AN XML BASED APPROACH PROPOSING AN EFFECTIVE SOLUTION TO THE DATA MANAGEMENT ISSUES WITHIN THE CONSTRUCTION INDUSTRY

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ENGINEERING

UNIVERSITY OF FLORIDA

2006

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Duzgun Agdas

To my family for being there every time I needed them.

ACKNOWLEDGMENTS

I thank my chair, Dr. Ralph D. Ellis, and the members of my supervisory committee, Dr. Charles R. Glagola and Dr. Michael C. MvVay, for their mentoring. Special thanks go to Dr. Ellis, as his willingness and experience were invaluable contributions to the successful completion of this thesis.

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Abstract of Thesis Presented to the Graduate School
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December 2006

Chair: Ralph D. Ellis
Major: Civil Engineering

The construction industry has long been known as lacking in IT investment and implementation. One of the most severe drawbacks of the phenomenon is observed in data management issues. As an industry characteristic, construction projects produce a vast amount of data from various different working groups, which makes the data management nearly impossible with traditional methods.

There have been various projects to solve this problem, to provide a methodology that will provide a seamless solution to the problems faced. None of them has yet to produce an effective solution. Any proposed solution method must be practical, economic and easy to use in order to overcome strong industry resistance.

A newly emerged technology, XML, offers an easy to implement, affordable and flexible solution to the data management problems. This thesis includes background research, development methodology and some initiative examples of such a solution.

CHAPTER 1
INTRODUCTION

The last two decades have witnessed the golden age for information technology (IT) development. Improvements in computer science and advancements in technology resulted in IT improvements. The progress caught attention of a number of different industries, and they started to invest in IT. One of the most successful implementation was in production industry. IT implementation not only changed the process definition but also brought new and more efficient management principles to the industry. The IT implementation enabled producers to get the best results in the shortest amount of time, in addition to giving them a lot of control over the process by reducing worker related errors.

Although IT innovations brought a lot in many industries, its implementation to construction industry was relatively gradual. A number of reasons are proposed to explain the phenomenon. Some of those include but not limited to:

- Construction industry is undoubtedly one of the most traditional industries. People tend to follow what they have been taught, and there is a strong user resistance to change.
- The industry is fragmented. There are a number of parties involved in construction regardless of the size and scope of the project. This makes it hard to implement a collaborative system.
- Construction industry is project based. Unlike the object oriented production industry, the products tend to be unique and it makes it hard to create a common framework applicable to multiple projects.
- The social hierarchy shows a huge variation within a company. While most of the workforce is hardly computer literate, it is not easy to implement the IT and make it available to all workers. Training will be required which needs time and money investment.
- The industry itself has a low profit margin when compared with others. Although the turnover values of structures is very significant, the low profit margins tend to lead to more compressed cash flows and resultantly reducing the company's economic power. Most construction companies tend to look for short term benefits instead of investing their money in IT implementation which is relatively expensive and not very likely to affect company significantly in short term.

Information Technology in Construction

Although the IT implementation in construction is harder than other industries, it will be most beneficial in construction. Within the traditional approach, yet the most important process is construction itself as a characteristic, a lot of time and money are spent on the administration processes and data involved tasks.

Some of the innovations are beginning to be used. The IT applications are generally applied to drawings, scheduling, and electronic construction data storing.

Almost all companies are using commercial software to schedule their jobs. The software applications are capable of creating box diagrams and bar charts as well as allocating and the resources. Although each and every other company involved in a project uses the same or similar type of device to handle scheduling, the interoperability in electronic format is very limited. The schedule updates are performed manually. Change orders delays are all processed and input to update the schedule again manually.

Another computerized application is the shop drawings. Every single construction company, regardless of the size, uses computers to handle all kinds of drawings. Yet they print those and submit the shop drawings for approval. The shop drawings are not static. As a result, every other change has to be marked, and the drawings need to be reprinted and resubmitted for approval. In addition, although the drawings are in electronic format, the quantity take offs, multiplication of the side lengths geometric figures drawn in two dimensions, are done by hand. It is not only a tedious activity but also very prone to produce errors as there will be lots of calculations.

The last major IT application to construction is data storage of, generally, progress reports and financial information. The information is placed in a data base, not very different from the

archiving the paperwork. The interoperability is limited to the company, not with the other parties.

Subcontracted Work

One of the drastically changing characteristics of construction is the amount of work to be subcontracted. It is the projection of division of labor principle applied to construction. Companies are willing to subcontract most of the job to specialists. It not only accelerates the process but also increases the quality of the job as every party will be performing the job they are best at. The construction industry is highly material and equipment-oriented, and unless the company is large enough in scale to perform projects of various types and sizes, acquiring all the required equipment and material would increase the overhead expenses drastically. Subcontracting construction work items is inevitable. Subcontracting requires a lot of additional data exchange requirements. The data to be interchanged within subcontractors includes but not limited to the following:

- Pay item information
- Weekly/Monthly construction progress reports
- Daily reports
- Change orders

A very recent study (American Subcontractors Association 2006) stated that the project participants are discouraged to share their information in digital format. There are even clauses added to some of the contracts to prevent it. The main concern of both the owner and the contractor is discrepancies between hardcopies and electronic documents. Currently the hardcopies are given priority in case of claims, and actually this is explicitly stated in “Standard General Conditions of the Construction Contract” published by the Engineers Joint Contract Documents Committee. This is a clear example of the tradition-bound construction industry.

The above mentioned problems are characteristics of US construction industry requirements and problems. The variation of the data, the companies need to interchange, increases when the construction becomes international. Recently big scale companies started getting jobs in foreign grounds. Even they may subcontract the whole job, the differences in standards, work item definitions, and languages make it hard for every participant of the project to evaluate the situation.

e-Construct

e-Construct (Econstruct 2001) is an international project designed to create a common framework for data exchange of the European construction industry. The aim of the project was to increase the competitiveness of the European building and construction industry, by creating frameworks to lead cheaper, faster and better construction.

The general problems encountered were originated from the causes related to the characteristic of the construction industry. The problems related to IT were including; miscommunications resulted from incompatible computer applications and lack of electronic communication between parties.

The common framework was created by using Extensible Markup Language (XML) and aimed to make the European construction industry united. Once the system was established, user would be able to do their research for material, and market surveying through one search engine that would be in users own language. The difference in specifications would not be a problem as the framework will reflect the changes. The interface created is to be a bridge constructed between suppliers, contractors, and the owner which would eventually eliminate the extra cost and time loss related to miscommunication between parties.

Construction Data Exchange Requirements

Construction industry is one of the highest budgeted yet little profitable industries. One of the common costs is related with lack of communication between parties. It not only adds to direct costs of the project but increases the indirect costs of the project considerably. The improvements in that manner will both increase the profit margin and quality of the product.

A study (Haas et al 1999) concluded that although the labor productivity of construction industry is increased from 80s to present date, management procedures were not leading factors in that increase. The productivity is increased as a result of more advanced technology and the decrease in real wages. Another survey (National Institute of Standards and Technology 2006) pointed out the costs caused by lacking in information interoperability in construction industry. The experiment methodology was to compare present situation to a hypothetical world scenario where data exchange is in electronic format. In the hypothetical world created, data interchange and communication between parties are instant by employing information technology tools. The results indicated that in year 2002 about 16 billion dollars spent on construction services might have been avoided by better utilized information management technologies for data exchange. In addition to the calculated loss, there are indirect costs that could not be calculated in that research. Those include but not limited to, reduced productivity and losing reputation and job opportunities.

Problem Definition

The above surveys pointed out that the construction industry needs electronic data exchange protocols to better manage the data which will lead to better management, increased productivity, and resultantly higher profit margins. Although some solutions were proposed, the high cost and complexity of the early proposed solutions made them not very applicable. The solution should be cheap, and the application of it should be simple.

The most promising solution might be creating an interface to enable parties to interact instantly. Extensible markup language (XML) can provide such a solution. XML offers (The World Wide Web Consortium 2003) a common language for each project participant for data interchange. Once the common language is created the data management will be handled better with much less effort which will lead to better decision making ability by manager.

CHAPTER 2
EXTENSIBLE MARKUP LANGUAGE

Overview of Extensible Markup Language

XML is a W3C recommended, very flexible data language that can be used to represent different types of data. It is derived from Standard Generalized Markup Language (SGML). XML is like Hyper Text Markup Language (HTML) which is markup language that is used to publish hypertext formatted data on World Wide Web, yet, XML and HTML are attributed for different purposes. HTML is used to only describe how data should be presented, whereas XML describes the data itself.

Although XML and HTML are alike in structure, they have differences in their structures (O'Reilly Media 2006). HTML has fixed tags. HTML compilers have to follow these tags to define his document. The developers needs to put a constant effort trying to keep up with recent technology, as the extent of the HTML documents depends on the extent of the defined tags. The applicability of enhancements to HTML is limited to the software, whose vendors participated in the development process. In addition to that backward compatibility is a great issue. On the contrary, XML allows the author to define his own tags and his own document structure. It allows the user to define tags and form the structural relationships between elements. As all the tags are to be defined by the user, there is no predefined semantics.

Comparison of XML to HTML

XML and HTML have completely different purposes. XML is not a replacement for HTML. It is important to understand that HTML is a platform that will enable one to present his data, whereas XML is the data. The future of internet will be depending on XML, but the poor representation of data is a problem which might be handled by employing HTML.

Advantages of XML

XML has the potential to be the ultimate solution to the data management problems of any industry. It is not only easy to implement but also inexpensive and does not require extensive maintenance services. XML will allow the users (Refsnes Data 2006) to exchange data, to share data, and to store data.

The foremost and distinctive advantage of XML is that it can provide a common framework for data exchange between two or more incompatible systems. With the recent technological advancements, more companies are using computers to store data, or complete certain progresses. One of the major hidden indirect costs of projects is resulted from poor data management within participants of the project. Each party needs to spend time and money on modifications to the data they got from the other party if they want to use that information. This will produce extra overhead cost to the project as well as leading to longer project completion time. In addition, the reliability of the data will be depending on the person in charge to make modifications to the data.

Data sharing is another asset of XML. Once the system is established, through XML interfaces, the parties will be able to share their information. This will especially be beneficial when the construction involves subcontracting. It will reduce the paperwork generated and data sharing will be performed much faster with more dependable data. As the XML data sharing does not require any software or hardware, implementation will not be a major issue (Most of the web browsers support XML). Besides, the files to be used will be basic text files of relatively small sizes. That will eliminate the broadband connection requirement.

XML may also be employed to store the data. The code gives users to have control over the way he wants to store the data. XML also can be used to retrieve data from already existing

data bases. The advantage of XML is the flexibility that will allow the user to modify the database or files that the data is stored.

The assets of XML that will contribute more to my research are explained above. In addition to those, XML can be used to create separate data fields within the document. As the data will be stored in XML files separated from the HTML, the modifications in data will not require changes in HTML code. Traditionally any change in data to a webpage created by HTML will require modifications to code. XML will allow the user to concentrate on format of webpage rather than dealing with the data. This will make maintenance be handled easier.

Structure of XML

Although XML is an extensible meta-language and user has control over defining the tags, it follows certain easy to follow but strict rules.

To begin with, XML files start with the declaration line which basically states the file is an XML file. It will include the information about the XML version and the encoding.

```
<?xml version="1.0" encoding="UTF-8"?>
```

XML file starting with the above declaration line is conforming to the version 1.0 and the character set used is UTF-8 (Unicode Transformation Format-8).

```
<?xml version="1.0" encoding="UTF-8"?>
        <Interview>
                <Q>What is your major</Q>
                <A>Civil Engineering</A>
        </Interview>
```

Above is a simple XML document. The first line is the declaration line as mentioned above. <Interview> is the root element and <Q> and <A> are the child elements of the root element. As can be seen, all of the elements have a closing tag (</>) except for the declaration line (An XML element is everything between an opening and a closing tag). Declaration line is

not part of the data on the document, but it is necessary to include. It includes give information about the code version and the encoding type. It is the first thing a browser checks before running an XML file. If the first line is not included, the application file will fail to run properly. In addition to that, the elements need to be nested properly within the root element. For the above example there are only root and child elements. If there were sub-child elements, they would have been nested within child elements. It also should be kept in mind that the elements are case sensitive in XML unlike HTML.

XML files may contain attributes in addition to the elements. Attributes are used to give additional information about elements. For instance, in the above code 1.0 and UTF-8 are attributes to xml version and encoding. i.e. <encoding="UTF-8">.

XML files may also include comments. They are anything between <!-- and -->. Comments are generally intended to provide additional information about programmer and the version of the schema about the schema. Like the declaration line, comments are not part of data but they provide useful information.

XML Schema

XML schemas (The World Wide Web Consortium 2003) are XML files that are used to define the structure of the XML documents. In addition to defining the structure, they carry information about the element type definitions and types. XML schemas are W3C recommendations (from May 2, 2001), and they are also known as XSD files. They contain information about all the elements and attributes; give information about data types and structure of the application document. They form an outline that is going to be the structure of the XML file. XML schema development is of paramount importance. Unless the parties that are to share or exchange information are using the common schemas, they will not be able to make use of the

information on the XML documents. An XML application file is valid and meaningful provided it has a valid schema.

XML schemas are turned out to be replacements for Document Type Definition (DTD) files (Refsnes Data 2006). The DTD files were used for the same purpose as XSD files, defining the structure of XML document. The DTD files used to define the structure of SGML documents and as XML inherited its structure from SGML, it has inherited the data type definition format to define its structure too. Although the DTD files are to be created for the same purpose, XSD files have some advantages on the DTD files.

DTD files use a different format then the XML files. XSD files on the other hand, are nothing but XML files. An XML literate user can create the XML schemas where as DTD requires a learning process as they are not in XML file format. DTD files do not support all kinds of element definitions as the built-in data definitions are limited than that of XSD files. In addition, they are not extensible. The very most distinctive advantage of XML is being extensible and so are XSD files where as DTD files are not. In year 2001, XML schemas were recommended by W3C, and became the universally accepted document definition procedure of XML files.

The Structure of XML Schema

The following is a sample XML schema for the previous simple XML document given above:

```
<?xml version="1.0" encoding="UTF-8"?>
        <schema>
                <element name="Interview">
                        <complexType>
                                <sequence>
                                        <element name="Q" type="xs:string"/>
                                        <element name="A" type="xs:string"/>
                                </sequence>
                        </complexType>
```

```
        </element>
</schema>
```

The first line is the declaration line which is explained earlier. <schema> is the root element here. It states the XML document is a schema file and this comment is same for every schema file.

In the code above, the root element was the Interview, whereas here it is schema. Elements Q and A was child elements of the root element. <element name="Interview"> is stating the name of the child element this time. <complexType> line nested within the previous comment states that the elements is of a complex type. There will be a more comprehensive explanation of the data types of schemas in upcoming chapters. For this specific case, the complex data type is composed of two basic data type elements. <sequence> line defines the sequencing of the two simple elements. <element name="Q" type="string"/> and <element name="A" type="string"/> lines defines the sequencing, and also name the elements and their types. Here both elements are of simple type of string that is generally used for elements composed of characters. Again the following data type section will include detailed information about them.

