/Internet Requirements:

The slowest connection though out the Board and its schools is an ISDN -> 64 Kb, which is the systems minimum requirement for connection speed. This basically means that files of 1 Meg in size should take no longer than 2 minutes to download. Although there is no standard connection speed the board also has T1 and ADSL connections, which must also be considered when designing the system so that it can be used to its full potential.

Backup Requirements:

A CD writer must be incorporated as part of the system in order to backup all documents and system files. Re-Writable CD’s will also be required to store the information. The writer must be able to write no slower that 8x and all files must be compressed using a PK WINZIP application.

Lifecycle Requirements

Quality of the Design:

Since this system is web based and will be primarily coded using well known Web programming languages, enhanceability will not be a problem for future evolution of the system. This will be especially important in correcting errors or making changes to the system in the far future. The system will also take into account future expansion of file data storage by archiving or deleting data files, which are not used. This will save hard drive space. Managing the system will be simple, since the systems software will allow administration updateable options to edit system configurations, data files and the Web Site, which provides the information.

Limits on Development:

The limit, as to the development time for the system is 2 months, since the co-op student who will be implementing the software is only on contract for this period of time and must go back to school. The physical effort to digitize the data onto hard disk will be supplied by volunteer co-op students with virtually unlimited time to do this. Resource availability is almost unlimited as the School Board has every component already available to develop the system at present. Although ideally we would like to see the lifecycle requirements continue in a spiral pattern, we believe after the initial Analysis and Design, Implementation and Evaluation are the only two aspects that will be continually addressed in the future of the systems evolution. This is due to the expense of development and other limitations.
Economic Requirements

Earlier, we discussed the Cost/Benefit Analysis of alternatives we proposed over the current system. The total costs for the current system stands at approximately $27,267 per year (see Appendix 6: Detailed Monetary Cost Analysis of the Current System). This dollar amount includes the cost of time spent by teachers to find Curriculum Support Materials. It includes the cost to process orders for Curriculum Support Materials requested by the schools, the cost to process distribution of mandatory Curriculum Support Materials by the Board to its schools, and lastly the cost for production and shipping of these documents. This is shown in Table 1 below (copied from above).

<table>
<thead>
<tr>
<th>Operation</th>
<th>Operational Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Searching Time for Teachers I</td>
<td>$20,000.00</td>
</tr>
<tr>
<td>Documents Specially Requested by the Schools II</td>
<td>$1,425.00</td>
</tr>
<tr>
<td>Mandatory Curriculum Documents sent out by the Board III</td>
<td>$2,142.00</td>
</tr>
<tr>
<td>Printing costs IV</td>
<td>$2,700.00</td>
</tr>
<tr>
<td>Courier costs V</td>
<td>$1,000.00</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td>$27,267.00</td>
</tr>
</tbody>
</table>

Table 1: Cost Analysis of the Current System

Economic Requirements dictate that the current systems Total Costs must be lower in our proposed system. We did a detailed evaluation of the both the immediate and long-term costs of the proposed system (see Appendices 7 – 9: Detailed Cost Analyses), which is summarized in Table 2 below (copied from above) as Development and Operational Cost respectively. We can see in this table that the Total Cost of the proposed system is less expensive than the current system by $9,127. Therefore, the approximate required Total Cost of our proposed system must be $18,140.

<table>
<thead>
<tr>
<th>System Type</th>
<th>Development Cost</th>
<th>Operational Cost</th>
<th>Total Cost</th>
<th>Cost Difference from Current System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current system</td>
<td>$0</td>
<td>$27,267</td>
<td>$27,267</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Internet DB Order System</strong></td>
<td><strong>$8,040</strong></td>
<td><strong>$10,100</strong></td>
<td><strong>$18,140</strong></td>
<td><strong>$9,127 less</strong></td>
</tr>
</tbody>
</table>

Table 2: Minimal Cost Associated with Each Alternative System

Human Factors

We as designers of the proposed system (the O.M.S. team members), are “experts” in the area of Human Factors. After taking courses at University of Toronto (CSC318 & CSC 428), we know that addressing human factors such as user-friendliness will reduce a lot of costs and create happier users who will not just use the system once, but will continuously return to use the system time and time again. Since we will be aiding in the development of the software, we will provide human factor conditions for the interface and do proper user testing to insure that anyone will find the system easy to use as well as enjoyable to operate. Some of the Human Factors we will outline for the interface are color of background screen, size of buttons and text, terminology used to describe things, ability to handle human error by providing proper feedback to user, sound and visual feedback for handicapped users etc…
Testability

Testing of the system will be done using both cohesion and coupling characteristics. This will insure the system is usable prior to introducing it to the general users. This will also show that the system works properly and it determines whether or not it needs further development. All test subjects must accept the system and the error rate of usage must be lower than 5% in order for the system to be considered ready. Aside from numerical data of errors, interviews and surveys must be conducted to gain knowledge of other unseen errors detected by the user. This way, we can use their input to make improvements on the system.

Test subjects must range from all user groups of the system to insure full functionality and readiness of the system. It is also recommended that the first test groups be the trainers of the actual system to their departments, since they will have the most hands on experience with the system.