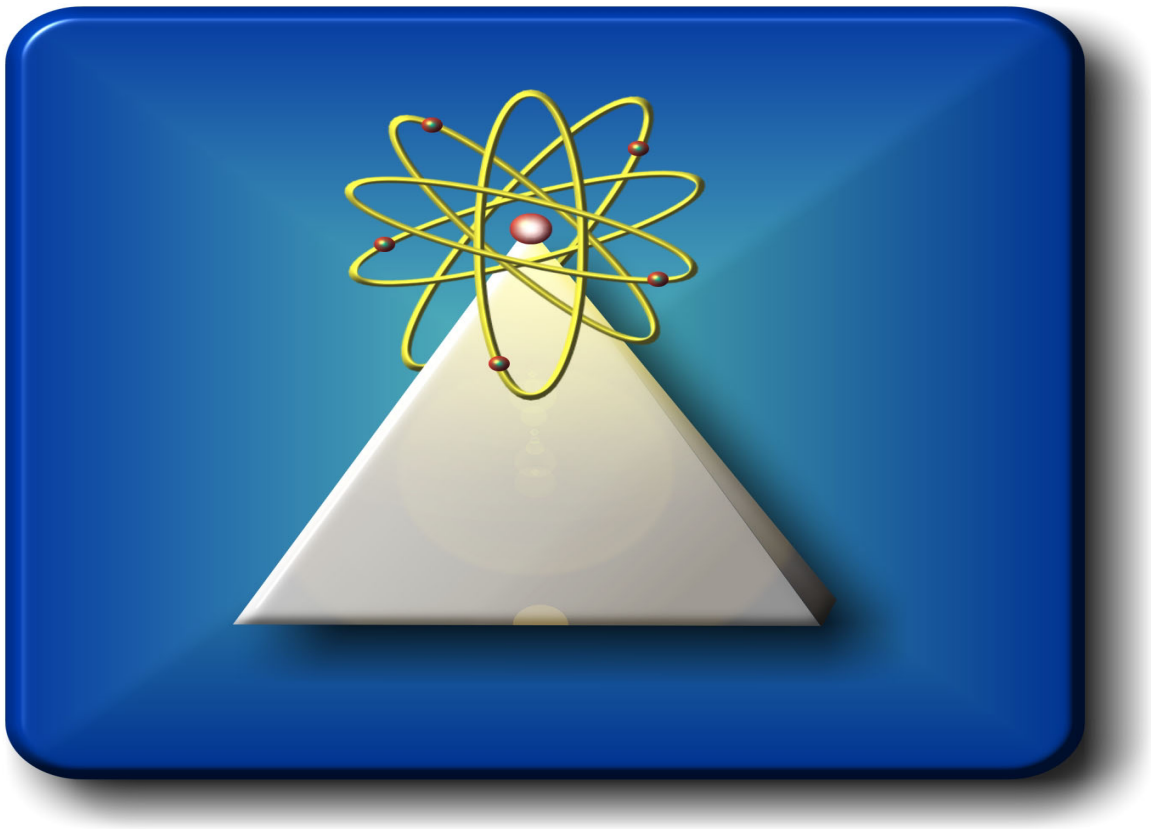

Programming Objects in Clarion

by

Russell B. Eggen

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Acknowledgments

During the writing of any book, an author is assisted by many people. This book is no exception. I wish to express my thanks to the following people:

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I would be remiss without expressing some thanks (in no particular order) to **Mark Goldberg**, **Dave Harms**, **Tom Hebenstreit** and **Mike Gould** for their assistance, comments and encouragement.

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To my wife, **Kathleen** for feeding me, offering encouragement ("that's nice, dear" and pats on the back), proofreading (catching those typos), ordering me to get some sleep once in a while, and just putting up with me.

And most of all, my thanks goes to the Clarion community. They are constantly curious, willing to learn and not afraid to ask questions in the quest to greater understanding. I dedicate this book to them to them.

And last, but certainly not least, the fine crew at **Softvelocity**. Without their tireless (and often thankless) actions, Clarion may not be in existence today.

This is an Unusual Book

Any book about Clarion (or any other subject) discusses the entire subject. Not this book. It was never my aim to pen another tome. See *Developing Clarion for Windows Applications* by **Dave Harms** and **Ross Santos**. That book is still valid today. If you need to read and learn about Clarion as a whole, I cannot recommend a better book.

There is another book by **Bruce Johnson** (link provided later). I like his effort as he focuses on the Application Builder Classes or ABC. For those that need more data about ABC, I cannot recommend his book enough either. However, this book covers more than just ABC. So I feel safe that I am not competing with Bruce (like I would want to anyway!)

Instead, I decided to focus on one Clarion topic, Object Oriented Programming. Think about it for a minute. That is quite a vast subject, more than just ABC. Clarion and OOP have been talked about, debated, taught, articles written and covered to death (even by yours truly). So what makes this book different from what was previously covered?

This is the *first* time all OOP topics are gathered together in one spot. In addition, each topic is in sequence. Thus, each chapter is more advanced than the previous chapter and builds on the covered data.

The reader should note that ABC is somewhere in the middle of the learning curve. There is data you need to know *before* you get into ABC and data that I recommend you know *after* ABC. My focus and goal is to bring the reader from the theory of OOP, to coding their own tools using these concepts.

I decided to not limit anything by skill level. The basic Clarion developers might be scared away and the advanced coders might think it too basic to bother. Thus, I decided to simply lay it out and explain in detail as I go. My intent was not to cater to any skill level, the only requirement being that one is familiar with Clarion.

This book is designed to be a living document. This means I plan to update it as new versions of Clarion warrant such tasks, to make corrections, and make topics more clear as reader feedback arrives. You can rest easy that I plan this book to remain as current as possible. I took great pains to ensure that the book is as version neutral as possible. Thus it applies to Clarion versions 4 through 6.

I hope the material presented here helps you become a more productive Clarion developer.

Russell B. Eggen

June 2003

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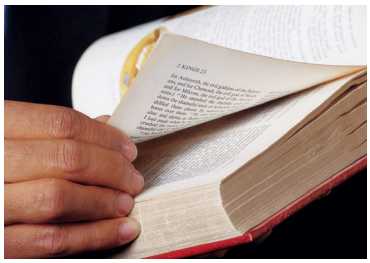
Chapter 1 - Struggling with Objects

Introduction

When first asked to present the topic of Object Oriented Programming at the East Tennessee Conference in May of 2002 (also known as ETC III), I decided to ask the Clarion community what they perceived to be the problem with working with objects. I could have just assumed I knew what the problem was, but I decided to ask what others thought. I am glad I asked as the answers were not what I was expecting. The answers I got back did paint a picture. However, not just any picture. When someone answers one of my questions I must follow up with, "Why did they say that?"



My investigation revealed something that I never really considered. Despite the many good articles, books, documentation and newsgroups threads, dealing with objects is still difficult! I got a few reasons why this was so. Some of the common justifications were that an application was too far into its development cycle to go into ABC (the OOP based templates). Also, people still think linear instead of abstracts when writing code.