Details of XML Schema Data Types

Simple data types

The simple data types are the ones that are built in within the XML version. Although there are a vast number of built-in data types, the most widely used ones are: integer, double, boolean, time, date, string, and dateTime. Definitions of those together with respective examples are given in Table 3-1.

Complex data types

The complex data types are used for the elements that contain other elements and/or attributes. There are no certain rules to the complex type definitions provided the basics of the

XML rules are followed (Some of those are explained in the following chapters). User can define his own complex data types provided it is not possible to express the data content with the simple data types. Recall the example given above the interview element is defined to be consisted of two elements.

XML Schema Components

Sequence

This tag is used in schema to define the order of the elements of within the complex type element. If the above schema were used to create an instance document, the instance document should have an order of child elements ad follows.

```
<Q>What is your major?</Q>
<A>Civil Engineering</A>
```

Recall the related part of the schema:

```
<xs:sequence>
        <xs:element name="Q" type="xs:string"/>
        <xs:element name="A” type="xs:string"/>
</xs:sequence>
```

The schema specifies the order, and it is to be followed. If not there will be an error produced and the instance document will not run properly.

Namespace

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns=“http://www.duzgunagdas.com“
targetNamespace="http://www.duzgunagdas.com"
xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified" >
    <xs:element name="Interview">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="Q" type="xs:string"/>
                <xs:element name="A” type="xs:string"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

The second and third lines above include the namespace information about the schema. (Xmlns is referred to xml namespace). The namespace concept is nothing but a clever and easy way of preventing the possible naming conflicts between different schemas, which might have same element names. The namespace states that the names that are used in the schema are coming from the namespace specified. Namespaces are generally web addresses. Although there are no written rules about the naming, it is more convenient to name it after the party who created it. The above schema is created by me and a proper would be my own web address, although it does not actually exist.

Here the comment line, xmlns="http://www.duzgunagdas.com" is referred to as both the default and target namespaces. elementFormDefault="qualified" line states that the names that are used in this specific schema are to be qualified within the namespace.

Restriction

These are predefined limitations that can be put to the simple data types in order to confine the data to certain values or similarly in order to exclude certain values. There are certain in built restriction comments available for the user.

The above mentioned restrictions apply to simple data types which are given in earlier sections. The restriction commands can be used to redefine the context of a previously defined complex data type. This might be helpful in long term, in case of changes to the data format.

Another application of the restriction tag together with the complex data types is restricting the content of the complex data with the previously defined data types. By this way, one can confine the data type content of his own complex data to those of an already existing one.

The following is a simple illustration of the use of restriction on character length on the simple string data types which are nested within the complex type element Interview. I wanted a

minimum of 10 and a maximum of 18 character length (Additional restriction comments can be obtained from the cited references).

```
<xs:element name="Interview">
        <xs:complexType>
                <xs:sequence>
                        <xs:element name="Q">
                                <xs:simpleType>
                                        <xs:restriction base="xs:string">
                                                <xs:minLength value="10"/>
                                                <xs:maxLength value="18"/>
                                        </xs:restriction>
                                </xs:simpleType>
                        </xs:element>
                        <xs:element name="A">
                                <xs:simpleType>
                                        <xs:restriction base="xs:string">
                                                <xs:minLength value="10"/>
                                                <xs:maxLength value="18"/>
                                        </xs:restriction>
                                </xs:simpleType>
                        </xs:element>
                </xs:sequence>
        </xs:complexType>
</xs:element>
```

Here it is explicitly stated that the data elements are of simple data types. In order to use the restriction command, the data type explicitly needs to be stated. Although it is the same schema used above, modifications were necessary to use the restriction tag.

Extension

Although one can define his own complex data types to have elements with attributes, extension elements can be used to extend a simple data type to create a complex one. The already existing, in-built, simple data type will be base for the new complex data type. The following is an example. Suppose there is a simple element, <element name="reporter name" type="string". And after defining the schema, it is required to add the age and gender of the reporter. The extension tag allows user to do so.

```
<xs:element name="reporter name">
        <xs:complexType>
                <xs:extension base="string">
                        <element name="gender" type="string"/>
                        <element name ="age" type="integer"/>
                </xs:extension>
        </xs:complexType>
</xs:element>
```

Although the extensions can be used for the above mentioned purpose, the more important use of extension tag is extending a complex data type with another one. This way already defined elements in complex data types will be used collaboratively. It is important as in real life applications generally data types will be way too complicated than the above mentioned basic schema data types.

Import

Import function is used to import global element definitions from other schemas. If already defined name tags were to be used for the schema design, one can use import tag and include that namespace in the schema. Two or more XML schemas can be used simultaneously within the same schema. The import function can be used for schemas with different target namespaces. Import comment must be the child element of schema element. It is, therefore, will apply to the whole schema. Following is an example:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns="duzgun"
 xmlns:gml="http://www.opengis.net/gml"
 xmlns:txl="http://www.transxml.net/schema/txl/0.3"
 targetNamespace="duzgun" elementFormDefault="qualified">
 <xs:import namespace="http://www.opengis.net/gml"
   schemaLocation="gml/3.1.1/base/gml.xsd"/>
 <xs:import namespace="http://www.transxml.net/schema/txl/0.3" schemaLocation="TXL-
   GML20060123pxs.xsd"/>
```

Above schema is a fraction of a schema developed by me, which is given in full extend in following chapters. Two different namespaces are imported for the above schema. These

namespaces are imported in order to use already defined data type definitions they contain for the schema I have created. The required data type definitions were defined in the schema TXL-GML20060123pxs.xsd of TransXML project. As that schema was using the content of the gml.xsd schema, and as the namespace content of that schema is also different from the TransXML schema, both namespaces were imported. The first namespace is http://www.opengis.net/gml, and the schema location is defined by a local link. The second schema, whose namespace is http://www.transxml.net/schema/txl/0.3, is also located by a local link. Remote links can be used to define the schema locations provided they are accessible on web. Here, both gml.xsd and the TXL-GML20060123pxs.xsd schemas are located under close proximity of the main schema.

Include

This comment is very similar to the import comment. The only difference is that it allows users to combine schemas that are targeted to the same namespace or no namespaces. As the schemas will be using the same target namespace, namespace command line will not be necessary. The schema location should be sufficient to locate the schemas. This comment allows user to create smaller and simpler schemas. For repeating data type definitions for the same project, some base schemas addressing common data type definitions can be created and used more than once.