ABC has its critics; some of their points are valid. That somehow made a good excuse not to use ABC. In other words, Clarion developers put a lot of "sweat equity" into learning the Clarion template set. That learning curve was not exactly easy as these templates produce a lot of code. Clarion programs were fat with unneeded code and it took time to wade through it. The original Clarion templates, (I don't know how to be diplomatic about this), are awful. I could state many arguments supporting that claim, but I am drifting off topic.

Now, the designers of ABC told everyone, "Never mind!" That is not a clever idea despite the best efforts of Topspeed staff (of which I was a member). What I mean by that is that if you are to upset accepted ideas, you had better be prepared to replace them. The education department certainly put their best efforts in this. So did those in documentation.

During the Topspeed days, you may recall a group of talented developers known as "Team Topspeed". These people knew Clarion very well and each member was a specialist in some area. Moreover, they were quite willing to share their knowledge with others.

I am going to let the cat out of the bag here, but Team Topspeed (TTS) struggled with ABC in the many beta stages. They objected on many of the same issues that later developers would struggle. They were quite willing to learn, but they did raise some legitimate concerns. After all, this was one of their functions, just not in the public eye.

For example, one member raised a very good point. When discussing the issue of code re-use, the rebuttal was "So what? I use routines for that. Show me why OOP is better". Another member questioned the wisdom of naming a report object "ThisWindow". In case

you are wondering, the small *People* application was the result of that conversation.

The whole point of this is simply to say that others went through the pain of shifting their style of coding too. I must include myself in this group. I learned the procedural, top- down style of programming. It works. It is very difficult indeed to change, let alone give up what works.

During my years as a Topspeed instructor, I had the honor (or was that sheer terror?) of teaching the very first ABC class. If that was not bad enough, ABC was in beta version 3 (out of 6) at the time. For those that were around, beta 3 was a complete re-write as beta 2 was unworkable. I was nowhere near the TS offices where I could easily get some help.

There I was, standing in front of about 10 students, all of them waiting to see and hear about this new "silver bullet" called ABC. I was under no pressure at all! Looking back on that experience, it was rough, but I think I got most folks through the difficult bits.

In later classes, I kept revising the OOP lessons based on surveys students filled out at the end of class. Until I got to the point, where I taught one class and three of those students were just amazed at how easy it really is. That is a nice thing for them to say, but I was aiming higher.

"Could you apply this data in your current projects?" I asked. "Absolutely!" they said. I grinned and informed them that within hours they were going to prove this point (I had some lab exercises waiting). They proved they could apply the materials I presented.

Thus, I knew my data was correct as I could now deliver the theory and when applied, it worked. This book is the result of those experiences.

Now let me explain how all of this flows.

How to study this subject

Based on those teaching experiences and what my survey revealed, I believe I have assembled a great collection of data about coding objects. However, I am changing my tactics slightly. I thought I could just repeat my education lecture, but so many have heard or read this before. It needs to be fresh. It needs to address problems many Clarion developers face head on. It must be fun. It needs real life code in as little space as possible to assist understanding. It must have some practical, not just theory.

The reason for this is simple. If you cannot apply what you have studied, no matter how well you understand it, you cannot use the theory. However, exercises should be simple, let the student have a win with the materials covered. None should take more than 5 minutes to complete. I refuse to use cruel trick questions. I'm not interested in who can be clever, I am only interested if you can apply what you've studied.

If I discuss LOOP statements, then I expect you to code a LOOP structure. Any LOOP structure, I don't care for fancy. You can add "fancy" by yourself later on. "Fancy" is your job, not mine.

To ensure your knowledge increases, each new topic builds on the last topic. I surely hope that you get "it" by reading and applying the material in this book. Objects can make your Clarion applications small, fast and far easier to maintain. However, you must be willing to do a bit of front-loaded work. That is the price to pay. That sounds bad, so let me give you some good news.

If you design and code your objects well, you will do it once, but you will use that code everywhere, greatly reducing your future workload. That price does not sound so bad now.

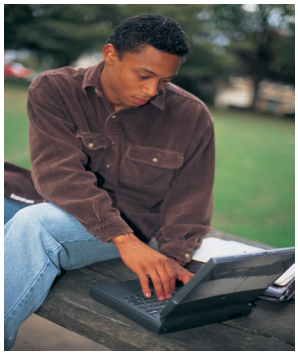
The sequence of study topics

Discovered and tested in live class room settings, I've discovered that the proper sequence of topics starts with the basics and moves the student through each one, building their knowledge and skills. Thus, the sequence of study is as follows:

- Object Oriented Programming
- ABC templates
- Converting existing code to objects
- Coding template wrappers for those objects.

What about ABC?

When ABC made its debut with Clarion 4, the templates around the ABC objects did such a good job of doing the "OOP bits" for you, I used to be in the camp of those thinking they did not need to know OOP. After all, I could make a fully functioning ABC application. Many others can too, so the importance of understanding the underlying technology fell by the wayside.



However, this success soon created new problems. Many Clarion developers were asking about embed points. Where can they add some code to make a procedure do what they wanted? This is directly symptomatic of not understanding the underlying concepts of OOP.

I came to that conclusion after many years of teaching Clarion. Before one class, I decided I would hit OOP hard. I wanted to see if my theory and observation were indeed correct. I found that the end of class lab exercises were much easier for the students to not only do, but complete. I had my evidence.

This is why there is an ABC section after the OOP section. Once you understand what ABC is doing from an OOP viewpoint, finding embeds is easy, in the worst case, easier than you think.

Coding your own classes

No book of this type is complete without a discussion of converting existing code to

objects. Chapter 5 covers this very topic. Many ABC users would be surprised to find that ABC's relation tree is not OOP at all. There are no objects for relation trees in ABC! The ABC templates borrow heavily from the old legacy templates. They do call certain objects, but that is about all the "conversion" does on this.

In one chapter, you go through a guided tour of the conversion and writing your own class. When you are done, you have something useful as well.

Template Wrappers

Chapter 6 covers how to write template wrappers for objects you create. This builds on the previous chapter. You will have template wrappers for the relation tree class.

Now that is out of the way, let me continue with the theory of OOP, which was the sole topic in my presentation at ETC III.

Chapter 2 - The Theory of OOP

A Good Start

In every subject one studies, there must be a basic, simple starting point. I cannot tell you how often I wondered where is the starting point when you struggling with a new subject. Let me get this part out of the way right now so I can get into the "magic".

OOP is spelled O-O-P.

Did everyone get that? Excellent! Now, I will build on this concept.

OOP is not POO spelled backwards. How does that seem for everyone? Is anyone lost?

Am I going too fast? Is everyone having fun? No one is unconscious and everyone is wide-awake? Then I will proceed.

OOP defined

Pet Peeve

When I study something new, I must have a list of keywords with workable definitions in order to learn that subject. Imagine my disgust when I visited many bookstores to find a good book on OOP and I did not find one - that is correct, not a single book. I found rows and rows of books on the subject of OOP. Some used C++ for example code; others used Delphi or some other language. All of them I rejected. Not because there were no Clarion examples, but because all but two of these authors did not even attempt to define OOP! Moreover, the two authors that attempted definitions came up lacking. Here is one such example:

"OOP deals with objects that have certain characteristics such as <buzzword>",

Why do I think that is lacking? That definition can't work! What do I mean by that? You cannot apply this definition, no matter how bright you happen to be. How can you apply a definition such as the above? Can you even use it in a sentence that makes sense? All right, enough of my pet peeve, I will not keep you waiting any longer.

OOP is an acronym meaning **O**bject **O**riented **P**rogramming.

You are sitting there thinking, "I knew that, so what?" Defining acronyms is not helpful if one does not know the words of the acronym. However, if we get the definitions of these words, perhaps understanding of "what is it?" becomes visible. For those that have seen these definitions before, it will not hurt to revisit them.

Object - [n] 1) Anything that can be apprehended intellectually. *What **object** do you think of when I say that? Do you have an **object** that starts with the letter E? What **object** best represents success?* 2) Anything that is visible. *What is that **object** in your mouth? Have you ever seen an unidentified flying **object**?*

Orient (ed) [vt] To point or direct at something or in a direction. *If you would **orient** your gaze to the south end of the runway, you see the shuttle is about to land*

Program (ming) [v] The act of writing computer code to perform a certain task. *The project is now in phase two of **programming**.*

Combine these three words and you have another definition. Object Oriented Programming means the "writing of code directed or aimed at objects".

Your first exercise (under a minute)

Don't mean to break your train of thought, but believe it or not, you've just studied an area that many people cannot explain. So for this exercise, simply define "OOP" in your own words. Refer to the above example if you need to. And finally, use "OOP" in a few sentences of your own creation, showing the above meaning (seriously). Do this until you feel comfortable with it. Some people need to do about 10 or more sentences before they get comfortable. Some require less.

Once you have done this, please proceed.

Now you may find yourself asking, "Where do I start?"

I think a more precise question would be, "How does Clarion do OOP?" Get that question answered and I think you have your starting point. To be more precise, since the subject is really "objects", what is the meaning of that? Let me use a real, yet over-simplified example.

In a business application, you deal with data files. There are files of all shapes, sizes and types. If you were to design a file object, what would it do? One cannot get very far without opening a file, so it must do that. In addition, it must close a file, so add that to the list. You should be getting an idea of what a file object should do. There is more to files than opening and closing them. However, I am leaving it there.

You should notice one thing I did not mention. Which file am I talking about? In a procedural world, you must name the file you wish to open and close. In the OOP world, you do not. This means that you only need to think about an object that will work the same on *any* file. This is what others mean when they tell you to think of abstract data. Abstract data does not have clear borders; it is a broad brushstroke, like the file object.

What you do is gather all the bits that would apply to a file - any file. The definition of the object looks incomplete; by itself, it does nothing. That is correct as you do not want the object doing everything or even knowing what the file name is. You supply the file name at runtime. I will explain that at the appropriate time. First, you need to define what actions and attributes that apply to a given file. You place these into a container or bucket.

That brings me to the first OOP keyword.

Encapsulation

Yow! That is a big word! This needs a definition quick!

> **Encapsulate** [vt, vi] To enclose, as in a capsule. *When the vault door closed, they were **encapsulated**. Your lies **encapsulated** your reputation as untrustworthy. **Encapsulate** your thoughts on this issue.*

So what does this mean in the OOP sense? Why is this important? If you have some code that is in its own little world, you *encapsulate* that code. Alternatively, one could say it may be an object. What does this really buy you? The answer to that question is so that you may address this "grouping" as a single thing or entity.

A simple example of what I mean by that, is in this sentence: "I'll never trust him again as he is a Judas." You know what I mean by the word "Judas". I am referring to the Biblical story of the betrayal of Jesus by a disciple named Judas. Thus, the word "Judas" encapsulates the betrayal of Jesus and how this happened. If "Judas" were not encapsulated as a concept, you would need many more words to describe why a person is not trustworthy, what did they do to earn that reputation, etc.

If you were to code a cat, you want the cat code distinct and different from a dog. You also do not want the dog bits mixing in with the cat bits. I am getting a little ahead of myself here, but I wanted you to get an easy image in your head without getting too technical at this point. You can see that if you wanted to code a cat, you want nothing to do with anything that is "non-cat". Thus, you enclose the cat code in its own capsule.

This is where the concept of a CLASS comes in.

The CLASS statement

In Clarion, use the CLASS statement. The CLASS statement *is* encapsulation. Hold on to your shorts, but this and one other statement are the only pure OOP statements in Clarion! That should help with any nervousness about a learning curve. You learned one of the OOP statements in Clarion and there is only one more coming! How good is that?

OK, enough chin wagging, let us see some code!

```
FileClass       CLASS
Name              CSTRING(256)
Path              CSTRING(256)
Open              PROCEDURE
Close             PROCEDURE
                END
```

The above is a simple class definition. Notice I said "definition". This means it belongs in the data section of your program. It is in the same section with variables, WINDOW, FILE, VIEW, REPORT and other data definitions. The data section in Clarion is anything after PROGRAM (or MEMBER or PROCEDURE) and before the CODE statement.

Think of it like an enclosed MAP statement, but with data definitions as well. The above CLASS deals with the opening and closing of a file. There is more to that, but I wish to

keep these concepts simple for the moment.

There is one thing that may not be obvious to you by looking at this definition. The name of the CLASS is "FileClass" not "CustomerFileClass". You do not wish to code the same code for a different file. The Clarion templates produce code in this manner. Why code the same thing repeatedly using a different label? I do not know about you, but I would get bored. There is more to say about code re-use, which I will discuss later. First, I need to introduce some new buzzwords into your vocabulary.

Property - defined

If you notice, there are two data types in the above CLASS structure. These are *properties* to use the OOP lingo. Properties describe the attributes of an object. How big is it? What color or size is it? This is like describing yourself to someone you never met.

Method - defined

There are two procedures in this definition as well. A *method* is the term for these procedures. That is what the CLASS does.

When you describe an object with code, you declare a CLASS structure. Then list the properties and methods in it. A CLASS therefore, encapsulates methods and properties. Taken together this is the beginning of an object. What do I mean by saying "beginning"?

Declaring a CLASS is not always declaring an object. This is why Clarion uses the word CLASS and not the word OBJECT. The reason is that an object must exist in order to use it, but a definition (or declaration) of something does not always bring an object into existance. A CLASS definition does not always bring an object into existence. This brings me to the next keyword in the OOP vocabulary.

Instantiation

Instantiation 1) The creation of an object. ***Instantiation*** *of the house results from its blueprints.* 2) An object ready for use. *You cannot use an object without* ***instantiating*** *first.* [From a Latin word meaning, "Being present"]

Here is the key to instantiation: You may have more than one instance of a type of object the class declares. This means you define it once and instantiate it multiple times. The advantage of this should start coming into focus now. Simply put, define once, then instantiate the objects that you need from that definition.

For example, I declare a *FileClass*. However, I instantiate a *CustomerFileClass* based on the *FileClass* definition. I will not and do not need to declare a clone of the *FileClass* to use it on the *Customer* file.

How to instantiate a Class

This is easy to do. There are three ways to instantiate any class (examples follow).

1) A class declared without the TYPE attribute declares both a type of the object and an instance of that object type. A class defintion with the TYPE attribute does not instantiate a CLASS, it is a definition only.