```
<xs:include schemaLocation="schema1.xsd"/>
```

The above comment line should be enough to import the schema schema1, provided it is locally available. Similar to the case of import function, remote links might also be used to describe the schema location if they are accessible via internet.

Table 3-1. XML simple data types

Data type	Definition	Example
Integer	Any non-decimal number	12354 -123
Double	Numbers with decimal values	123.45
Boolean	Values that are either true or false	True False
Date	Date in yy-mm-dd format	1250-10-10
Time	Time in hh:mm:ss format	11:10:00
dateTime	Date and time in yy-mm-ddThh:mm:ss format	1950-11-10T10:00:00
String	Data consisting of characters	abc Abc-1254

CHAPTER 3
GEOGRAPHY MARKUP LANGUAGE

Overview of Geography Markup Language

Geography Markup Language is a complete and comprehensive XML grammar used to describe both spatial and non-spatial geographic information. It is developed by Open Geospatial Consortium (OGC) and currently version 3.1.1 is used. It is the latest and most comprehensive set of specifications.

Although GML is designed specifically to convey geographic information, it enables users to create with less effort and in a more uniform way. GML is an XML extension rather than being a different language. It has more built in elements and predefined context than regular XML. It is more efficient and easy to create the schemas by making them GML compatible whether the data includes geographic information or not.

Structure of GML

Throughout the design phase of my own research, I intend to use already created GML schemas rather than creating my own. Although GML is a subset of XML, it requires additional learning process, as it has considerable differences with XML. Therefore, pointing out the differences with XML and GML will be enough. Excessive GML structure definition will not be relevant.

The GML hierarchy (Styler 2006) consists of objects, properties, and values. The objects have properties, and properties define the values. It is similar to the root element, child element, sub-child element relations in XML. The labeling shows variations with the regular XML convention. In GML the objects follows the UpperCamelCase notation (The first and the subsequent words are all start with upper case letters, if any) whereas, the properties follow lowerCamelCase notation (The first words start with lower case letters, and the subsequent

words are all start with upper case letters, if any). This makes it clear what is an object and what is a property. In XML there is no such differentiation. Both classes and attributes either use lowerCamelCase notation or UpperCamelCase notation which causes ambiguity in deciding what is a class and what is an attribute or element.

GML Experiment

The "GML Experiment" (NCHRP 2005) was conducted by TransXML project research team to see the efficiency of making the schemas GML compatible. The proposed way was creating two parallel schemas and instance documents, a schema and an instance document which are GML compatible and another two written with plain XML, and comparing them against each other. In order to evaluate the misperception of GML addressing only geographic information, both geographic and non-geographic data created for the experiment. The main interest was evaluating the following:

- effort required to the develop documents using plain XML and GML compatible XML
- whether the added GML components made the schemas complicated or made them easier to follow and understand
- whether GML made the schema easier to comprehend or not
- if GML provide an ample solution framework for differing kinds of work

The conclusions derived from the experiment are as following:

- Schema development is easier with GML. GML has more predefined elements definitions which reduces the amount of work to be done significantly. In this specific experiment, although the data range was not very wide, design team took advantage of using GML. In the presence of more and complicated data GML will be more appreciated. Even the basic inherited properties, ID, description etc., can make it a lot easier to develop the schema.
- GML is more structured than plain XML. There are not a lot of restrictions to XML which enables it to be flexible, but the extra flexibility might cause ambiguity. GML offers a more structured way of creating extensible documents. The difference in naming the objects and properties (UpperCamelCase and lowerCamelCase) makes it easier to understand the document.

- The GML experiment clearly indicated that the GML covers more than geographic information. It may also be used with non-geographic data to make the process easier and more understandable

CHAPTER 4
XML APPLICATIONS

A number of XML based data exchange protocols have been created recently. The following (NCHRP 2004) are some of those XML applications:

LandXML

It is developed to share and exchange all land related data including surveying and surface data. The schema is supported by a number of commercial software applications. Employing LandXML might be of great help during design issues related but not limited to roads.

aecXML Infrastructure Project Schema

Developed by the aecXML infrastructure working group, the schema addresses the project pay items for various stages of construction. One of the major and issues regarding construction management includes payment information about various work items on different stages of projects. The aecXML schema enables user to use the design information to come up with the cost estimations and/or payment information.

DIGGS

DIGGS (Data Interchange for Geotechnical and Environmental Specialists) is a research project aimed to create an international XML based geotechnical data interchange format which is GML compliant. The framework also should include a data dictionary. DIGGS working group have produced over 60 schemas including but not limited to schemas for material sampling, in-situ testing, piling and foundation data. The DIGGS project is significant, as it covers one of the most complicated data construction industry has. DIGGS is the only XML application protocol with a complete data dictionary.

TransXML

TransXML project is a NCHRP funded project whose scope is to develop a common framework for transportation construction data exchange. The project is limited by four key business areas; transportation construction and materials, transportation safety, highway bridge structures, and survey/road design. The project aimed to create an interactive framework for the key business areas as well as providing a base for future schema development, which is to be an ample solution to transportation construction data exchange problem. The projects second phase, creating the schemas and application files for the key business areas, is completed. The outcome summary of the project is as follows:

- **Transportation construction/materials:** Bid package, construction progress package, material sampling, and testing package project construction status package are the major application files are included.
- **Transportation safety:** Two application files were created. The first application allows users to search through crash records stored using the NHTSA FARS Safety XML schema. Users may also link these crash records to the related highway safety information. The HISA schema is used for that purpose. The second application file demonstrates how multiple sources of crash data using different XML schemas can be combined in a single crash report.
- **Highway bridge structures:** The file contains a software installation file whose purpose is to demonstrate the translation of a Bridge TransXML instance document produced by a bridge analysis software to a format that could be interpreted by another bridge analysis software. It's creating an interface that makes it possible to use the analysis of different software applications interchangeably.
- **Survey/Roadway design:** The purpose of the application is to demonstrate how to import and display GIS area features into a CAD design drawing. The application was developed on Microstation version 08.05.01.xx Windows x86 using MDL (Microstation Development Language).

CHAPTER 5
SCHEMA RESEARCH PROJECT

Introduction to Research Methodology and Requirements

Florida Department of Transportation is Florida's largest governmental organization. Every other year billions of dollars worth of construction is completed for FDOT. As a characteristic of construction industry, a lot of documents are produced and that makes the data management hard to deal with the traditional approach. In addition to the mass amount of paperwork produced, the chances of user related errors occurring increases. Some of the problems FDOT officials are facing are; the time and human hours spent to create the documents, to modify the documents that are created by different parties etc. XML can provide a solution to these problems. In order to overcome the above mentioned problems, a research project proposal is developed at University of Florida, Department of Civil and Coastal Engineering. The proposal was submitted, and accepted by FDOT.

Research Project Outline

The research project is aimed (Ellis et al 2006) to create the required XML schemas that will enable data interchange possible. The project outline is as follows:

Review of FDOT Data Exchange Needs

This task is to be completed by carrying out interviews with the personnel at different levels within FDOT. The results will include information about the current construction data in detail. The main issue will be creating an inventory and then mapping the data with respect to the generator, usage, and storage. Once the data mapped, the needs for data exchange should be defined.

Review and Assessment of TransXML and DIGGS Standards

The products of the TransXML and DIGGS projects should be reviewed in detail. The data definitions and the schemas of both projects are to be examined carefully in order to see their relevance and applicability to the FDOT data exchange requirements.

Development of Schemas and Conflict Solutions with Existing Schemas

The schemas will be created according to the needs of FDOT data exchange requirements that are already identified. After they are created their compliance with the other projects' schemas should be compared and possible conflicts should be resolved.

Developing a Construction Exchange Protocol Website

The developed data dictionary and the schemas will be made public on the webpage created. The website will also include the construction data interchange framework. The website will allow managers to consult on data exchange issues.

Implementation

The created website will also be used to serve as an information tool where the project results will be published. Additional information sessions will be held for managers about the project. The details of the implementation plan will be available once a certain progress level achieved.

CHAPTER 6
INDIVIDUAL RESEARCH

Introduction

My goal is to create an ample solution to the data management problems construction managers are facing. It is not logical to try to develop a solution like that from the very beginning of the research. Therefore, I have decided to start working with the project I am involved in, it is mentioned above, in order to better analyze the situation, and to use the project findings for my own research. The project and my research will not be different up to a certain point, as transportation construction is under the big umbrella of construction. Once the project is finished, the products of it should be used as a ladder to achieve the more comprehensive solution.

The project work started with the meetings with the people in charge of the data management in district office. The purpose was to get familiar with the FDOT construction data and to see what data needs to be exchanged. The results I got were not very encouraging. Some of the data was not in electronic format which made them impossible to store electronically and very hard to retrieve. The ones that are stored electronically were not consistent with each other. Some of the data on the papers is scanned and stored in a hard drive while some other data is stored through commercial software.

In order to get more familiar with the FDOT construction data, I have recommended to creating my own data dictionary and later map the data on the dictionary. The best idea was working with the forms available on the FDOT webpage. These forms are available to public at FDOT's website (http://www.dot.state.fl.us). They are used to exchange any kind of construction data with FDOT. This approach is advantageous whether the data on the forms represents the whole set of the FDOT construction data or not. If the data on the construction related forms

represents the whole data inventory of FDOT, I would be creating the most comprehensive data dictionary. If not, I would be working on a task to convert the data on forms to electronic format which is an activity I need to complete for the project I am currently involved in. Once the required feedback from various departments of FDOT is obtained, the above mentioned ambiguity would be resolved.

Data Dictionary

Because of the vast total number of the forms, it was not possible to create the data dictionary of the whole forms. Instead, the most relevant ones to research were chosen to work with. In order to categorize the forms with respect to their relevance, I have listed them with respect to the office producing. Once that classification was done, it was easier to decide on which ones are more relevant to the research priorities.

The forms later were filtered and in order to validate the approach, a meeting was set up with FDOT officials.

The initial dictionary was not a very complicated, but it was a useful tool to address the needs of the research. The data in the data dictionary was pulled from the forms. Once the forms were decided, I started looking for the forms that are in the archives in order to see what the actual data looks like. It was important as I have needed the data types to create the data dictionary.

The data dictionary definition is not unique and can show variation regarding the needs of the research. When deciding on the components of the data dictionary, I have used some professional advice from some of the TransXML and DIGGS project participants, and it was modified with respect to the needs of the research.

A snapshot from the data dictionary column headers can be found in the appendices. I have not included the whole data dictionary as it is not yet completed. I have created data inventory of

the forms that I developed schemas for. The data inventory is nothing but the completed fraction of the data dictionary.

Schema Development

Relatively basic forms and corresponding data definitions were chosen to start with. The short term target was determining the effort needed for creating the schemas and the instance documents. Forms 700-010-15, 700-010-25, 700-010-64 and 275-020-08 were chosen to start with whose titles are “Work Plan Controlling Item of Work”, “Contractor Past Performance Rating”, “Engineer's Maintenance of Traffic (MOT) Evaluation at Crash Site”, and “Trainee Enrollment & Notice of Personal Action” respectively.

As I already had the data items extracted from the forms and validated the data types by looking in to the completed forms, creating the schemas was relatively easy. The examples of schemas and the instance document can be found at the references.

Comments on Schema Development

“Trainee Enrollment & Notice of Personal Action” form is a fairly straight forward and easy to complete form. The data recording does not require any skills, but it has to be signed by 4 different parties 9 times total. That requires the form be physically transported at least 7 times. When the number of data and the amount work performed every year is considered, it is a big problem. The form is provided in Figure 7-1.

Once the XML is employed, each participant would be able to log in to the developed website with their user names and passwords upload the information they need to share with other parties. Not only the process will speed up but also the instant feedback will enable the users to interact faster.

While creating the schemas, I have used a predefined data type definition that was created in TransXML. The address type defined in the “TXL-GML20060123pxs.xsd” schema in

TransXML project, is referred to as the address type of the trainee, as well as address of contractor in the schema for contractor's past performance rating form, which is given in Appendix C. (The schema is available at http://www.transxml.net, and the schema fraction is published with the permission from NCHRP). Although this is a little contribution to the schema development, it is important to point out the methodology of employing other schemas for my research.

I have not used GML extensions for the schemas for a couple of reasons. I wanted to keep them as simple as possible, as most of the people I am working with are not very familiar with the XML technology. I included details that are sufficient to express the data content on the forms. More importantly, I was able to create the schemas by using XML data type definitions only. Yet, I have followed the GML notation while creating the schemas. The extensibility of the schemas makes them possible to be extended by a GML schema if needed.

XML Schema for Trainee Enrollment & Notice of Personal Action Form

The following schema code is created:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns="duzgun"
xmlns:gml=http://www.opengis.net/gml
 xmlns:txl="http://www.transxml.net/schema/txl/0.3" targetNamespace="duzgun"
elementFormDefault="qualified">
 <xs:import namespace="http://www.opengis.net/gml"
 schemaLocation="gml/3.1.1/base/gml.xsd"/>
 <xs:import namespace="http://www.transxml.net/schema/txl/0.3" schemaLocation="TXL-
 GML20060123pxs.xsd"/>
   <xs:element name="TraineeEnrollmentAndNoticeOfPersonnelAction">
      <xs:complexType>
         <xs:sequence>
            <xs:element name="ProjectIdentification">
               <xs:complexType>
                  <xs:sequence>
                              <xs:element name="financialProjectNo" type="xs:integer"/>
                              <xs:element name="FAPNo" type="xs:integer"/>
                              <xs:element name="contractNo" type="xs:string"/>
                              <xs:element name="county" type="xs:string"/>
```

```
                <xs:element name="district" type="xs:integer"/>
                <xs:element name="contractorName" type="xs:string"/>
                <xs:element  name="FEIDNo" type="xs:integer"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>
      <xs:element name="EnrollmentAndTraineeIdentification">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="trainingClassification" type="xs:string"/>
            <xs:element name="traineeName" type="xs:string"/>
            <xs:element name="traineeSSN" type="xs:integer"/>
            <xs:element name="traineeRace">
              <xs:simpleType>
                <xs:restriction base="xs:string">
                  <xs:enumeration value="Black"/>
                  <xs:enumeration value="White"/>
                  <xs:enumeration value="Hispanic"/>
                  <xs:enumeration value="Am. Indian"/>
                  <xs:enumeration value="Asian/Pac Islander"/>
                  <xs:enumeration value="Other"/>
                </xs:restriction>
              </xs:simpleType>
            </xs:element>
            <xs:element name="sex">
              <xs:simpleType>
                <xs:restriction base="xs:string">
                  <xs:enumeration value="Male"/>
                  <xs:enumeration value="Female"/>
                </xs:restriction>
              </xs:simpleType>
            </xs:element>
            <xs:element name="dateOfBirth" type="xs:date"/>
            <xs:element name="traineeAddress"
            type="txl:StreetAddressPropertyType"/>
            <xs:element name="instructorNameAndClassification"
            type="xs:string"/>
            <xs:element name="incomeData">
              <xs:complexType>
                <xs:sequence>
                  <xs:element name="annualFamilyIncome" type="xs:integer"/>
                  <xs:element name="traineesAnnualIncome" type="xs:integer"/>
                  <xs:element name="noOfDependents" type="xs:integer"/>
                </xs:sequence>
              </xs:complexType>
            </xs:element>
```

```
        <xs:element name="previousTrainingClassification" type="xs:string"/>
        <xs:element name="enrollmentDateRequested" type="xs:date"/>
        <xs:element name="contractorNameAndDate" type="xs:string"/>
      </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="EnrollmentApproval">
        <xs:complexType>
            <xs:sequence>
               <xs:element name="acceptableTraineeReview"
                 type="xs:boolean"/>
               <xs:element name="enrollmentApproval" type="xs:boolean"/>
               <xs:element name=
              "districtContractComplianceManagerNameAndDate"
              type="xs:string"/>
            </xs:sequence>
          </xs:complexType>
</xs:element>
<xs:element name="GraduationRequest">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="dateOfSuccessfulObservation" type="xs:date"/>
      <xs:element name="proficienceyMilestone">
        <xs:simpleType>
          <xs:restriction base="xs:string">
            <xs:enumeration value="100-240 Hrs"/>
            <xs:enumeration value="241-450 Hrs"/>
            <xs:enumeration value="451-650 Hrs"/>
            <xs:enumeration value="Completion of All"/>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element name="totalTrainingHours" type="xs:integer"/>
      <xs:element name="contractorNameAndDate" type="xs:string"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="GraduationApproval">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="graduationApproved" type="xs:boolean"/>
      <xs:element
      name="districtContractComplianceManagerNameAndDate"
      type="xs:string"/>
    </xs:sequence>
  </xs:complexType>
```

```
</xs:element>
<xs:element name="ContractorRequestToAwardBankingCertificate">
   <xs:complexType>
      <xs:sequence>
      <xs:element name="contractorNameAndDate" type="xs:string"/>
      </xs:sequence>
   </xs:complexType>
</xs:element>
<xs:element name="BankingApproval">
   <xs:complexType>
      <xs:sequence>
         <xs:element name="bankingApproved" type="xs:boolean"/>
         <xs:element
          name="districtContractComplianceManagerNameAndDate"
         type="xs:string"/>
      </xs:sequence>
   </xs:complexType>
</xs:element>
<xs:element name="TraineeTransferRequest">
   <xs:complexType>
      <xs:sequence>
         <xs:element name="financialProjectNoTransferredTo"
          type="xs:integer"/>
         <xs:element name="FAPNo" type="xs:integer"/>
         <xs:element name="district" type="xs:integer"/>
         <xs:element name="hoursPriorToTransfer" type="xs:integer"/>
         <xs:element name="effectiveDate" type="xs:date"/>
         <xs:element name="contractorNameAndDate" type="xs:string"/>
      </xs:sequence>
   </xs:complexType>
</xs:element>
<xs:element name="TransferApproval">
   <xs:complexType>
      <xs:sequence>
         <xs:element name="sendingDCCMNameAndDate" type="xs:string"/>
         <xs:element name="receivingDCCMNameAndDate" type="xs:string"/>
      </xs:sequence>
   </xs:complexType>
</xs:element>
<xs:element name="NoticeOfTerminationPriorToGraduation">
   <xs:complexType>
      <xs:sequence>
         <xs:element name="typeOfTermination">
            <xs:simpleType>
               <xs:restriction base="xs:string">
                  <xs:enumeration value="Voluntary"/>
```

```
                        <xs:enumeration value="Involuntary"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="reasonForTermination" type="xs:string"/>
            <xs:element name="effectiveDate" type="xs:date"/>
            <xs:element name="hoursAccumulatedAtTermination
            type="xs:integer"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:schema>
```

The logical outline of the schema is given in Figure 7-2. Table 7-1 represents the data inventory created for that form. The sections of the form are translated as the child elements of the root element of the schema. I have chosen the name of the root element name of the schema as the title of the form to make it more conventional. The sub-child elements are the work items in the forms. The way the forms are produced made the schema development much easier as they are already in the hierarchical format needed for XML documents. This will not only make it easier to develop the instance documents and the schemas, but also will be the basis of future data bases that are likely to be developed.

XML Instance Document for Trainee Enrollment & Notice of Personal Action Form

The instance document is created using the schema created (All the data on the instance documents is valid but fictional). The code is as follows;

```
<?xml version="1.0" encoding="UTF-8"?>
<TraineeEnrollmentAndNoticeOfPersonnelAction
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="duzgun 275-020-08.xsd"
  xmlns:gml="http://www.opengis.net/gml"
  xmlns:txl="http://www.transxml.net/schema/txl/0.3"
  xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns="duzgun">
    <ProjectIdentification>
      <financialProjectNo>121321321</financialProjectNo>
```

```
    <FAPNo>125425</FAPNo>
    <contractNo>t8787878</contractNo>
    <county>alachua</county>
    <district>2</district>
    <contractorName>John Doe</contractorName>
    <FEIDNo>12121</FEIDNo>
  </ProjectIdentification>
  <EnrollmentAndTraineeIdentification>
    <trainingClassification>type three</trainingClassification>
    <traineeName>Jane Doe</traineeName>
    <traineeSSN>1254653</traineeSSN>
    <traineeRace>White</traineeRace>
    <sex>Female</sex>
    <dateOfBirth>1965-11-11</dateOfBirth>
    <traineeAddress>
      <txl:StreetAddress>
        <txl:street>3800 SW</txl:street>
        <txl:cityName>gainesville</txl:cityName>
        <txl:stateCode>FL</txl:stateCode>
        <txl:postalCodeID>32608</txl:postalCodeID>
        <txl:postalCodeExtension>1254</txl:postalCodeExtension>
        <txl:addressCategory>headquarters</txl:addressCategory>
      </txl:StreetAddress>
    </traineeAddress>
    <instructorNameAndClassification>John Doe the
    Trainer</instructorNameAndClassification>
    <incomeData>
      <annualFamilyIncome>12500</annualFamilyIncome>
      <traineesAnnualIncome>4564654</traineesAnnualIncome>
      <noOfDependents>3</noOfDependents>
    </incomeData>
    <previousTrainingClassification>type III</previousTrainingClassification>
    <enrollmentDateRequested>2003-11-11</enrollmentDateRequested>
    <contractorNameAndDate>John Doe 1203-10-10</contractorNameAndDate>
  </EnrollmentAndTraineeIdentification>
  <EnrollmentApproval>
    <acceptableTraineeReview>false</acceptableTraineeReview>
    <enrollmentApproval>true</enrollmentApproval>
    <districtContractComplianceManagerNameAndDate>John Doe 1256-11-11
    </districtContractComplianceManagerNameAndDate>
  </EnrollmentApproval>
  <GraduationRequest>
    <dateOfSuccessfulObservation>1254-10-10</dateOfSuccessfulObservation>
    <proficienceyMilestone>451-650 Hrs</proficienceyMilestone>
    <totalTrainingHours>1254</totalTrainingHours>
    <contractorNameAndDate>1456-09-09</contractorNameAndDate>
```

```
  </GraduationRequest>
  <GraduationApproval>
    <graduationApproved>true</graduationApproved>
    <districtContractComplianceManagerNameAndDate>John Doe 1256-11-11
    </districtContractComplianceManagerNameAndDate>
  </GraduationApproval>
  <ContractorRequestToAwardBankingCertificate>
    <contractorNameAndDate>John Doe 1203-10-10</contractorNameAndDate>
  </ContractorRequestToAwardBankingCertificate>
  <BankingApproval>
    <bankingApproved>true</bankingApproved>
    <districtContractComplianceManagerNameAndDate>John Doe 1256-11-11
    </districtContractComplianceManagerNameAndDate>
  </BankingApproval>
  <TraineeTransferRequest>
    <financialProjectNoTransferredTo>21212121</financialProjectNoTransferredTo>
    <FAPNo>5545454545</FAPNo>
    <district>2</district>
    <hoursPriorToTransfer>56</hoursPriorToTransfer>
    <effectiveDate>1254-10-10</effectiveDate>
    <contractorNameAndDate>John Doe 1203-10-10</contractorNameAndDate>
  </TraineeTransferRequest>
  <TransferApproval>
    <sendingDCCMNameAndDate>John Doe 9999-01-12</sendingDCCMNameAndDate>
    <receivingDCCMNameAndDate>John Doe 4545-10-31</receivingDCCMNameAndDate>
  </TransferApproval>
  <NoticeOfTerminationPriorToGraduation>
    <typeOfTermination>Voluntary</typeOfTermination>
    <reasonForTermination>Lack of enthusiasm</reasonForTermination>
    <effectiveDate>1000-01-01</effectiveDate>
    <hoursAccumulatedAtTermination>125442</hoursAccumulatedAtTermination>
  </NoticeOfTerminationPriorToGraduation>
</TraineeEnrollmentAndNoticeOfPersonnelAction>
```

Above is the raw code for the instance document. Once the required stylesheet document is prepared the XHTML document can be modified to look similar to the actual form. This minor detail may not seem important but it might be crucial to overcome the before mentioned industry resistance. The outline of the instance document is provided in Figure 7-3.