2) A simple data declaration statement with the data type being the label of previously declared class structure, instantiates an object of the same type as the previous class.

3) Declaring a reference to the label of a previously declared class structure, then using NEW and DISPOSE instantiates and destroys an object respectively.

Global objects

A class declared in the global data section is instantiated for you automatically at the CODE statement that marks the beginning of your program. When you RETURN to the operating system, the object is destroyed for you. This means that these object's visibility and lifetime are global. In the code example below are the 3 ways of instantiation.

```
  PROGRAM                     !Program global Data and Code

MyClass     CLASS             !Declare an object and
Property      LONG            ! a type of object
Method        PROCEDURE
            END

ClassA      MyClass           !Declare MyClass object
ClassB      &MyClass          !Declare MyClass reference

  CODE              !MyClass and ClassA automagically instantiated
  ClassB &= NEW(MyClass)      !Explicitly Instantiate object
! some code here
  DISPOSE(ClassB)             !Destroy object (required)
  RETURN            !MyClass and ClassA automagically destroyed
```

Modular objects

A class declared in the modular data section is instantiated for you automatically at the CODE statement that marks the beginning of your program. When you RETURN to the operating system, the object is destroyed for you.

This means that these object's lifetime is global, but the visibility (or scope) is limited.

```
  MEMBER('MyApplication')     !Module Data

MyClass      CLASS              !Declare an object and
Property       LONG             ! a type of object
Method         PROCEDURE
             END

ClassA       MyClass            !Declare MyClass object
ClassB       &MyClass           !Declare MyClass reference

  CODE              !MyClass and ClassA automagically instantiated
  ClassB &= NEW MyClass        !Explicitly Instantiate object
! some code here
  DISPOSE(ClassB)              !Destroy object (required)
  RETURN            !MyClass and ClassA automagically destroyed
```

Local objects

Objects declared in a procedure's data section are instantiated for you automatically at the CODE statement that marks the beginning of the procedure's executable code, and automatically destroyed for you when you RETURN from the PROCEDURE. This limits their lifetime and visibility to the PROCEDURE within which they are declared.

```
SomeProc          PROCEDURE    !Local Data and Code

MyClass      CLASS              !Declare an object and
Property       LONG             ! a type of object
Method         PROCEDURE
             END

ClassA       MyClass            !Declare MyClass object
ClassB       &MyClass           !Declare MyClass reference

  CODE              !MyClass and ClassA automagically instantiated
  ClassB &= NEW(MyClass)       !Instantiate ClassB object
! execute some code
  DISPOSE(ClassB)              !Destroy ClassB object (required)
  RETURN            !MyClass and ClassA automagically destroyed
```

That should be straightforward. The point in bringing this up is that a CLASS is treated the same as simple variable declarations concerning when they are available and what code may access them. This also means that if you try to use an object's methods or properties when they are not in scope, you get errors.

Which instantiation method to use?

I often hear the question, "Which instantiation method is the best one to use?" The honest answer is "It depends." When presented with a choice, the common conclusion is

that once you pick one, you cannot change your mind, or one method works better than the others. This is simply not true. You may instantiate an object any way you deem best. There is more to say as to why, but there are other topics to cover first. This leads into the next topic.

Dot syntax

Dot syntax, also called "field qualification syntax" is simply a way of telling which object owns which property or method. It is the same premise as using the prefix on labels in your code. One difference is you use a period instead of the colon.

In other words, you may have two or more class structures with methods called *Init*. The way to distinguish them is by prepending the object name, followed by a period and then the method name. The same is true for properties.

Think of it like an English sentence. You read first the noun, then a verb or some other modifier to complete the sentence. Granted, they are short sentences, but you can get the idea.

```
Fred        CLASS
Pay           DECIMAL(7.2)
Hours         LONG
Work          PROCEDURE(LONG),DECIMAL
            END
```

If you use the above class in your code, you would use it like this:

```
CODE
FRED.Pay = FRED.Work(FRED.Hours)
```

You could surmise that the code is working on Fred's pay. The rule is simple, when referring to any method or property from any class, use dot syntax notation.

However, you may notice there is a problem with the code. It will only calculate Fred's pay. If your name is not Fred, you would be upset getting no pay.

Here is where the procedural style coders fall down on the design and even in their approach to this problem. They would write the same code for each of their employees. Eventually, you would have code that works. If it works, then why fix it? Assuming that the code always correctly calculates Fred's pay, would it not make sense to re-use the above code? However, the object's name is Fred, how do you do this? I suppose you could name it Employee instead of Fred, which makes sense. However, which employee is paid? Not much progress really. I will explain this after a short detour.

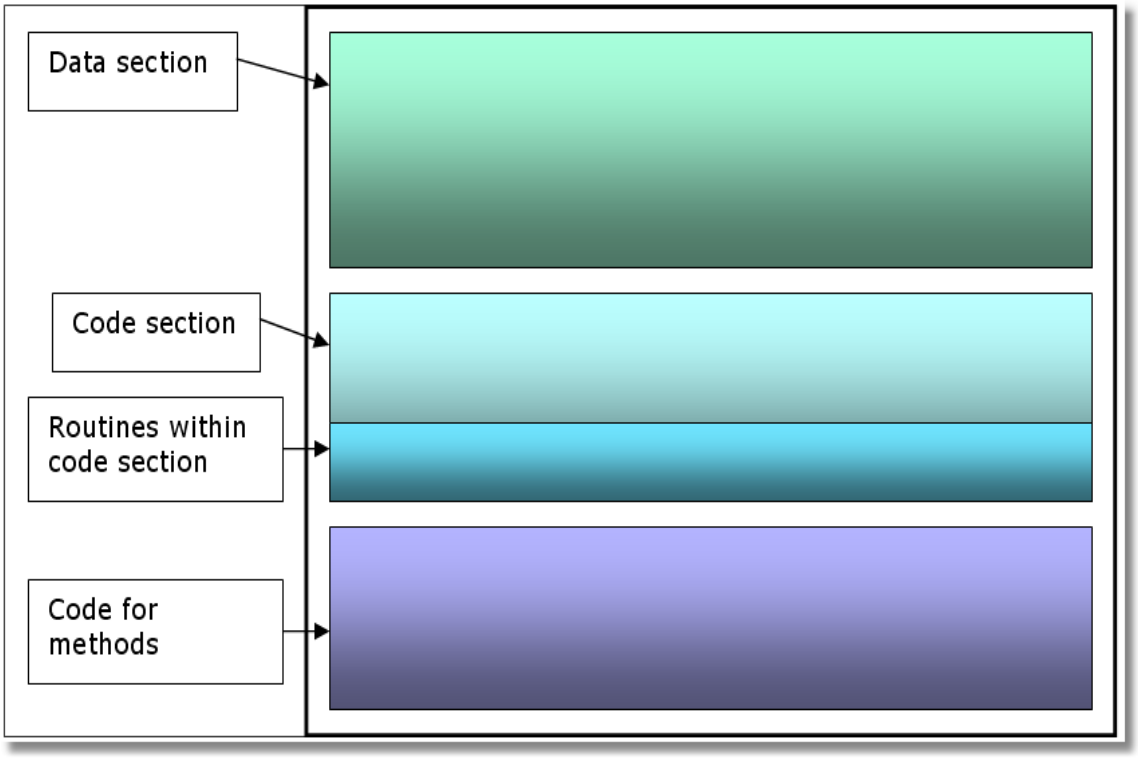
Object naming in method code

Whenever you declare a class with methods, you must code those methods. All method code must be placed last in your source file. The sequence is the data declarations at the

top, then the CODE statement. That terminates the data section. All code you write after the CODE statement is the main code of the procedure. This includes any ROUTINEs that follow the main code.