Table 7-1. Data inventory of trainee enrollment & notice of personnel action form

Label on form	Data type
Financial project no	Integer
FAP No	Integer

Table 7-1. Continued

Label on form	Data type
Contract no	String
County	String
District	Integer
Contractor name	String
FEID no	Integer
Proposed training classification	String
Trainee's name (first/ middle initial /last)	String
Trainee social security number	Integer
Trainee's race	String
Sex	String
Date of birth	Date
Trainee's mailing address	Address
Instructor's name & classification	String
Annual family income	Integer
Trainee's annual income	Integer
Number of dependants	Integer
Previous classifications	String
Enrollment date requested	Date
Contractor's name & date	String
Date	Date
Acceptable trainee interview	Boolean
Enrollment approved	Boolean
DCCM name & date	String
Date of successful observation	Date
Proficiency demonstrated at milestone	String
Total accumulated training hours	Integer
Graduation approved	Boolean
DCCM name & Date	String
Contractor's name & date	String
Banking approved	Boolean
DCCM name & date	String
Financial project no. transferred to	Integer
F.A.P no.	Integer
District	Integer
Hours prior to transfer	Integer
Effective date	Date
Contractor's name & date	Date
Sending DCCM name & date	String
Receiving DCCM name & date	String
Type of Termination	String
Reason for Termination	String
Effective Date	Date
Hrs Accumulated At Termination	Integer

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

TRAINEE ENROLLMENT & NOTICE OF PERSONNEL ACTION

SECTION 1: PROJECT IDENTIFICATION

1. Financial Project No.	2. F.A.P. No.	3. Contract No.	4. County	5. District

6. Contractor Name	7. FEID No.

SECTION 2: ENROLLMENT & TRAINEE IDENTIFICATION

8. Proposed Training Classification:	9. Trainee's Name (first/ middle initial /last)

10. Trainee Social Security No.	11. Trainee's Race	12. Sex	13.Date of Birth
	☐Black (Not of Hispanic Origin) ☐White(Not of Hispanic Origin ☐Hispanic ☐ Am. Indian/Al Native ☐Asian/Pac. Islander	☐Male ☐Female	

14. Trainee's Mailing Address	15. .Instructor's Name & Classification	16. Income Data-Complete only if Non Minority Male enrollment		
		Annual family income	Trainees annual income	No. of dependents

17. List previous classifications for which training was received and list classifications worked in	18. Enrollment Date Requested

19. Trainee's Signature	20. Contractor's Signature & Date
	Date

SECTION 3: ENROLLMENT APPROVAL

21. Acceptable Trainee Interview?	22. Enrollment Approved?	23. District Contract Compliance Manager (DCCM) Signature & Date
☐ Yes ☐ No	☐ Yes ☐ No	Date

SECTION 4: GRADUATION REQUEST

24. Date of Successful observation	25. Proficiency Demonstrated at Milestone	26. Total Accumulated Training Hours	27. Contractor's Signature
	☐ 100-240 Hrs ☐ 451-650 Hrs ☐ 241-450 Hrs ☐ Completion of all		Date

SECTION 5: GRADUATION APPROVAL

28. Graduation Approved?	29. District Contract Compliance Manager (DCCM) Signature & Date
☐ Yes ☐ No	Date

SECTION 6: CONTRACTOR'S REQUST TO AWARD BANKING CERTIFICATE

30. Contractor's Signature & Date
Date

SECTION 7: BANKING APPROVAL

31 Banking Approved?	32. District Contract Compliance Manager (DCCM) Signature & Date
☐ Yes ☐ No	Date

SECTION 8: TRAINEE TRANSFER REQUEST

33. Financial Project No. Transferred to	34. F.A.P no.	35. District	36. Hrs prior to Transfer	37 Effective Date

38 Contractor's Signature & Date
Date

SECTION 9: TRANSFER APPROVAL

39 Sending DCCM Signature & Date		40. Receiving DCCM Signature & Date	
	Date		Date

SECTION 10: NOTICE OF TERMINATION PRIOR TO GRADUATION

41.Type of Termination	42 Reason for Termination	43. Effective Date	44. Hrs Accum. At Term.
☐ Voluntary ☐ Involuntary			

Figure 7-1. Trainee enrollment & notice of personnel action form

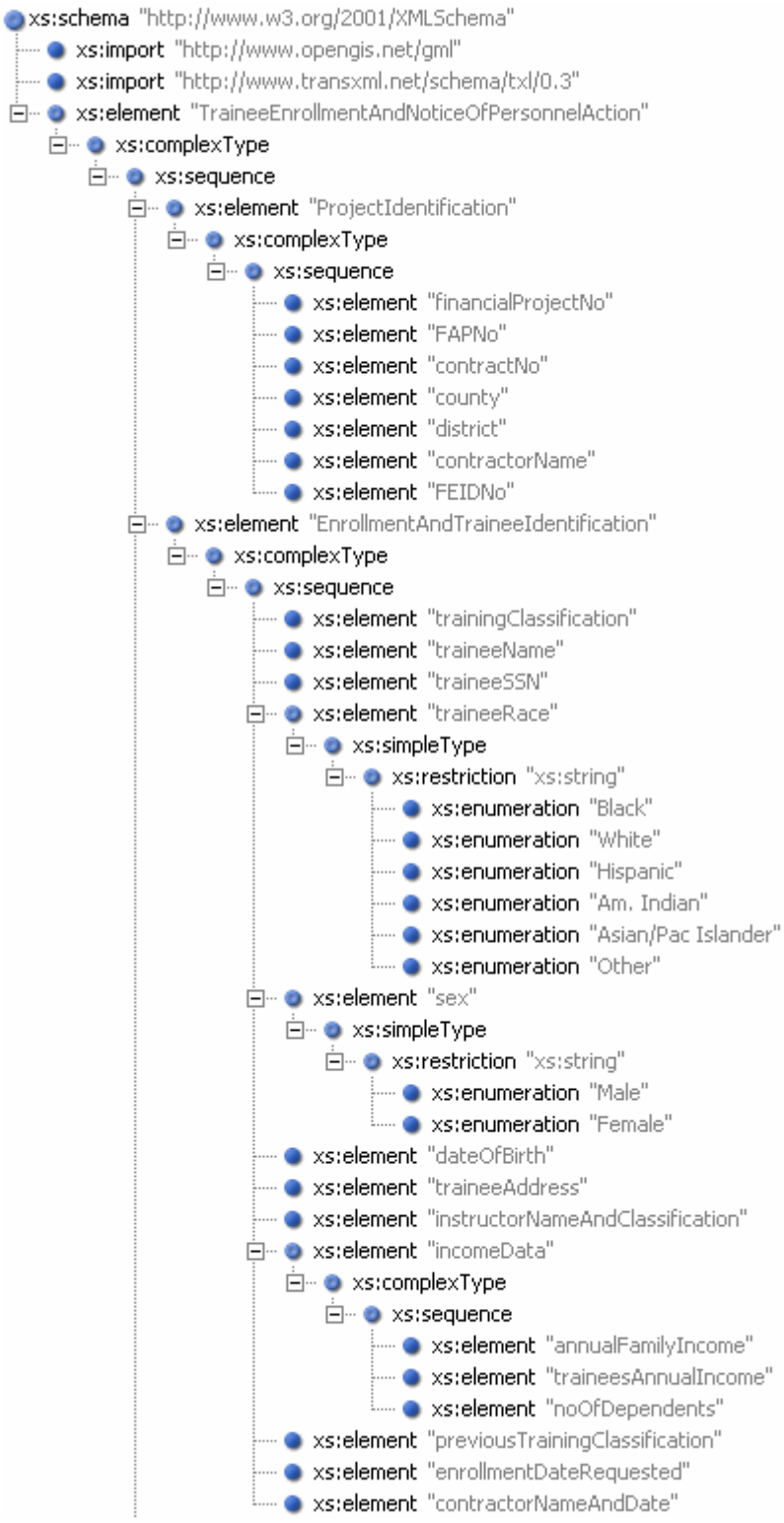

Figure 7-2. Outline of the XML schema for trainee enrollment & notice of personnel action form

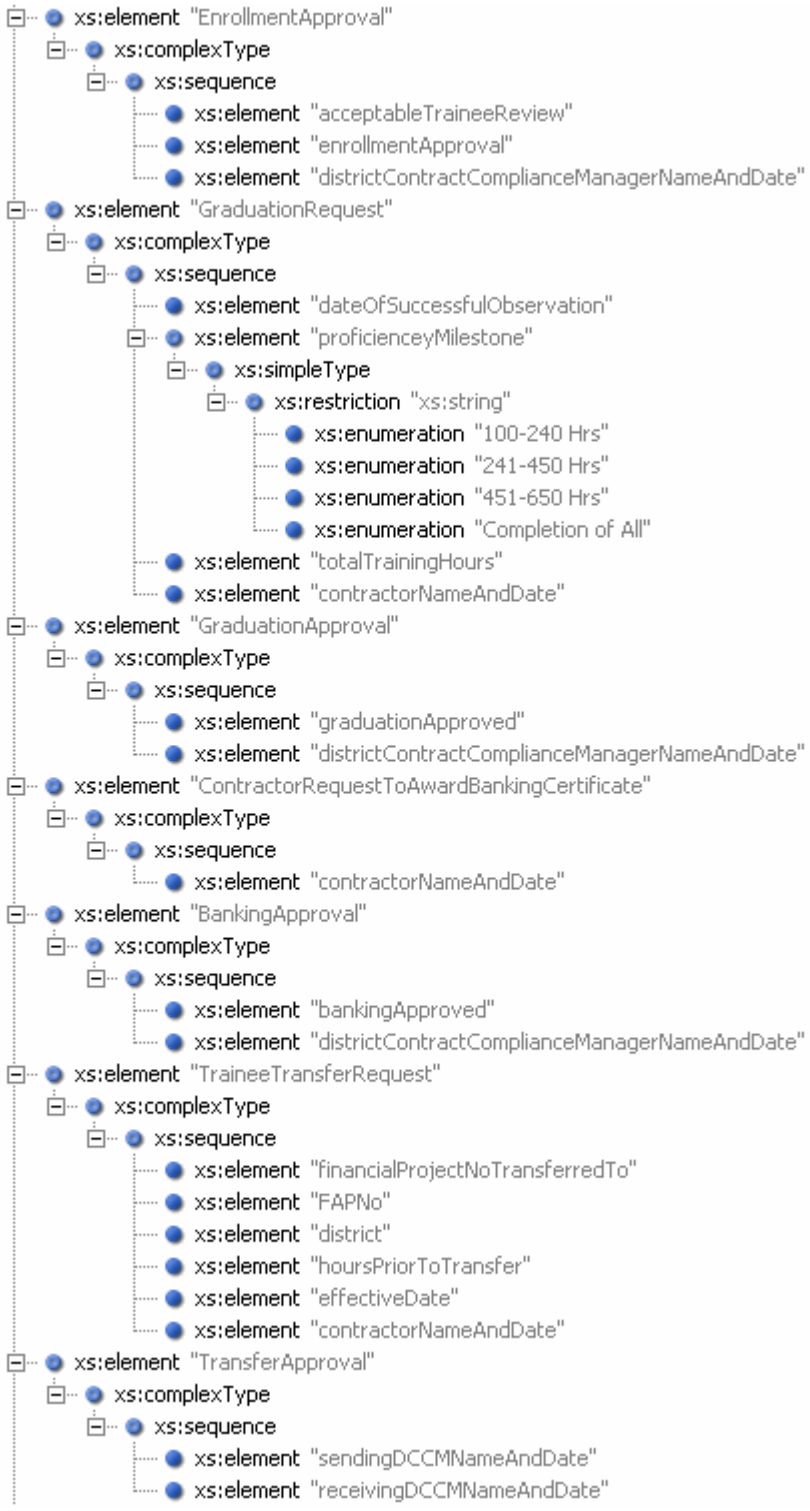

Figure 7-2. Continued

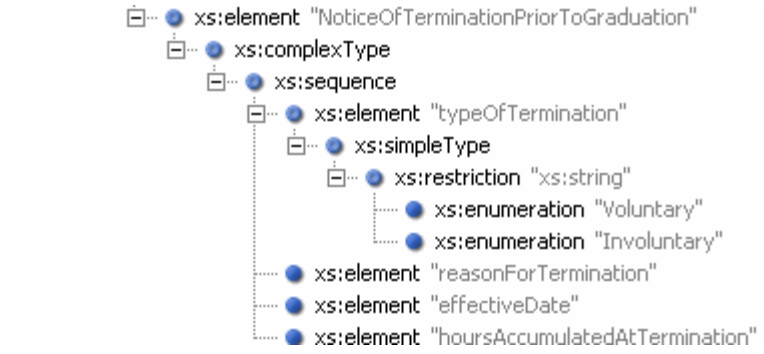

Figure 7-2. Continued

Figure 7-3. Outline of the XML instance document for trainee enrollment & notice of personnel action form

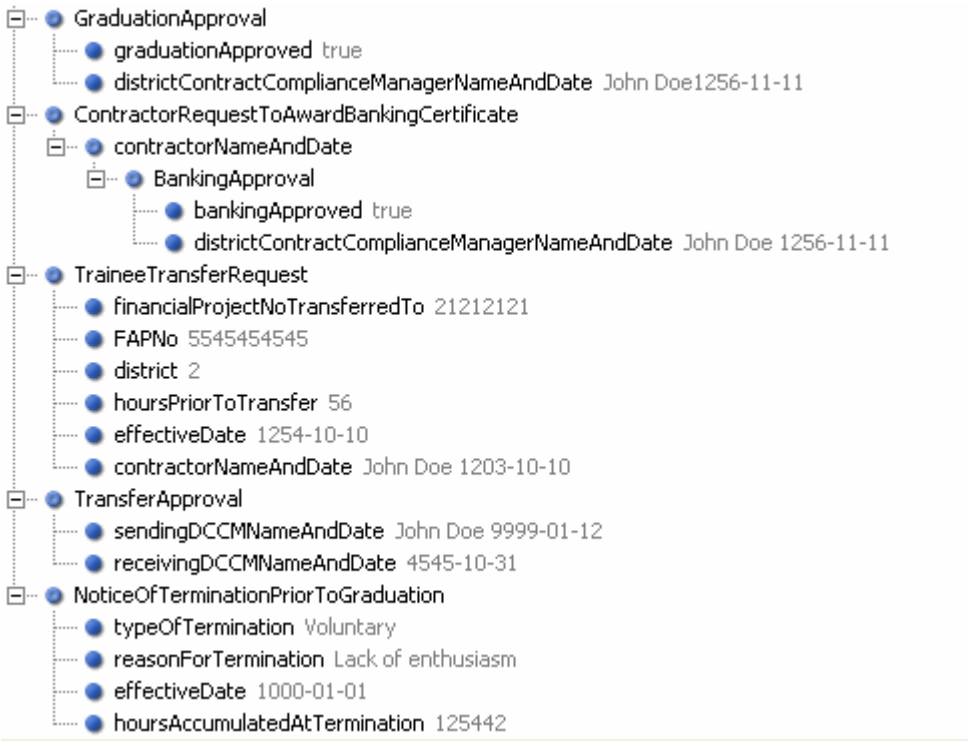

Figure 7-3. Continued

CHAPTER 7
CONCLUSION AND FUTURE OPPORTUNITIES

Conclusion

This thesis is to propose an enhancement method to the current the data management applications within the construction industry. The total solution will evolve together with the research project I am involved in. Although the project deals only with the transportation construction data, some more effort will make it possible to develop a more general solution once the project is completed. FDOT is mainly performing transportation construction, but the minor work items to be same or similar with general construction. With some effort, a possible gap between construction in general and transportation construction can be filled. Later stages of the project will require more schemas, and the application files be developed. As the small examples of using the already existing schema components implied, the already created schemas will be employed more.