Method code always follows the last main code statement or routine, whichever is applicable. Just scroll down to the bottom of your source file and that is where the code for methods belongs. It does not matter which order the method code appears either, as long as it is at the bottom of your source file, after the main body of source.

Study the following figure. This illustrates where the different sections belong in your source file.



There is another way of coding methods using the INCLUDE statement, but that is covered later.

Therefore, the source where *Fred* is used would look like this:

```
! PROGRAM or MEMBER or PROCEDURE
Fred             CLASS              !Data section
Pay               DECIMAL (7.2)
Hours             LONG
Work              PROCEDURE (LONG),DECIMAL
             END

  CODE                              !Main body of code
  FRED.Pay = FRED.Work(FRED.Hours)
  !End of main body of code

FRED.Work              PROCEDURE (LONG) !Method code
  CODE
! Whatever code is needed to calculate pay
```

Granted, you need more than the above to have a working Clarion procedure. The concept is what is important at this stage. A demonstration of working code comes later.

Notice you must name which method you are using to write code. It is always the class label, in this case *Fred*. In the main body of code, you use that label. However, in the code for the method, there is no way to know which object is executing. This is because you may have many instances of this object in use. In addition, I am giving you the restriction to code this only once. You will soon see this is not a restriction at all.

SELF

Therefore, instead of using the label of the class in the method code (as opposed to the main body of code), use the label SELF. The definition of SELF is "whatever the current object is." You can see this in the following code listing:

```
  PROGRAM
Employee         CLASS, TYPE       !Declare object TYPE
Pay               DECIMAL(7,2)
Hours             DECIMAL(3,I)
Calcpay           PROCEDURE
Work              PROCEDURE (*DECIMAL),DECIMAL
                 END
Fred             Employee    !Instantiate objects of Employee type
Barney           Employee

  CODE
  Fred.Pay = Fred.Work(Fred.Hours)    !Code outside "Fred" object

Employee.CalcPay      PROCEDURE          !Method Definition
  CODE
  SELF.Pay = SELF.Work(SELF.Hours)    !Code inside method Listing
```

Using the above code, SELF is really *Fred* as *Fred* is the object name in the main body of code. If another line of code existed with *Barney*, then SELF would be *Barney*. The key concept to get from this is that for both *Fred* and *Barney*, you execute the same code!

You are not executing a copy; you are not executing a clone. You are executing an instance of the *Employee.CalcPay* method. You write the code once, but use it many times for different objects.

This is something you cannot do with routines. Routines act on one piece of data and that is it. If you need to do the same thing on another entity and find yourself coding yet another routine, time to think about a class instead.

Let me give you a conceptual example of what I mean.

The Microwave object

Before I watch the "big game" on TV, I like to make nachos. I have several good recipes, but I want my nachos fast. Therefore, I microwave them. The microwave does a great job of melting the cheese, warming the chili and beans. I know exactly how long and what power setting I want to make those nachos perfect. I only have one microwave oven. Yet I also use it to reheat my coffee, melt or soften butter, fry bacon and other recipes. Again, I only have one microwave oven.

Why do I keep saying that? If I were to code a microwave oven like some others write code (including the Clarion templates), I would have one oven for cooking my nachos, another for heating coffee, another to soften butter, and yet another to fry my bacon.

It means I must code my microwaves with no controls on them, as the power levels and time to cook are already set. It means that if I need to do something different, no matter how small those differences may be, I need to code a brand new microwave oven!

Therefore, I will ask around to see if anyone has a microwave oven template that I can simply buy. I do not really want to code it repeatedly. I will let a template code it repeatedly, like the legacy (Clarion) templates.

Just how much of a microwave oven is the same as any other microwave oven? Why do I need to code the box, the electron gun, and hard code the power level and hard code the time needed to cook? Are you seeing the point? Being a lazy programmer, I will define a microwave class and then re-use what I need. This means I will not define yet another

microwave oven, but re-use it! Just like in real life.

```
MicroWave       CLASS,TYPE
Power             LONG
Time              LONG
Cook              PROCEDURE(LONG xPower, LONG xTime),LONG,PROC
                  END

Nachos          MicroWave
Reheat          MicroWave

Power:High      EQUATE(10)
Power:Low       EQUATE(1)

  CODE                              !Main body of code
  IF Nachos.Cook(Power:High,45)
    SoundDing()
  END
  IF Reheat.Cook(Power:Low,60)
    SoundDing()
  END

MicroWave.Cook      PROCEDURE(LONG xPower, LONG xTime)
Counter   LONG,AUTO

  CODE
  SELF.Power = xPower
  SELF.Time = xTime
  LOOP Counter = 1 TO SELF.Time
    !Cooking code here.
  END
  RETURN True
```

You can see that both the *Nachos* and *Reheat* objects are *Microwave* data types and these objects are instantiated. In the main body of code, I used both objects, but if you notice, there is only one procedure labeled "*Cook*". This is because I used the same microwave to cook my nachos and to reheat something.

Are you starting to see the picture of what is going on here? So far, we covered encapsulation and instantiation. These are powerful, yet simple concepts. There is another benefit to these concepts before I move on.

If you notice, I have the *Cook* method coded in one place. Yet if my nachos burn or my coffee is cold, I have a bug in my code. Now ask yourself, how many places do you have to look to find the bug?

Coding OOP style not only allows the writing of less code, but it also reduces your maintenance. In the worst case, the maintenance is easy when you do need to fix something.

Constructors and Destructors

These are two more keywords in the OOP lexicon. There are special methods in a CLASS. The *constructor* is a method automatically called when an object is instantiated. It does not matter how it is instantiated. The *destructor* is a method automatically called when you destroy an object, regardless of how.

Their use is very simple. Declare a method named *Construct* with no parameters in your class. Same with the destructor except name it *Destruct*. You may use one, the other, neither, or both. Their use is totally up to you.

Why use them?

If you wish code to execute when an object is instantiated, then make a constructor. Such common uses are initializing variables, making reference assignments and other setup chores. If you know your design calls for the same things to happen, this is a good use for a constructor. Your other choice is to have your other methods do these chores.

If you have a constructor, the chances of coding a destructor increase. A typical use would be to clean up anything the constructor did, dereferencing, etc.

Why not use them?

Constructors and destructors do not take parameters. They do not return any values either. If you need to pass parameters to an object or check return codes (such as when an object instantiates OK), you need to use other means.

The use of these is totally up to you. Nothing says you must use them and nothing says you should never use them. Depending on who you talk to, you may get arguments for both sides of the issue.

Returning to the *FileClass* code to illustrate constructors and destructors, this is what it would look like in Clarion.

```
FileClass   CLASS,TYPE
Name          CSTRING(255)
Path          CSTRING(255)
WorkQ         &TypeQue        !TypeQue definition not shown
Open          PROCEDURE
Close         PROCEDURE
Construct     PROCEDURE
Destruct      PROCEDURE
            END
!Main body of code here

FileClass.Construct    PROCEDURE
  CODE
  SELF.WorkQ &= NEW(TypeQue)
? ASSERT(SELF.WorkQ &= NULL, 'Cannot reference WorkQ')

FileClass.Destruct     PROCEDURE
  CODE
  IF ~SELF.WorkQ &= NULL
    FREE(SELF.WorkQ)
    DISPOSE(SELF.WorkQ)
  END
```

Looking over the above code listing, it shows a simple declaration for the constructor and destructor in the class declaration. Below the comment indicating where normally you see the main code, are the two methods. In this case, you see a reference assignment to a property. The ASSERT is debug code that will show the assert message if the condition is false (the assertion being that the condition is always true). The point here is that this code executes every time this object instantiates, regardless how.

The destructor "undoes" what the constructor built. If the reference is not NULL, it FREEs the QUEUE, then DISPOSEs the QUEUE.

This is a good reason to use constructors and destructors. A destructor can "clean up" what a constructor did.

There is more to constructors and destructors. I will revisit that later. For now, I need to add a bit more to encapsulation.

Extreme Encapsulation

You recall that a class encapsulates data contained in it. This could imply that this hides data from the outside world. In one sense, this is a good thing, as you certainly do not want anything from the outside to step on data and corrupt it. It is a guarantee that the data is in a reliable state.

Clarion supports this with the PRIVATE attribute. When used as an attribute in a property or method declaration in a class, then only other members of that class may access that property or method. In other words, it hides them from everything outside the class.

```
MyClass             CLASS
MyProperty            LONG,PRIVATE          !private Property
Method                PROCEDURE
MyMethod              PROCEDURE,PRIVATE     !private method
END
  CODE
  MyClass.MyMethod                          !Invalid here
  MyClass.Method                            !Valid here
  MyClass.MyProperty = 10                   !Invalid here

MyClass.Method    PROCEDURE
  CODE
  SELF.MyMethod                             !Valid here
  SELF.MyProperty = 10                      !Valid here
```

When to use the Private Attribute

So when would you wish to use this? In the early days of ABC, there was heavy use of the PRIVATE attribute. The reason was that it was still in a state of change, and when the code changed, it did not break anything. That is still a valid use today, even with non-ABC objects.

Another reason is whenever you have something that only that class is responsible for, that is a good choice for a PRIVATE attribute. Depends on what you need that reference to do.

There is more to say about this, but I need to cover some other ground first.

Inheritance and Derivation

You know that Inheritance means you receive a vast sum of money after a rich relative died. OK, that does not seem to apply to Clarion, let alone OOP.

Inheritance (n) - something received from a predecessor, sum as a trait, or characteristic. *He **inherited** his nastiness from his father. My vocal tone is my mother's **inheritance** to me.*

Inheritance is similar to another common OOP term: **derive**.

Derive (v): To convey from one (treated as a source) to another, as by transmission, descent, etc.; to transmit, impart, communicate, pass on, hand on. *You **derived** your sense of humor from Uncle Harry. He **derived** his knowledge from hard study.*

This is where OOP can get a bit tricky, especially to those trying to grasp it for the first time. To derive a new class, you simply name the parent class as the parameter to the new class statement. The new class declaration inherits everything from the parent class. The difference here is that, in OOP no one has to die for the child to inherit.

This is a good opportunity to introduce some more OOP terms: *Base* class and *Derived* class.

A **base class** is a class that has no parameter to its class statement -- meaning it does not inherit anything -- however, a **derived class** always has a parameter naming its parent class. Notice that this did not say that the parameter to the derived class statement names a base class -- it does not always do this. The parameter to a derived class statement names its parent class, which could be either a base class or another derived class. This means that you can have multiple generations of inheritance.

Let me illustrate this with the *FileClass*.

```
FileClass    CLASS,TYPE
Name           CSTRING(255)
Path           CSTRING(255)
WorkQ          &TypeQue        !TypeQue definition is not shown
Open           PROCEDURE
Close          PROCEDURE
Construct      PROCEDURE
Destruct       PROCEDURE
             END
CustomerClass     CLASS(FileClass)  !Derived class
!Contents of the class structure here.
                  END
  CODE
   !Some code to point to the customer file
   CustomerClass.Open                !Open Customer file
```

Extending a class

In the above code listing, *CustomerClass* inherits everything from *FileClass*. When you derive a new class, the purpose of doing so is usually to extend the class. In other words, you want all of the functionality of the parent, but you want to embellish or add new code. All without changing the original definition and without writing the same code you already have that works.

That is a very good thing to do and makes maintenance easier. Let us say you have a *VendorFile* class derived from the *FileClass* too. If opening the *Vendor* file works, but opening the *Customer* file goes "bang", you can safely assume the base *FileClass* is fine. That must mean there is a bug in the *CustomerClass*. Now you know where to look. So, that is a huge benefit.

This should indicate to you how to design a set of classes. Make a base class that has everything in common about the type of object you need. For example, code a file class that is as general as possible. This class has everything that you may need to handle only one file. By that, you do not yet know which file, let alone the driver type.

As I touched upon before, you need to open a file, and close it. This is a common thing to do for any file. I would strongly suggest that you keep such designs very simple. By that, I mean so simple it hurts. Have you noticed I have said nothing about checking for errors or handling relations? Those are general in nature as well.

An *ErrorClass* has broader applications than looking for file errors. Therefore, that would be another class. A *RelationClass* could be complex, but that could have a *FileClass* as its parent. In this case, the *RelationClass* derives everything it knows about files from its parent.

Derivation and inheritance are powerful, yet simple concepts in OOP. Those seeing classes derived from parents for the first time can get confused. This is because the code does not look to be complete.

Overriding a class

Another thing you can do with inheritance is override parent methods. This is very simple to do. All you need to do is declare a method with the same label and prototype as the parent method. This means that you want to toss out the parent's method and code everything in the derived class. That gives a first impression that it is double work.

Why would you do this? The parent method may not be applicable for what you need to do. In this case, simply write the replacement code. You can combine both methods if you wish and I will explain how to do that shortly.

Multiple Inheritance

Clarion does not support multiple inheritances. You may derive ***only*** from a single parent. Other languages such as C++ do support this concept, but this does not mean Clarion is crippled. Multiple inheritances introduce ambiguity into the code and this is not only hard on the compiler, but the programmer.

If Clarion supported this, you would have to code disambiguate methods to explain to the compiler which objects derive from where. That is not a good use of programmer time.

Composition

Where multiple inheritance would be useful, Clarion uses a simple way of giving you the advantages of multiple inheritance, but without the ambiguity. *Composition* is the term for this technique.

Composition - In a child class, the data type of a property is a reference to another class.