The next step in the project will be developing an XML interface that will enable two incompatible computer applications FDOT employing now. Once that phase is completed, XML will be more appreciated, and it will be a big step to towards completing the solution procedure as most of the companies are actually using computers to handle the vast majority of tedious work items.

Once the data dictionary is completed, the data mapping and schema compatibility issues are all going to be resolved. The interactive web site and required info sessions will wrap up the project and the monitoring will enable me to get required feedback from the users to better utilize the ample solution.

The schemas developed for the construction forms might not provide the best approach for a more general solution, but they provide a good idea of how the schema development will be

handled. More than likely, the schema instance document relation will not be in the case presented here. In this phase of research, I created 4 schemas for 4 application files, each of which are related with a construction form. Once the data dictionary is developed, the work item relations will be defined, and a more systematic approach will be developed. The later stages of project will include development of base schemas, which will include data type definitions that are repeated in different forms. That will eliminate the necessity of defining same or similar work item descriptions for different schemas, and the schemas will be easier to create as most of the data types would have already been defined in those base schemas. As I do not have the complete data dictionary for the time being, I had to develop a specific schema for each instance document, which is not the most efficient way.

Future of XML and Possible Impacts on Construction Industry

The future of the internet, NGI (Next generation Internet), will be depending on XML. Integration to XML technology will be of paramount importance in order to keep up with the recent developments.

XML based seamless data management might be one of the most drastic changes ever happened to construction industry. It will not only accelerate the processes, saving money and time, but also will lead to better management applications. Automotive industry has been using Total Quality Management (TQM) principles for almost fifty years. Cases are similar for other quality and production principles. There have been many attempts to implement these to construction to excel in production. Those attempts turn out to be unsuccessful most of the time. The most common excuse was blaming the unpredictability of the construction industry. The unpredictability is the result of poor data management principles and applications. Construction managers need to have better data management principles to better utilize the data at their hands. All the quality control and quality assurance principles require strong statistical analysis to figure

out deviations. A strong statistical analysis requires valid data. Not many of construction companies can keep up with that requirement. The proposed solution in that thesis will make it possible for every company to have absolute control over their data.

APPENDIX A
FDOT CONSTRUCTION FORM REVIEW AND DATA DICTIONARY

The following tables contains the forms are the FDOT construction forms used for initial steps of research, with respect to the office produces them.

FDOT Construction Form Review

FDOT Construction Offices and Respective Forms

Aviation office

Table A-1. Aviation office construction forms

Form no	Form title
725-040-11	Airspace obstruction permit application
725-040-12	Airport site approval and license application
725-040-1	Airport license renewal application

Office of the comptroller

Table A-2. Office of the comptroller construction office

Form no	Form title
300-000-01	Travel form
300-000-06	Consultant travel form
350-020-03	Agreement summary sheet
350-020-04	Tentative acceptance agreement utility installation by DOT contractor
350-080-14	Application for refund from state of Florida

Construction office

Table A-3. Construction office construction forms

Form no	Form title
675-010-10	Nonconforming structural steel and miscellaneous metal component data sheet
675-030-03	Asphaltic concrete pay reduction summary sheet
675-060-10	Asphalt pavement straightedge test report

Contracts administration office

Table A-4. Contracts administration office construction forms

Form no	Form title
375-000-02	Fax order form
375-000-31	Bid document confidentiality agreement as to trade secret & proprietary documents
375-000-32	Bid document escrow affidavit

Table A-4. Continued

Form no	Form title
375-000-33	Bid document escrow agreement
375-020-09	Bid or proposal bond
375-020-18	Declaration of joint venture and power of attorney for bidding on specified
375-020-20	Bid protest bond
375-020-22	Certification of current capacity
375-020-37	Application for qualification for emergency debris removal

Environmental management office

Table A-5. Environmental management office construction forms

Form no	Form title
650-040-01	Permit transmittal memorandum
650-040-03	Stormwater pollution prevention plan construction inspection report
650-040-04	Owner/Operator certification preparation of documents and inspection report
650-040-05	Contractor certification preparation of documents--npdes general permit
650-040-07	Contractor certification/npdes general permit for storm water discharges
650-050-01	Letter of intent Florida scenic highways program
650-050-02	Eligibility application Florida scenic highways program
650-050-03	Field inventory form Florida scenic highways program
650-050-04	Corridor impressions survey form Florida scenic highways program
650-050-05	Designation application Florida scenic highways program
650-050-06	Application for vegetation management at outdoor advertising signs
650-050-09	Permit for landscaping on state road right of way
650-050-10	Florida highway beautification council grant application

Equal opportunity office

Table A-6. Equal opportunity office construction forms

Form no	Form title
275-010-10	Title VI program and related statutes discrimination complaint
275-010-11	Title VI/Title VIII quarterly report
275-010-12	Construction contractors EEO report
275-020-01	Federal aid highway construction summary
275-020-02	O.J.T. monthly time report - Trenching machine operator
275-020-04	O.J.T. monthly time report - Asphalt luteman raker
275-020-07	On-the-job Training Schedule Compliance Check
275-020-08	Trainee enrollment and notification of personnel action
275-020-09	O.J.T. monthly time report - Concrete curb/sidewalk machine operator
275-020-13	O.J.T. monthly time report - Erosion control specialist
275-020-17	O.J.T. monthly time report - Earth wall erector
275-020-18	O.J.T. monthly time report - Installer/tester
275-020-19	O.J.T. monthly time report - Roller operator
275-020-20	O.J.T. monthly time report – Front end loader operator

Table A-6. Continued

Form no	Form title
275-020-22	O.J.T. monthly time report - Highway or bridge ironworker, reinforcing
275-020-23	O.J.T. monthly time report - Scraper-pan operator
275-020-24	O.J.T. monthly time report - Form/Curb & gutter builder (structures)
275-020-25	O.J.T. monthly time report - Grade checker
275-020-26	O.J.T. monthly time report - Asphalt/Bridge deck screed operator
275-020-27	O.J.T. monthly time report - Highway concrete finisher
275-020-28	Equal employment opportunity officers
275-020-29	O.J.T. monthly time report - Highway or bridge carpenter
275-020-30	O.J.T. monthly time report - Pipelayer
275-020-31	O.J.T. monthly time report - Backhoe operator
275-020-35	O.J.T. monthly time report - Painter, highway or bridge
275-020-36	O.J.T. monthly time report - Air compressor operator
275-020-37	O.J.T. monthly time report - Asphalt distributor
275-020-38	O.J.T. monthly time report - Asphalt paving machine operator
275-020-39	O.J.T. monthly time report - Asphalt plant drier operator
275-020-43	Certification of subcontract amount to DBE contractor
275-020-44	O.J.T. monthly time report equipment maintenance technician
275-020-45	O.J.T. monthly time report - Motor grader operator
275-020-46	O.J.T. monthly time report - Milling machine operator
275-020-47	O.J.T. monthly time report - Concrete paving finishing machine operator
275-020-48	O.J.T. monthly time report - Concrete paving machine/ spreader operator
275-020-49	O.J.T. monthly time report - Deckhand
275-020-51	O.J.T. monthly time report - Mechanic
275-020-58	O.J.T. monthly time report - Truck driver
275-020-60	O.J.T. monthly time report - Tractor operator
275-020-64	O.J.T. monthly time report - Stone and aggregate spreader operator
275-020-65	O.J.T. monthly time report - Sign erector
275-020-67	O.J.T. monthly time report - Pile driver
275-020-70	O.J.T. monthly time report - Piledriver leadman
275-020-71	O.J.T. monthly time report - Mixer operator
275-020-75	O.J.T. monthly time report - Mason
275-020-77	O.J.T. monthly time report - Landscape worker
275-020-79	O.J.T. monthly time report - Instrument person
275-020-80	O.J.T. monthly time report - Highway or bridge ironworker, structural
275-020-81	O.J.T. monthly time report - Guard rail erector
275-020-88	O.J.T. monthly time report - Crane, clamshell, backhoe, derrick, dragline
275-020-93	O.J.T. monthly time report – Bulldozer operator
275-020-94	O.J.T. monthly time report - Traffic signalization installer/mechanic
275-020-96	On-the-job training schedule
275-020-98	O.J.T. monthly time report - Traffic control specialist
275-021-01	On-the-job training request for proficiency demonstration
275-021-02	On-the-job training trainee interview
275-021-03	Banking certificate of training
275-021-04	Contractor certification of EEO/AA policy and plan adoption

Table A-6. Continued

Form no	Form title
275-021-05	Supervisory and office personnel EEO meeting record
275-021-06	Project personnel EEO meeting record
275-021-07	Contractor company wide EEO report
275-021-08	Contractor's annual July EEO report
275-021-10	Inspection report for job site bulletin board
275-021-11	Certificate of training
275-021-12	Daily weekly report for on-the-job trainees
275-021-13	Notification to FDOT of EEO officer
275-030-01	Schedule a certification form no. 1
275-030-070	Application for construction management development program & bond guarantee
275-030-071	Application for small business certification (SBC)
275-030-073	Technical assistance request
275-030-074	Justification for bond guarantee
275-030-10	Bid opportunity list
275-030-11	DBE bid package information
275-030-11A	Anticipated DBE participation statement
275-030-11B	DBE affirmative action plan

Estimates office

Table A-7. Estimates office construction forms

Form no	Form title
600-00-02	Pay item request: New/Expanded structure

Financial development office

Table A-8. Financial development office construction forms

Form no	Form title
350-020-05	State infrastructure bank (SIB) application
350-020-08	State infrastructure bank (SIB) recipient semi-annual progress report
350-050-36	Local highway finance report (FHWA form 536)
350-090-17	Toll facility revolving trust fund quarterly report

Office of general counsel

Table A-9. Office of general counsel construction forms

Form no	Form title
050-020-26	Exempt documents request form
350-020-08	Statement of claim for property damage
350-050-36	Statement of claim property damage with personal injuries

Office of information systems

Table A-10. Office of information systems construction forms

Form no	Form title
325-060-05	FDOT computer security access request
325-060-06	Corporate account request

Office of general inspector

Table A-11. Office of general inspector construction forms

Form no	Form title
450-000-01	Self certification of accounting system and reimbursement rates

ITS program office

Table A-12. ITS program office construction forms

Form no	Form title
750-010-04	FAA notice of proposed construction or alteration
750-010-05	Application for antenna structure registration
750-040-01	Tower use agreement

Maintenance office

Table A-13. Maintenance office construction forms

Form no	Form title
010-000-07	Adopt-a-highway litter removal agreement
375-020-01	Daily report of maintenance project
375-020-02	Maintenance project weekly summary
375-020-05	Contract maintenance work document
375-020-24	Maintenance contract time extension
375-020-40	Contractor's invoice
375-020-43	Contractor field performance report
850-000-15	Herbicide application log
850-005-01	Report of repair and certification of funds expenditure
850-005-02	State force and contract cost documentation
850-010-06	Load capacity information
850-010-16	Application for bridge inspection certification
850-030-05	Monitoring well inspection log
850-040-01	Overweight/Overdimensional permit
850-040-02	Request for special road use permit trip application
850-040-65	Request for temporary closing/special use of state road
850-040-70	Permit application for solicitation of contributions or to conduct safety break
850-040-71	Notification and request for facility use
850-040-72	Indemnification agreement
850-040-85	Permit for moving building over state roads
850-040-90	Application for permit to move building over state roads

Table A-13. Continued

Form no	Form title
850-045-01	Rest area comment card
850-045-05	Application for memorial monument
850-050-03	Inspection report (guardrail, reflectivity & single & multipost sign insp rpt)
850-055-01	Call box system testing, inspection and maintenance
850-055-02	Type II attenuator inspection report other type units
850-055-03	Type I attenuator inspection report
850-055-04	Attenuator inventory update
850-055-05	Type II attenuator inspection report - Hidro cell sandwich and cluster
850-055-06	Type II attenuator inspection report - G-R-E-A-T
850-055-07	Type II attenuator inspection report - Sand barrel, energite and fitch
850-055-08	Type II attenuator inspection report - Hex foam sandwich
850-055-09	Type II attenuator inspection report - Guadguard
850-055-10	Type II attenuator inspection report - Brakemaster
850-055-11	Type II attenuator inspection report TAU - II

Materials office

Table A-14. Materials office construction forms

Form no	Form title
675-000-01	Qualification performance report
675-000-05	Laboratory qualification application
675-010-02	Compressive strength of concrete cylinders
675-010-03	Concrete design mix
675-010-04	Concrete design mix (Metric)
675-020-02	Aggregate system fine aggregate code form
675-020-03	Aggregate system base aggregate code form
675-020-04	Aggregate system coarse aggregate code form
675-020-05	Pipe backfill code sheet
675-020-06	Embankment, subgrade, and base code sheet
675-020-21	Density log sheet
675-020-22	Density log book
675-020-23	Density inspection report
675-020-25	Earthwork density report
675-020-26	Earthwork daily report of construction
675-020-27	Contractor quality control density record system
675-020-28	Verification earthwork density record system
675-030-02	Control charts for acceptance tests
675-030-04	Asphaltic concrete control strip density
675-030-06	Daily report of asphalt plant inspector
675-030-07	Daily report of asphalt paving inspector
675-030-08	Bituminous mixture summary
675-030-09	Pavement evaluation coring and condition data
675-030-10	Core out averages work sheet
675-030-17	Asphalt independent verification report

Table A-14. Continued

Form no	Form title
675-030-18	Asphalt plant - daily report of quality control
675-030-19	Asphalt plant - verification report
675-030-20	Asphalt roadway - daily report of quality control
675-030-21	Asphalt roadway - verification report
675-030-22	Asphalt plant - pay factor worksheets
675-030-22A	Asphalt plant - pay factor worksheets, July 2005 specification version
675-030-23	Asphalt resolution report
675-030-23A	Asphalt resolution report (LIMS)
675-030-24	Asphalt mix design summary report
675-030-24A	Asphalt mix design summary report, version 2 (excel 2003 - full install)
675-030-25	Asphalt plant worksheet
675-030-25A	Asphalt plant worksheet
675-050-01	Material release notification
675-050-02	Control of concrete
675-050-04	Sample transmittal card (C-22)
675-050-05	Mixer identification card
675-050-10	Delivery ticket for non structural concrete
675-070-01	Production joint welding procedure
675-070-02	Production joint weld procedure specification
675-070-03	Weld procedure qualification record
700-030-12	Referee analysis