Composition gives you all the benefits of inheritance too. The main difference is that you do not have to write any code to disambiguate what you mean. One line of code is all you ever need. Let me illustrate this with an example:

```
ApplePie        CLASS,TYPE          !Declare Base Class
Apples            STRING(20)
Crust             STRING(20)
Bake              PROCEDURE
                END

IceCream        CLASS,TYPE          !Declare Base Class
Flavor            STRING(20)
Scoop             PROCEDURE
                END

AlaMode         CLASS(ApplePie)     !Composition: Derive from a CLASS
OnTheSide         &IceCream         ! and contain a reference to
Serve             PROCEDURE         ! an object of another CLASS
                END
```

You can see from the above listing the *AlaMode* class derives from the *ApplePie* class. You can tell this as *ApplePie* is a parameter in the class statement, thus it is a child class. However, look at the *OnTheSide* property. It is a reference to the *IceCream* class.

Both inherit everything from their "parents". The reference to *IceCream* is the same thing as declaring the *IceCream* class inside of the *AlaMode* class. It is also the functional equivalent of listing more than one parent as a parameter of the class statement. However, the reference is the legal way to do this, and keeps your code clean.

Moderate Encapsulation

Recall that a method or property with a PRIVATE attribute is for the exclusive use inside the class. Absent of that attribute, methods and properties are "public", meaning you may access them from outside the class. Sometimes, you do not want either.

Use the PROTECTED attribute when you need to restrict methods and properties to the class they belong and any derived classes that may need them.

You may wish to use this attribute when you need some protection, but you need this protection in child classes.

```
MyClass     CLASS                   !Declare Base Class
Property      LONG
MyProperty    LONG,PROTECTED        !Semi-Private
Method        PROCEDURE
            END

ClassA      CLASS(MyClass)          !Declare Derived Class
AProperty     LONG
AMethod       PROCEDURE
            END

  CODE                              !Main body of code
  ClassA.MyProperty = 10            !Illegal statement

ClassA.AMethod          PROCEDURE
  CODE
  SELF.MyProperty = 1               !OK within method of class
```

Overriding

This is another keyword of OOP. In the Clarion context, here is the workable definition:

Override - A method in a derived class that has the same label and prototype (any parameters and/or return type) as its parent.

That is simple enough, but why would you want to do this? The answer to that question goes back to derivation. If you recall, a derived class extends the behavior of a parent class. However, you do not change the functionality of the parent. The same is true for overridden methods. Here is a simple example.

```
ApplePie    CLASS,TYPE              !Declare Base Class
Apple         STRING(20)
Crust         STRING(20)
Bake          PROCEDURE
            END

Dutch       CLASS(ApplePie)         !Declare Derived Class
CrumbleTop    STRING(20)
            END

American    CLASS(ApplePie)         !Declare Derived Class
TopCrust      STRING(20)
            END

Grandmas    CLASS(ApplePie)         !Declare Derived Class
CaramelTop    STRING(20)
Bake          PROCEDURE             !Overridden method
            END
```

You can see the *Bake* method in the *ApplePie* class. That makes sense, as you need to bake apple pies. Look at the *Grandmas* class. It also has a *Bake* method. Compare the two methods and you see they both have the same label and the same prototype.

Thus, the derived *Grandmas* class overrides the *ApplePie* method. This means that for whatever reason, the parent method may not be applicable to the child class. Thus, you write the appropriate code.

An *ApplePie.Bake* method may be fine for apple pies in general. In addition, that method is fine for *Dutch* and *American* pies. However, *Grandmas* may be a special recipe where a special bake method is required.

There is more to overriding methods than this, but I am leaving it here for now.

More on Constructors and Destructors

I mentioned previously that there is more to tell you about Automatic Constructors and Destructors. Well, now is a good time to tell you about how inheritance affects Constructors and Destructors.

What happens when a parent class has a *Construct* method and the derived class needs one? I already covered overriding methods in derived classes, so you might guess that the derived class *Construct* method would simply override the parent class method. That guess would be wrong, of course.

So why is it wrong? Because overriding the parent class constructor might mean that code that is required to initialize inherited properties might not execute. If the inherited parent class properties failed to initialize, you might end up with unexpected behavior in your derived class. Therefore, *automatic* overrides do not happen with constructors. Instead, by default, they all execute in order when the object is instantiated.

First, the parent class constructor executes, then the derived class constructor executes. They execute in the order of their derivation. Base class constructors always execute first followed by any derived class constructors, in derivation order. The constructor for the most derived class always executes last.

The same reasoning is true for destructors, except reverse the order of their execution. When you destroy the most derived class, its destructor automatically executes first, and on up the chain of derivation until the base class destructor executes last. In other words, LIFO: Last In First Out.

This is all standard. The way constructors and destructors work by default in the Clarion language is the same way they work in most other OOP languages. However, Clarion does give you some flexibility that some other OOP languages do not.

Automatic overriding of Constructors and Destructors does not happen in Clarion. The key word here is “automatic.” You can override them in Clarion if you want to — something you cannot do in some other OOP languages. If you add the REPLACE attribute to the prototype of your *Construct* or *Destruct* method, you are telling the compiler that you do want to override the method.

So, what does that buy you? Suppose you need to initialize a variable in your derived class before the parent class constructor executes. The only way to do that is to override the constructor. You simply add the REPLACE attribute on the prototype of the derived class Construct method, then write your code.

The concern about automatically overriding constructors and destructors is still valid, and you should consider it carefully when you manually override them. Nevertheless, the designers have thought of that. First, a small detour and then I will return.

PARENT

You recall that the way to reference the current object within the code of a method is to use SELF instead of the object name. There is another tool in Clarion's OOP syntax that allows you to call a method from a parent class even when you have overridden that method.

Prepending PARENT to the method name explicitly calls the parent class's method, even when overridden. This technique holds true not only for Constructors and Destructors, but also for any overridden methods.

```
MyClass         CLASS,TYPE              !Declare Base Class
Property          LONG
Method            PROCEDURE
Construct         PROCEDURE             !Method code not shown
                END

ClassA          CLASS(MyClass)          !Declare Derived Class
Aproperty               LONG
Construct               PROCEDURE,REPLACE
                END

  CODE                                  !ClassA Instantiation here
  <Main code here>

ClassA.Construct            PROCEDURE
  CODE
  SELF.Aproperty = GLO:Flag             !Initialize then call
  PARENT.Construct                      ! parent constructor
```

In the above listing, the assumption here is that *MyClass* writes to *GLO:Flag*. But when that happens, the derived *ClassA* class needs to grab the value of *GLO: Flag* before that happens. In addition, your design says you cannot change the code in *MyClass*. Without the REPLACE attribute, you painted yourself in a corner.

Therefore, when you need explicit control of the execution order of your constructors or destructors, you simply put the REPLACE attribute on the prototype. Then, in your constructor or destructor method's code, directly call *Parent.Construct* or *Parent.Destruct* at the exact point within your logic that is most appropriate to what you need to do. That could be before, after, or in the middle of your derived class's code — wherever you need it to be.

Polymorphism

This is the last major OOP buzzword you must learn. For those that are wondering, it does not mean you have a parrot with a drug problem.