Personnel resource office

Table A-15. Personnel resource office construction forms

Form no	Form title
250-025-01	Employee grievance form
250-025-01A	Employee grievance disposition
250-030-10	Exempt social security number request
250-035-01	Workers' compensation memorandum
250-050-02	Leadership academy: Individual implementation plan
250-050-11	TRESS course roster (without PDH's)

Office of policy planning

Table A-16. Office of policy planning construction forms

Form no	Form title
525-010-01	Interlocal agreement for creation of the metropolitan planning organization
525-010-02	Transportation planning funds joint participation agreement
525-010-03	Intergovernmental coordination and review and public transportation coordination

Procurement office

Table A-17. Procurement office construction forms

Form no	Form title
375-030-01	Request for qualification package for professional consultants
375-030-12	Standard professional services agreement
375-030-20	Disadvantaged business enterprise (DBE) certification
375-030-21	DBE participation statement
375-030-25	Task work order for professional services
375-030-26	Task work order amendment form for professional services
375-030-30	Truth in negotiation certification
375-030-31	MBE payment certification
375-030-32	Certification regarding debarment, suspension, ineligibility and voluntary exclusion
375-030-33	Certification for disclosure of lobbying
375-030-5B	Invoice summary sheet
375-030-5D	Invoice summary sheet (Multi-project/Task)
375-030-5E	One page invoice
375-040-18	Drug-free workplace program certification
375-040-24	MBE planned utilization
375-040-26	Bid or proposal bond
375-040-27	Performance bond
375-040-49	Credit card charge complaint

Project management and development office

Table A-18. Project management and development office construction forms

Form no	Form title
375-030-08A	Consultant schedule evaluation
375-030-08B	Consultant management evaluation
375-030-08C	Consultant quality evaluation - Type of work, group 2 project development and environmental
375-030-08D	Consultant quality evaluation - Type of work, group 3 highway design - roadway
375-030-08E	Consultant quality evaluation - Type of work, group 4 highway design - bridges
375-030-08F	Consultant quality evaluation - Type of work, group 5 bridge inspection
375-030-08G	Consultant quality evaluation - Type of work, group 6 traffic engineering and operation
375-030-08H	Consultant quality evaluation - Type of work, group 7 traffic operations design
375-030-08I	Consultant quality evaluation - Type of work, group 8 surveying and mapping
375-030-08J	Consultant quality evaluation - Type of work, group 9 soil exploration, material testing
375-030-08K	Consultant quality evaluation - Type of work, group 11 engineering contract administration
375-030-08M	Consultant quality evaluation - Type of work, group 13 planning
375-030-08N	Consultant quality evaluation - Type of work, group 14 architect
375-030-08P	Consultant quality evaluation - Type of work, group 15 landscape architect

Table A-18. Continued

Form no	Form title
375-030-08R	Consultant quality evaluation - Type of work, group 21 acquisition, negotiation, closing
375-030-08U	Consultant quality evaluation - Type of work, group 24 acquisition relocation assistance
375-030-08V	Consultant quality evaluation - Type of work, group 25 right of way clearing and leasing
375-030-08W	Consultant quality evaluation - Type of work, group 99 non-standard work type
375-030-08X	Consultant CEI work performance evaluation
375-030-08Z	Constructability evaluation
525-010-30	Federal-aid project funding request
525-010-32	Local agency program supplemental agreement
525-010-33	Local agency certification qualification agreement
525-010-40	Local agency program agreement
525-010-401	Local agency program agreement - Exhibit 1
525-010-40A	Local agency program agreement - Exhibit A
525-010-40B	Local agency program agreement - Exhibit B
525-010-40D	Local agency program agreement - Exhibit D
525-010-40L	Local agency program agreement - Exhibit L
525-010-40M	Local agency program agreement - Exhibit RL
525-010-40R	Local agency program agreement - Exhibit R
525-010-40T	Local agency program agreement - Exhibit T

Public transportation and modal administrator office

Table A-19. Transportation and modal administrator office construction forms

Form no	Form title
725-030-06	Public transportation joint participation agreement
725-030-06E	EXHIBITS - Public transportation joint participation agreement
725-030-07	Public transportation supplemental joint participation agreement

Rail office

Table A-20. Rail office construction forms

Form no	Form title
725-080-86	Rail corrider crossing permit application

Office of right of way

Table A-21. Office of right of way construction forms

Form no	Form title
575-030-02	Representative authorization
575-030-03	Right of way negotiation contact record and suit information
575-030-07	Offer and purchase agreement
575-030-08	Counteroffer and purchase agreement

Table A-21. Continued

Form no	Form title
575-030-12	Donation of property to FDOT
575-030-15	Right of entry agreement
575-030-16	Closing statement
575-030-17	Application for payment of closing costs
575-030-18	Public disclosure affidavit
575-030-19	Public disclosure act exemption affidavit (Corporate - exempt)
575-030-20	Corporation exemption document
575-030-21	Public disclosure act exemption affidavit (Trust-exempt condemnation)
575-030-22	Public eminent domain document
575-030-24	Recommendation for settlement
575-030-25	Mediation report
575-030-27	Request for taxpayer identification number
575-030-30	Trial/Hearing report
575-030-31	Notice to owner
575-030-32	Notice to owner - Spanish
575-030-33	Notice to business owner
575-030-34	Notice to business owner - Spanish
575-030-35	Request for vendor identification number
575-030-36	Invoice for protective rent payment
575-040-01	Business survey questionnaire
575-040-02	Household survey questionnaire
575-040-03	Statement of eligibility for supplementary replacement housing payment for 90
575-040-03S	Statement of eligibility (Spanish) for supplementary replacement housing payment for 90
575-040-04	Relocation assistance costs
575-040-05	Replacement housing payment determination three comparables method
575-040-06	Statement of eligibility for supplementary replacement housing payment for own
575-040-06S	Statement of eligibility (Spanish) for supplementary replacement housing payment for 180-day
575-040-08	Hazardous substance letter
575-040-09	90-day letter of assurance
575-040-09S	90-day letter of assurance (Spanish)
575-040-10	Replacement housing payment transaction package
575-040-11	30-day notice to vacate
575-040-11S	30-day notice to vacate (Spanish)
575-040-12	Income certification
575-040-13	Replacement housing questionnaire/certification
575-040-14	Application and claim for replacement housing payment
575-040-15	Move cost estimate
575-040-16	Search expense itemization
575-040-17	Personal property inventory
575-040-19	Receipt for business move options information packet
575-040-20	Moving expense calculation and payment determination
575-040-21	Moving cost transaction package

Table A-21. Continued

Form no	Form title
575-040-22	Direct payment agreement
575-040-23	Application and claim for reimbursement of moving costs
575-040-24	Warrant acknowledgement
575-040-25	Relocation payment appeal
575-040-26	Trip log for reimbursement of search cost
575-040-27	Labor cost worksheet
575-040-28	Owned equipment usage and charges
575-040-29	Receipt for information packet for residential moves
575-040-30	Notice of eligibility nonresidential/ signs
575-040-30S	Notice of eligibility nonresidential signs (Spanish)
575-040-31	Notice of eligibility residential
575-040-31S	Notice of eligibility residential (Spanish)
575-040-32	Offer of benefits on-premise signs
575-040-33	Notice of claim denial/right to appeal
575-060-01	Property inventory
575-060-02	Cash receipt form
575-060-03	Affidavit
575-060-04	Demolition and removal contract minus contract
575-060-05	Demolition and removal contract plus contract
575-060-06	Performance bond (Surety)
575-060-07	Contract completion report
575-060-08	Asbestos abatement contract
575-060-09	Field inspection
575-060-10	Performance bond (Cash)
575-060-11	Release & Notice of non-friable asbestos containing materials temp. Leased/Occupied
575-060-12	Collection form
575-060-13	Non-collusion declaration and compliance with 49 CFR 29.
575-060-16	Affidavit "asbestos abatement"
575-060-17	Release and right of entry agreement for asbestos survey
575-060-17S	Release and right of entry agreement for asbestos survey (Spanish)
575-060-18	Release and notice of non-friable asbestos containing materials (ACM)
575-060-19	Release and notice of friable asbestos hazard
575-060-22	Radon gas notification
575-060-22S	Radon gas notification (Spanish)
575-060-31	Proposed lease notification
575-060-32	Airspace agreement
575-060-33	Lease agreement
575-060-33S	Lease agreement (Spanish)
575-060-34	Initial O and M management plan review
575-060-35	Initial building survey review
575-060-36	Initial abatement technical specification review
575-060-37	Radon gas notification and disclosure of lead-based paint hazards warning

Table A-21. Continued

Form no	Form title
575-060-37S	Radon gas notification and disclosure of lead-based paint hazards warning (Spanish)
575-070-01	Outdoor advertising permit tag replacement request
575-070-02	Outdoor advertising license application
575-070-04	Application for outdoor advertising permit
575-070-12	Outdoor advertising permit cancellation certification
575-070-18	Application to place banners on non limited access right of way
575-070-25	Outdoor advertising permit transfer affidavit
575-095-07	Local agency program/FDOT right of way certification
575-095-09	Local agency program/FDOT - no additional right of way certification
575-095-10	Right of way certification - Design build
FLI-163	Logo application/annual permit renewal

Roadway design office

Table A-22. Roadway design office construction forms

Form No	Form Title
592-12	Drainage Connection Permit Application
592-13	Drainage Connection Permit

Safety office

Table A-23. Safety office construction forms

Form no	Form title
500-000-25	Detailed damage inspection report
500-065-01	Subgrant application for highway safety funds
500-065-04	Statement of highway safety project costs
500-065-05	Summary statement of personnel services cost
500-065-06	Personnel services time sheet
500-065-07	Detail of costs
500-065-09	Non-expendable property accountability record
500-065-17	Highway safety concept paper coversheet
500-065-18	Concept paper evaluation form

Specification office

Table A-24. Specifications office construction forms

Form no	Form title
630-020-01	Notification of alleged deficiency transportation products - Qualified prod

Structures office

Table A-25. Structures office construction forms

Form no	Form title
625-020-05	ADA consituent curb ramp request
625-020-06	ADA consituent accessible route request

Support services office

Table A-26. Support services office construction forms

Form No	Form Title
050-020-02	Records Submittal Request

Systems planning office

Table A-27. Systems planning office construction forms

Form no	Form title
850-040-14	Driveway/Connection application category a (single family homes, duplexes)
850-040-15	Driveway/Connection application for all categories
850-040-16	Receipt of connection application and fee (or waiver of fee)
850-040-17	Record of waived requirements for all categories
850-040-18	Driveway connection permit for all categories
850-040-19	Record drawings report by permittee's professional engineer
850-040-20	Security instrument receipt
850-040-21	State highway access connection completeness review
850-040-22	Applicant time extension form
850-040-23	Proposed state hwy access driveway/connection notice of intent to deny permit
850-040-24	Proposed state highway access connection notice of intent to issue permit
850-040-26	Violation and notice to show cause

Traffic engineering and operations office

Table A-28. Traffic engineering and operations office construction forms

Form no	Form title
700-010-22	Final acceptance of traffic signal installation(s) & transfer of maintenance
750-010-02	Submittal data - traffic control equipment
750-010-03	Vehicle spot speed study
750-010-12	Application for traffic control device certification
750-010-13	Certified traffic control signal device complaint form
750-010-22	Traffic signal maintenance and compensation agreement
750-020-01	Traffic signal warrant summary
750-020-02	Summary of vehicle movements
750-020-03	Vehicle movements data sheet
750-020-04	Condition diagram
750-020-05	Collision diagram
750-020-06	Crash summary

Table A-28. Continued

Form no	Form title
750-020-07	Intersection delay study
750-020-08	Vehicle gap size study
750-020-09	Pedestrian volume sheet
750-020-10	Summary of pedestrian movement
750-020-11	Pedestrian group size
750-020-12	Safe curve speed study
750-020-13	No passing zone study
750-020-14	Travel time and delay study field data
750-020-15	Guidelines for determining the operational status of existing lighting facilities on freeway
750-020-16	Guidelines for determining the operational status of existing lighting
750-020-17	Guidelines for determining the operational status of existing lighting
750-020-18	Roundabout justification study
750-020-19	Travel time and delay study field summary
750-040-02	Closed circuit television camera (CCTC) agreement

Transit office

Table A-29. Transit office construction forms

Form no	Form table
725-030-01	State fleet program vehicle release form
725-030-02	State fleet equipment inspection
725-030-03	State fleet program report maintenance summary
725-030-04	Work order state fleet program
725-030-05	Lease agreement for department of transportation vehicles and equipment
725-030-08	State fleet program transit bus PM inspection
725-030-09	State fleet program preventive maintenance and inspection vans and wagons
725-030-10	Certificate of compliance for a section 5311 subrecipient
725-030-11	FDOT medical examination report for bus transit system driver

Turnpike enterprise office

Table A-30. Turnpike enterprise office construction forms

Form no	Form title
800-040-01	Qualification of tandem trailer equipment (Tractor)
800-040-02	Qualification of tandem trailer equipment (First or lead trailers)
800-040-03	Certification of insurance
800-040-04	General certification covering tandem trailer operations by permittee
800-040-05	Qualification for special permit to operate tandem trailer vehicle
800-040-06	Certification of tandem trailer equipment (Dolly converters)
800-040-07	Qualification for special certificate to operate tandem trailer vehicle

Utilities office

Table A-31. Utilities office construction forms

Form no	Form title
710-010-04	Utility work order change no. __
710-010-05	Utility work schedule
710-010-06	Utility estimate summary
710-010-08	Required provisions for federal aid contracts with a UAO
710-010-09	Required provisions for federal aid contracts with an engineering contractor
710-010-12	Utility billing summary
710-010-18	Joint use of utility facilities agreement
710-010-20	Utility master agreement, (At UAO and FDOT expense combined)
710-010-21	Utility work by highway contractor agreement, (At FDOT expense)
710-010-22	Utility work by highway contractor agreement, (At utility expense)
710-010-30	State highway lighting, maintenance, and compensation agreement
710-010-50	Corporate resolution, delegation and special power of attorney
710-010-51	Delegation and special power of attorney
710-010-52	Roadway lighting system maintenance agreement
710-010-53	Roadway illumination services agreement
710-010-54	Utility work agreement (FDOT participating in expense)
710-010-55	Utility work agreement, (At UAO's sole expense)
710-010-56	Utility design by FDOT consultant agreement, (At utility expense)
710-010-57	Utility work by highway contractor agreement (Lump sum)
710-010-61	Utility exception
710-010-64	Utility work by highway contract master agreement (at UAO and FDOT expense combined)
710-010-65	Selective utility work agreement (FDOT participating in expense)
710-010-85	Utility permit

Filtered Construction Forms

These forms are reviewed and the forms in the following table chosen to be reviewed in order to create the initial data dictionary.

Construction office construction forms

Table A-32. Construction office filtered construction forms

Form no	Form title
700-010-08	MOT review report
700-010-15	Work plan controlling item of work
700-010-25	Contractors past performance report
700-010-64	Engineers maintenance of traffic evaluation at crash site
700-010-69	Wage and hour record
700-010-84	Drilled shaft log

Table A-32. Continued

Form no	Form title
700-010-86	Drilled shaft rock excavation log
700-010-89	Drilled shaft concrete placement log
700-050-08	Piling tabulations

Equal opportunity office construction forms

Table A-33. Equal opportunity office filtered construction forms

Form no	Form title
275-020-04	O.J.T. monthly time report - Asphalt luteman raker
275-020-07	On-the-job training schedule compliance check
275-020-08	Trainee enrollment and notification of personnel action
275-020-09	O.J.T. monthly time report - Concrete curb/sidewalk machine operator
275-020-13	O.J.T. monthly time report - Erosion control specialist
275-020-17	O.J.T. monthly time report - Earth wall erector
275-020-18	O.J.T. monthly time report - Installer/Tester
275-020-19	O.J.T. monthly time report - Roller operator
275-020-20	O.J.T. monthly time report - Front-end loader operator
275-020-22	O.J.T. monthly time report-Highway or bridge ironworker, reinforcing
275-020-23	O.J.T. monthly time report - Scraper-Pan operator
275-020-24	O.J.T. monthly time report - Form/Curb & gutter builder (Structures)
275-020-25	O.J.T. monthly time report - Grade checker
275-020-26	O.J.T. monthly time report - Asphalt/Bridge deck screed operator
275-020-27	O.J.T. monthly time report - Highway concrete finisher
275-020-28	Equal employment opportunity officers
275-020-29	O.J.T. monthly time report - Highway or bridge carpenter
275-020-30	O.J.T. monthly time report - Pipelayer
275-020-31	O.J.T. monthly time report - Backhoe operator
275-020-35	O.J.T. monthly time report - Painter, highway or bridge
275-020-36	O.J.T. monthly time report - Air compressor operator
275-020-37	O.J.T. monthly time report - Asphalt distributor
275-020-38	O.J.T. monthly time report - Asphalt paving machine operator
275-020-39	O.J.T. monthly time report - Asphalt plant drier operator
275-020-43	Certification of subcontract amount to DBE contractor
275-020-44	O.J.T. monthly time report equipment maintenance technician
275-020-45	O.J.T. monthly time report - Motor grader operator
275-020-46	O.J.T. monthly time report - Milling machine operator
275-020-47	O.J.T. monthly time report- Concrete paving finishing machine operator
275-020-48	O.J.T. monthly time report- Concrete paving machine/spreader operator
275-020-49	O.J.T. monthly time report - Deckhand
275-020-51	O.J.T. monthly time report - Mechanic
275-020-58	O.J.T. monthly time report - Truck driver
275-020-60	O.J.T. monthly time report - Tractor operator
275-020-64	O.J.T. monthly time report - Stone and aggregate spreader operator

Materials office construction forms

Table A-34. Materials office filtered construction forms

Form no	Form title
675-010-02	Compressive strength of concrete cylinders
675-010-03	Concrete design mix
675-020-22	Density log book

Data Dictionary

The initial data dictionary is created at early stages of the project and should evolve to its final form when required feedback from FDOT obtained. The data dictionary snapshot is given in the Table A-35.

Table A-35. Data dictionary snapshot

Label on form	Common name	Inventory name	Data type	Document	Producer	Consumer

Label on the form is referred to as the name given to data item on the form. This column will be extracted directly from the forms. Common name is the name attributed to data items in order to prevent labeling conflicts. Inventory name is the label used for the data items in my research inventory. Common name and the inventory name same for most of the elements. Data type is the type of data, either simple or complex. Document is referred to as the form number of the form listings from which the data is obtained. Producer is the party who has created the data. Consumer is the party that uses the data. The last two columns were created to be able to map the data. They are important in understanding that will be using the data and what they are going to use it for.

APPENDIX B
TRANSXML AND DIGGS DOCUMENTATION

TransXML and DIGGS are the ongoing projects that are most likely to contribute to my research. This section contains some additional data about the documents created in those projects.

TransXML Documentation

Table B-1. TransXML documentation

Business area	Application	Title
Transportation construction & materials	XML schema	TransXML bid package schema v.03
Transportation construction & materials	XML schema	TransXML construction progress schema v. 0.3
Survey/Roadway design	XML schema	TransXML design project schema v. 0.3
Transportation construction & materials	XML schema	TransXML linear reference schema v. 0.3
Transportation construction & materials	XML schema	TransXML material sampling and testing schema v. 03
Transportation construction & materials	XML schema	TransXML project construction status schema v. 03
Transportation construction & materials	XML schema	TransXML reference rchema v. 0.3
Transportation construction & materials	XML schema	TransXML base schema v. 0.3
Highway bridge structures	Software	TransXML bridge input converter
Transportation safety	XML schema	Crash list state
Transportation safety	XML schema	Fars
Transportation safety	XML schema	Fars_2005
Transportation safety	XML schema	Fars crash list
Transportation safety	XML schema	MMUC
Transportation safety	XML schema	MXDM
Transportation safety	XML schema	Summary
Transportation safety	XML schema	Value pair

DIGGS Documentation

Table B-2. DIGGS documentation

Application	Title
Text file	DIGGS data dictionary rev 23
XML schema	Aggregate abrasion value
XML schema	Aggregate crushing value
XML schema	Aggregate impact value
XML schema	Atterberg limits

Table B-2. Continued

Application	Title
XML schema	Blow
XML schema	Business associate
XML schema	Capwap
XML schema	Capwap segment
XML schema	Cast shaft
XML schema	Cast shaft component
XML schema	Cast shaft construction
XML schema	Cast shaft instance
XML schema	CBR detail
XML schema	CBR general
XML schema	Chalk tests
XML schema	Chemical tests
XML schema	Compaction detail
XML schema	Compaction general
XML schema	Compressive strength detail
XML schema	Compressive strength general
XML schema	Consolidation detail
XML schema	Consolidation general
XML schema	Detail
XML schema	Diggs CRS
XML schema	Dilatometer detail
XML schema	Dilatometer general
XML schema	Discontinuity data
XML schema	Driven penetration test detail
XML schema	Driven penetration test general
XML schema	Driven pile
XML schema	Driven pile component
XML schema	Driven pile construction
XML schema	Driven pile instance
XML schema	Driving analysis
XML schema	Driving log
XML schema	Elongation index
XML schema	Equipment
XML schema	Flakiness index
XML schema	Foundation group
XML schema	Fracture spacing
XML schema	Frost susceptibility detail
XML schema	Frost susceptibility general
XML schema	Hand vane
XML schema	Hole
XML schema	Hole construction
XML schema	Insitu CBR
XML schema	Insitu chemical tests
XML schema	Insitu density

Table B-2. Continued

Application	Title
XML schema	Insitu flame ionisation detector
XML schema	Insitu permeability detail
XML schema	Insitu permeability general
XML schema	Insitu photo ionisation detector
XML schema	Laboratory permeability
XML schema	Laboratory velocity
XML schema	Layer
XML schema	Library
XML schema	Load test
XML schema	Los Angeles abrasion
XML schema	Mcv detail
XML schema	Mcv general
XML schema	Meta data
XML schema	Monitoring point construction
XML schema	Monitoring point event
XML schema	Monitoring point general
XML schema	Monitoring point reading
XML schema	Other field tests
XML schema	Other laboratory tests
XML schema	Particle size general
XML schema	Pocket penetrometer
XML schema	Point load test
XML schema	Polished stone value
XML schema	Porosity
XML schema	Pressuremeter detail data
XML schema	Pressuremeter detail loops
XML schema	Pressuremeter detail test
XML schema	Pressuremeter general
XML schema	Project
XML schema	Redox potential
XML schema	Relative density
XML schema	Resistivity
XML schema	Sample
XML schema	Schmidt rebound hardness
XML schema	Shear box detail
XML schema	Shear box general
XML schema	Shore hardness
XML schema	Shrinkage
XML schema	Slake durability
XML schema	Soundness
XML schema	Specification
XML schema	Specimen
XML schema	Static cone test detail

Table B-2. Continued

Application	Title
XML schema	Static cone test general
XML schema	Suction
XML schema	Ten percent fines
XML schema	Transmission information
XML schema	Vane detail
XML schema	Vane general
XML schema	Water absorption
XML schema	Water levels in hole

APPENDIX C
ADDITIONAL DOCUMENTATION FOR INDIVIDUAL RESEARCH

As stated in previous chapters, I have created four schemas and four application files for the data on FDOT construction forms.

FDOT Construction Forms and Related Documentation

Engineer's MOT Evaluation at Crash Site Form and Data inventory

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

ENGINEER'S MAINTENANCE OF TRAFFIC (MOT) EVALUATION AT CRASH SITE

700-010-64
CONSTRUCTION
08/04
Page 1 of 3

Date/Time of Occurrence: _____ Report Date: _____

FIN Project No.: _____ State Road No.: _____ District: _____

Federal Project No.: _____ County: _____

Contract No.: _____ WPI No.: _____

MOT Evaluation at Crash Site:

Have there been other crashes in the same vicinity of the work zone?

○ YES ○ NO

If yes, give dates. _____

Police Investigated? ○ YES ○ NO

If available, attach police report.

Work Zone Location of Crash:
(Approach, transition, work area) _____

Is the immediate area at the crash site in accordance with State Standards, MUTCD and TCP? ○ YES ○ NO

Are there any recommended enhancements to the MOT at the crash site?

○ YES ○ NO

List enhancements to be made to the work site. _____

Distribution: Original to Project Administrator
Copies to: District Safety Engineer
Contractor
State Construction Office (MS 31)
State Safety Office (MS 53)

Figure C-1. Engineer's maintenance of traffic (MOT) evaluation at crash site form

DIAGRAM:

Crash Diagram including all traffic control devices present at the time of crash, vehicles involved, etc.

In addition to the above diagram, if the traffic control plan in effect follows guidelines of MUTCD, Part VI, indicate figure number, standard index sheet number, or plan sheet.

+ INDICATE NORTH

- Sign with flag & light
- Sign on Portable or Permanent Support
- Vertical Panel
- Barricade
- Cone
- Drum
- Flagger

ANALYSIS OF CONDITIONS: if known

Pavement:	Visibility:	Routing:
☐ Wet	☐ Clear	☐ Existing Pavement
☐ Dry	☐ Limited	☐ Detour
☐ Asphalt	☐ Night (darkness)	☐ Approach to Construction
☐ Concrete	☐ Day (daylight)	
☐ Other		

Type of Project:

☐ Resurfacing Undivided Median	☐ Reconstruction Undivided Median, Urban
☐ Resurfacing Divided Median	☐ Reconstruction Divided Median, Urban
☐ Widening Undivided Median	☐ New Construction, Undivided Median
☐ Reconstruction Undivided Median, Rural	☐ New Construction, Divided Median
☐ Reconstruction Divided Median, Rural	☐ Intersection
☐ Widening Undivided to Divided	☐ Other (Describe) _____

_____ Telephone Number (daytime)

_____ Signature of Project Administrator

Figure C-1. Continued

Table C-1. Engineer's MOT evaluation at crash site form data inventory

Label on form	Data Type
Date/Time of occurrence	dateTime
Report Date	Date
FIN project no	Integer
State road no	String
District	Integer
Federal project no	Integer
County	String
Contract no	Integer
WPI no	Integer
Have there been other crashes in the same vicinity of the work zone	Boolean
If yes, give dates	Date
Police investigated	Boolean
Work zone location of crash	String
MUTCD and TCP accordance	Boolean
Enhancements to the MOT at the crash site	Boolean
List enhancements	String
Analysis of conditions	
Pavement	String
Visibility	String
Routing	String
Type of project	String
Name of the engineer	String

XML schema for engineer's MOT evaluation at crash site form

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema elementFormDefault="qualified"
xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns="duzgun"
targetNamespace="duzgun">
   <xs:element name="MOTEvaluationAtCrashSite">
      <xs:complexType>
         <xs:sequence>
            <xs:element name="dateTimeOfOccurance" type="xs:dateTime"/>
            <xs:element name="reportDate" type="xs:date"/>
            <xs:element name="finProjectNo" type="xs:integer"/>
            <xs:element name="stateRoadNo" type="xs:string"/>
            <xs:element name="district" type="xs:integer"/>
            <xs:element name="federalProjectNo" type="xs:integer"/>
            <xs:element name="county" type="xs:string"/>
            <xs:element name="contractNo" type="xs:integer"/>
            <xs:element minOccurs="0" name="WPIno" type="xs:integer"/>
            <xs:element name="otherAccidents" type="xs:boolean"/>
            <xs:element minOccurs="0" name="ifYesGiveDate"/>
```

```
<xs:element name="workZoneLocationOfCrash" type="xs:string"/>
<xs:element name="MUTCDTCPAccordance" type="xs:boolean"/>
<xs:element name="recommendingEnhancements" type="xs:boolean"/>
<xs:element minOccurs="0" name="enhancements" type="xs:string"/>
<xs:element name="AnalysisOfConditions">
  <xs:complexType>
    <xs:sequence>
      <xs:element minOccurs="0" name="pavementCondition">
        <xs:simpleType>
          <xs:restriction base="xs:string">
            <xs:enumeration value="Wet"/>
            <xs:enumeration value="Dry"/>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element minOccurs="0" name="pavementMade">
        <xs:simpleType>
          <xs:restriction base="xs:string">
            <xs:enumeration value="Asphalt"/>
            <xs:enumeration value="Concrete"/>
            <xs:enumeration value="Other"/>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element minOccurs="0" name="visibility">
        <xs:simpleType>
          <xs:restriction base="xs:string">
            <xs:enumeration value="Clear"/>
            <xs:enumeration value="Limited"/>
            <xs:enumeration value="Night"/>
            <xs:enumeration value="Day"/>
            <xs:enumeration value=""/>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element minOccurs="0" name="routing">
        <xs:simpleType>
          <xs:restriction base="xs:string">
            <xs:enumeration value="Existing Pavement"/>
            <xs:enumeration value="Detour"/>
            <xs:enumeration value="Approach to Construction"/>
            <xs:enumeration value=""/>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element name="projectType">
```

```
                    <xs:simpleType>
                      <xs:restriction base="xs:string">
                        <xs:enumeration value="Resurcafing Undivided Median"/>
                        <xs:enumeration value="Resurcafing Divided Median"/>
                        <xs:enumeration value="Widening Undivided Median"/>
                        <xs:enumeration value="Reconstruction Undivided Median, Rural"/>
                        <xs:enumeration value="Reconstruction Divided Median, Rural"/>
                        <xs:enumeration value="Widening Undivided to Divided"/>
                        <xs:enumeration value="Reconstruction Undivided Median, Urban"/>
                        <xs:enumeration value="Reconstruction Divided Median, Urban"/>
                        <xs:enumeration value="New Construction, Undivided Median"/>
                        <xs:enumeration value="New Construction, Divided Median"/>
                        <xs:enumeration value="Intersection"/>
                        <xs:enumeration value="Other"/>
                      </xs:restriction>
                    </xs:simpleType>
                  </xs:element>
                 <xs:element name="ifOtherSpecify" type="xs:string" minOccurs="0"/>
                </xs:sequence>
              </xs:complexType>
            </xs:element>
            <xs:element name="nameOfTheEngineer" type="xs:string"/>
          </xs:sequence>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

XML instance document for engineer's MOT evaluation at crash site form

```
<MOTEvaluationAtCrashSite xmlns="duzgun"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="duzgun 700-015-68.xsd">
    <dateTimeOfOccurance>2002-04-01T03:25:00</dateTimeOfOccurance>
    <reportDate>2002-04-15</reportDate>
    <finProjectNo>21325915201</finProjectNo>
    <stateRoadNo>9A</stateRoadNo>
       <district>2</district>
       <federalProjectNo>29552691</federalProjectNo>
       <county>duval</county>
       <contractNo>21444</contractNo>
       <otherAccidents>false</otherAccidents>
       <ifYesGiveDate></ifYesGiveDate>
       <workZoneLocationOfCrash>work zone</workZoneLocationOfCrash>
       <MUTCDTCPAccordance>true</MUTCDTCPAccordance>
       <recommendingEnhancements>false</recommendingEnhancements>
       <enhancements></enhancements>
       <AnalysisOfConditions>
```

```
    <pavementCondition>Dry</pavementCondition>
    <pavementMade>Asphalt</pavementMade>
    <visibility>Limited</visibility>
    <routing>Approach to Construction</routing>
    <projectType>Reconstruction Divided Median, Urban</projectType>
    <ifOtherSpecify></ifOtherSpecify>
  </AnalysisOfConditions>
  <nameOfTheEngineer>John Doe</nameOfTheEngineer>
</MOTEvaluationAtCrashSite>
```

Contractor's Past Performance Rating Form and Data Inventory

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

CONTRACTOR'S PAST PERFORMANCE REPORT

700-010-25
CONSTRUCTION
09/05
Page 1 of 7

(Contractor Name) _____ (FIN Project No.)

(Address) _____ (County) _____ (Contract No.)

(Final Contract Amount) _____ (Type Of Work)

(Proj. Administrator/Firm or Residency) _____ (Date Final Accepted)

ANSWER ALL QUESTIONS

Performance	Maximum Value	Rated Value
1. Pursuit of the Work.	12	
2. Proper MOT and Minimize Impacts to Traveling Public	12	
3. Timely and Complete Submittal of Documents.	8	
4. Timely Completion of Project.	14/20 note # 4	
5. Coordination / Cooperation with CEI Personnel, Property Owners and Utilities Company.	10	
6. Mitigate Cost and Time Overruns	12	
7. Environmental Compliance	10/12 note # 4	
8. Conformance With Contract Documents.	20	
9. DBE Utilization	0/4 note # 4	
Total Score	98/110	

Project Administrator (signature) _____ Date _____ **Resident Engineer** (signature) _____ Date _____

Figure C-2. Contractor's past performance rating form

Table C-2. Contractor's past performance rating form data inventory

Label on form	Data type
Contractor name	String
FIN project no.	Integer
Address	Address
County	String
Contract no.	Integer
Final contract amount	Double
Type of work	String
Proj. administrator/firm or residency	String
Date final accepted	Date
Pursuit of the work	Integer
Proper MOT application	Integer
Timely submittal of documents	Integer
Timely completion of project	Integer
Coordination/Cooperation	Integer
Mitigate cost and time overruns	Integer
Environmental compliance	Integer
Conformance with contract documents	Integer
DBE utilization	Integer
Project administrator	String
Resident engineer	String

XML schema for contractor's past performance rating form

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns="duzgun"
xmlns:gml="http://www.opengis.net/gml" xmlns:txl="http://www.transxml.net/schema/txl/0.3"
targetNamespace="duzgun" elementFormDefault="qualified">
    <xs:import namespace="http://www.opengis.net/gml"
      schemaLocation="gml/3.1.1/base/gml.xsd"/>
    <xs:import namespace="http://www.transxml.net/schema/txl/0.3" schemaLocation="TXL-
    GML20060123pxs.xsd"/>
    <xs:element name="ContractorPerformanceRating">
      <xs:complexType>
        <xs:sequence>
          <xs:element name="contactorName" type="xs:string"/>
          <xs:element name="financialProjectNo" type="xs:integer"/>
          <xs:element name="address" type="txl:StreetAddressPropertyType"/>
          <xs:element name="county" type="xs:string"/>
          <xs:element name="contractNo" type="xs:integer"/>
          <xs:element name="finalContractAmount" type="xs:double"/>
          <xs:element name="typeOfWork" type="xs:string"/>
          <xs:element name="projectAdministrator" type="xs:string"/>
          <xs:element name="acceptanceDate" type="xs:date"/>
          <xs:element name="Performance">
```

```
<xs:complexType>
  <xs:sequence>
    <xs:element name="pursuitOfTheWork">
      <xs:simpleType>
      <xs:restriction base="xs:integer">
        <xs:maxInclusive value="12"/>
      </xs:restriction>
      </xs:simpleType>
    </xs:element>
    <xs:element name="properMOT">
      <xs:simpleType>
        <xs:restriction base="xs:integer">
          <xs:maxInclusive value="12"/>
        </xs:restriction>
      </xs:simpleType>
    </xs:element>
    <xs:element name="timelyAndCompleteDocumentSubmittal">
      <xs:simpleType>
        <xs:restriction base="xs:integer">
          <xs:maxInclusive value="8"/>
        </xs:restriction>
      </xs:simpleType>
    </xs:element>
    <xs:element name="timelyCompletion">
      <xs:simpleType>
        <xs:restriction base="xs:integer">
          <xs:maxInclusive value="20"/>
        </xs:restriction>
      </xs:simpleType>
    </xs:element>
    <xs:element name="coordination">
      <xs:simpleType>
        <xs:restriction base="xs:integer">
          <xs:maxInclusive value="10"/>
        </xs:restriction>
      </xs:simpleType>
    </xs:element>
    <xs:element name="mitigateCostAndTimeOverruns">
      <xs:simpleType>
        <xs:restriction base="xs:integer">
          <xs:maxInclusive value="12"/>
        </xs:restriction>
      </xs:simpleType>
    </xs:element>
    <xs:element name="environmentalCompliance">
      <xs:simpleType>
```

```
                        <xs:restriction base="xs:integer">
                            <xs:maxInclusive value="12"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="conformanceWithContractDocuments">
                    <xs:simpleType>
                        <xs:restriction base="xs:integer">
                            <xs:maxInclusive value="20"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="DBEUtilization">
                    <xs:simpleType>
                        <xs:restriction base="xs:integer">
                            <xs:maxInclusive value="4"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="totalScore">
                    <xs:simpleType>
                        <xs:restriction base="xs:integer">
                            <xs:maxInclusive value="110"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="projectAdministrator" type="xs:string"/>
    <xs:element name="date" type="xs:date"/>
    <xs:element name="residentEngineer" type="xs:string"/>
    <xs:element name="date" type="xs:date"/>
  </xs:sequence>
 </xs:complexType>
</xs:element>
</xs:schema>
```

XML instance document for contractor's past performance rating form

```
<?xml version="1.0" encoding="UTF-8"?>
<ContractorPerformanceRating xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="duzgun 700-010-25.xsd"
 xmlns:gml="http://www.opengis.net/gml"
 xmlns:txl="http://www.transxml.net/schema/txl/0.3"
 xmlns="duzgun">
   <contactorName>John Doe</contactorName>
```

```
    <financialProjectNo>123456789213</financialProjectNo>
    <address>
      <txl:StreetAddress>
        <txl:street>3800 SW</txl:street>
        <txl:cityName>gainesville</txl:cityName>
        <txl:stateCode>FL</txl:stateCode>
        <txl:postalCodeID>32608</txl:postalCodeID>
        <txl:postalCodeExtension>1254</txl:postalCodeExtension>
        <txl:addressCategory>headquarters</txl:addressCategory>
      </txl:StreetAddress>
      </address>
    <county>alachua</county>
    <contractNo>12542</contractNo>
    <finalContractAmount>12354654.00</finalContractAmount>
    <typeOfWork>Maintenance</typeOfWork>
    <projectAdministrator>Jane Doe</projectAdministrator>
    <acceptanceDate>1965-11-11</acceptanceDate>
    <Performance>
      <pursuitOfTheWork>12</pursuitOfTheWork>
      <properMOT>12</properMOT>
      <timelyAndCompleteDocumentSubmittal>8</timelyAndCompleteDocumentSubmittal>
      <timelyCompletion>4</timelyCompletion>
      <coordination>6</coordination>
      <mitigateCostAndTimeOverruns>5</mitigateCostAndTimeOverruns>
      <environmentalCompliance>7</environmentalCompliance>
      <conformanceWithContractDocuments>10</conformanceWithContractDocuments>
      <DBEUtilization>4</DBEUtilization>
      <totalScore>82</totalScore>
    </Performance>
    <projectAdministrator>John Doe</projectAdministrator>
    <date>1985-10-10</date>
    <residentEngineer>John Doe</residentEngineer>
    <date>1985-10-10</date>
</ContractorPerformanceRating>
```

Work Plan Controlling Item of Work Form and Data Inventory

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

700-010-15
CONSTRUCTION
10/02

WORK PLAN
CONTROLLING ITEM OF WORK

FINANCIAL PROJECT ID _____ CONTRACT NO. _____

In accordance with the accepted work schedule the controlling items of work for the period (☐ weekly/ ☐ biweekly) from _____ to _____ are as follows:

Description	Location/Limits

Prime Contractor or Subcontractors will work: ☐ 5 day work week ☐ 6 day work week ☐ 7 day work week ☐ Other

Contractor's comments:

Submitted by: _____
Contractor's Representative (signature) Date

Project Engineer's comments:

Approved by: _____
Project Engineer (signature) Date

Distribution: Original - Project File
1 Copy - Contractor (as requested)

Figure C-3. Work plan controlling item of work form

Table C-3. Work plan controlling item of work form data inventory

Label on Form	Data Type
Financial Project ID	Integer
Date from	Date
Date to	Date
Contract No.	String
Description	String
Location/Limits	String
Work days	Integer
Contractor's comments	String
Submitted by	String
Submission date	Date
PE comments	String
Reviewed by	String
Review date	Date
Approved by	String
Approval date	Date

XML schema for work plan controlling item of work form

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
elementFormDefault="qualified" xmlns="duzgun" targetNamespace="duzgun">
   <xs:element name="WorkPlanControllingItemOfWork">
      <xs:complexType>
         <xs:sequence>
            <xs:element name="financialProjectId" type="xs:integer"/>
            <xs:element name="contractNo" type="xs:string"/>
            <xs:element name="dateFrom" type="xs:date"/>
            <xs:element name="dateTo" type="xs:date"/>
            <xs:element name="description" type="xs:string"/>
            <xs:element name="location" type="xs:string"/>
            <xs:element name="contractorWorksFor" type="xs:string"/>
            <xs:element name="contractorComments" type="xs:string"/>
            <xs:element name="submittedBy" type="xs:string"/>
            <xs:element name="submissionDate" type="xs:date"/>
            <xs:element name="peComments" type="xs:string"/>
            <xs:element name="reviewedBy" type="xs:string"/>
            <xs:element name="reviewDate" type="xs:date"/>
            <xs:element name="approvedBy" type="xs:string"/>
            <xs:element name="approvalDate" type="xs:date"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>
</xs:schema>
```

XML instance document for work plan controlling item of work form

```
<?xml version="1.0" encoding="UTF-8"?>
   <WorkPlanControllingItemOfWork xmlns="duzgun"
     xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
     xsi:schemaLocation="duzgun 70001015.xsd">
    <financialProjectId>20778415201</financialProjectId>
    <contractNo>t2110</contractNo>
   <dateFrom>2001-10-11</dateFrom>
   <dateTo>2002-01-01</dateTo>
   <description>bridge superstructure</description>
   <location>gainesville</location>
   <contractorWorksFor>6 days</contractorWorksFor>
   <contractorComments></contractorComments>
   <submittedBy>John Doe</submittedBy>
   <submissionDate>2002-01-01</submissionDate>
   <peComments></peComments>
   <reviewedBy>John Doe</reviewedBy>
   <reviewDate>2002-01-01</reviewDate>
   <approvedBy>John Doe</approvedBy>
   <approvalDate>2002-01-07</approvalDate>
</WorkPlanControllingItemOfWork>
```

LIST OF REFERENCES

American Subcontractors Association, Inc (2006). *Electronic data exchange in construction.* Retrieved September 14, 2006, from http://www.asaonline.com/pdfs/June2006WhitePaper.pdf.

Econstruct (2001). *eConstruct homepage.* Retrieved September 27, 2006, from http://www.econstruct.org.

Ellis, R.D., McVay, M., Hoit, M. (2006). Integration of XML schemas for the exchange of FDOT construction project data. Research proposal, University of Florida, Department of Civil and Coastal Engineering, Florida.

Haas, C.T., Borcherding, J.D., Allmon, E., Goodrum, P. M. (1999). *U.S. construction labor productivity trends, 1970-1998.* Report, University of Texas at Austin, Center for Construction Industry Studies, Texas. Retrieved October 12, 2006, from http://www.cdc.gov/elcosh/docs/d0100/d000131/d000131.PDF.

O'Reilly Media, Inc. (2006). *What is XML?* Retrieved September 10, 2006 from http://www.xml.com/pub/a/98/10/guide0.html.

Refsnes Data (2006) *XML tutorial*. Retrieved August 26, 2006, from http://www.w3schools.com/xml/default.asp.

Refsnes Data (2006) *XML schema tutorial.* Retrieved September 15, 2006, from http://www.w3schools.com/schema/default.asp.

Styler, M. (2006). Development and implementation of the DIGGS format to perform LRFD resistance factor calibration of driven concrete piles in Florida. Master's thesis, University of Florida, Department of Civil and Coastal Engineering, Florida.

The World Wide Web Consortium (2003). *Extensible markup language*. Retrieved July 28, 2006, from http://www.w3.org/XML

The World Wide Web Consortium (2003). *XML schema*. Retrieved August 14, 2006, from http://www.w3.org/XML/Schema.

NCHRP Transportation Research Board (2005). *XML schemas for exchange of transportation data GML experiment summary report.* Retrieved June 28, 2006, from http://www.transxml.com/GML+Experiment/Group+Documents/default.aspx.

NCHRP Transportation Research Board (2004). *XML schemas for exchange of transportation data interim report sections 1-5.* Retrieved June 16, 2006, from http://www.transxml.com/Info/Project+Documents/250.aspx.

U.S. Department of Commerce Technology Administration, National Institute of Standards and

Technology (2006). *Cost analysis of inadequate interoperability in the U.S. capital facilities industry*. Retrieved October 10, 2006, from http://fire.nist.gov/bfrlpubs/build04/PDF/b04022.pdf.

BIOGRAPHICAL SKETCH

Duzgun Agdas was born on June 14, 1983, in Tunceli, Turkey. After completing his high school education, he has attended the civil engineering department of Middle East Technical University (METU) in Ankara, Turkey. Upon getting his Bachelor of Science degree in Civil Engineering in June 2005, the author was admitted to the University of Florida for graduate level studies. After getting his Master of Engineering degree in 2006, he will remain at UF for his doctorate.