Polymorphism - derives from two Greek words. It is the prefix *poly*- meaning "many" and the *suffix* -morphos meaning "form". Combine them together and you have a word meaning "many forms". Add the suffix, "-ism", and you have a new word. For you grammar types, it is also a noun, denoting a state, condition, or characteristic.

Polymorphism is the key point of object orient programming. However, it is not exclusive to OOP. Clarion supports various forms of polymorphism. For example, you may recall the *? and ? parameter types. These mean an unknown data type for parameter passing. Even Clarion for DOS supported these.

When Clarion for Windows first appeared, another form of polymorphism arrived. It is "function overloading". This is a procedure with the same label but a different prototype. Examples of this form of polymorphism are numerous in the Clarion language, such as OPEN and CLOSE.

Virtual methods

This last keyword belongs under the heading of polymorphism. What does "virtual" mean?

Virtual- adj. 1) Being such in power, force, or effect, though not actually or expressly such. *They are reduced to **virtual** independence on charity.* 2) Apparent, but not actually in existence. (From optics). *You can see your **virtual** image in a mirror.*

This is the single concept that drives procedural programmers crazy. When you say "virtual method" you are using the word "virtual" as an adjective. You are describing a method that seems to be in force, or is apparent. Let me lift the fog on this a little bit by giving you another definition:

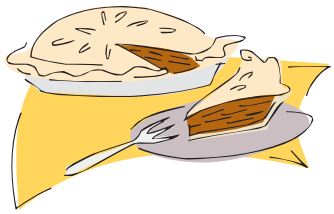
Virtual method - A method whose prototype is present in a parent class and a derived class, which both have the VIRTUAL attribute.

As far as you are concerned, that is all you need to do. You may be thinking that I did not clear any fog from this concept. Nevertheless, stay with me here as the above definition is very important. Again, this means that any virtual method means a method declared in the parent class and the derived class and both must have the VIRTUAL attribute. These methods must have the same label and prototype.

All right, what does this give you? What is so special about virtual methods? Let me put it in context for you. Recall that a derived class has methods that can "call up" to the parent class. You do this by using PARENT as the object name in the method code. This aligns well with the procedural concept. You also know that you declare any derived class after its parent. If you do not, you get compiler errors, as compilers do not take kindly to forward references.

However, a virtual method allows a parent class to call the overridden child method. You could think of it as a forward reference that actually works.

So what good is that? What benefit could you possibly get from something like this? For one, this means that you can change a parent class behavior without touching the code in it. It also means the parent knows an overridden method is in a child class and will use that method instead of its own!



The best way to illustrate this is with some simple code. I am returning to the apple pie example, but with some changes.

```
ApplePie        CLASS,TYPE
PreparePie        PROCEDURE
CreateCrust       PROCEDURE,VIRTUAL          !Virtual Methods
MakeFilling       PROCEDURE,VIRTUAL
                  END

Dutch           CLASS(ApplePie)
CreateCrust       PROCEDURE,VIRTUAL          !Virtual Methods
MakeFilling       PROCEDURE,VIRTUAL
                  END

  CODE
  Dutch.PreparePie                 !Call the Dutch object's Virtuals

ApplePie.PreparePie  PROCEDURE
  CODE
  SELF.CreateCrust
  SELF.MakeFilling
```

First, you may make some assumptions about this code. Even a non-cook knows there are some steps involved in preparing any pie. This code is in the *ApplePie.PreparePie* method as the assumption is that it will not change.

The *Dutch* class derives from its parent, *ApplePie*. You can see this in the class statement for it. It also has *CreateCrust* and *MakeFilling* methods like its parent. Notice that in both declarations, the VIRTUAL attribute is present.

In the main body of code, there is one line, *Dutch.PreparePie*. You know this is legal as *Dutch* inherits the *PreparePie* method from its parent. Thus, there is only one version of the code for *PreparePie* and this method belongs to *ApplePie*. This is why you see this code. In addition, due to inheritance you know you do not have to code a *Dutch.PreparePie* method.

OK, that is all fine for the easy stuff, like derivation and inheritance and you know why the *Dutch.PreparePie* call is legal.

So where is the code for *PreparePie*? It is in the *ApplePie* class -- *only*. You can see the code. It creates a crust and makes the filling.

When the call to *Dutch.PreparePie* executes, it is really using the code from *ApplePie.PreparePie*. Thus, the two lines of code execute as if this is the code:

```
ApplePie.PreparePie  PROCEDURE
  CODE
  Dutch.CreateCrust
  Dutch.MakeFilling
```

You should now see that the parent is calling down or forward to its child class and executing its method as if it were its own. You could also surmise that if there were a *Grandmas* and *American* apple pie classes derived from *ApplePie*, they too would use the inherited *PreparePie* method (assuming the same prototype and virtual attributes).

This also means that you do not have to change the parent class because the virtual override means the parent executes the child method instead -- all without extra coding. That is the real magic to coding with objects.

If you wish, you can code a virtual method to use the parent method anyway. You would want to do this when the parent method has useful code. You do this simply by using the PARENT label. ABC based applications use this technique in all of their virtual methods.

DERIVED

There is a new attribute since the introduction to OOP with the release of Clarion 2 (yes, Clarion 2!) That is the DERIVED attribute. It means "virtual". To be more precise, it means "virtual protection". This attribute is for child methods only. All the rules of virtual methods apply and this does not change.

What the DERIVED attribute offers is prototype protection. It enforces the definition of virtual methods, especially the prototype of overridden methods.

Let us say you have a parent virtual method that takes a SHORT as a parameter. As your project matures, many derived methods must use a SHORT as a parameter. However, the designer of this parent class discovers it should be a LONG instead. The change to the method occurs.

While this is technically correct, what you really accomplished was converting a virtual override to a function overload. It is possible to get a clean compile, depending on the child method's code. However, when you test the change, you find the application does not function as it did before, or perhaps worse.

Of course, you discover the real problem and change one or two derived methods so the virtual methods are back in place. Did you get them all? How can you be sure?

The rule of thumb is that virtual methods in a base class have the VIRTUAL attribute on all virtual methods. Any classes derived from it with virtual methods use the DERIVED attribute. Thus, when you do make a prototype change, the compiler

knows you want virtual overrides, not function overloading. It will signal this by giving you a compiler error. Use the error editor to fix the prototypes in all child classes used. Then re-compile your project.

Late Binding

Early or Static binding is the stuff taught in your programming theory class where all procedure calls are resolved at compile time. However, since calls to virtual methods cannot be resolved at compile time, the compiler must build a Virtual Method Table or VMT at compile time and set up the method call for late or dynamic binding. At run time, when the call to the virtual method executes, late binding means that the actual method to call is by a lookup into the VMT. You know a lot about lookups, since it is a standard database application technique.

Now, in many other OOP languages this late binding for virtual methods can cause a real performance hit. However, in Clarion the entire late binding process takes only one extra reference at runtime than early binding, so there's no performance hit in Clarion.

Actually, virtual methods in Clarion are so efficient that when you look at the code generated by the ABC Templates, you will find that almost all the code generated is now in Virtual Methods.

That brings us to the next OOP issue in this chapter -- scoping.

Local Derived Methods

Local Derived Methods are in a derived class structure within a PROCEDURE. The Local Derived Method definitions (meaning the executable code) must immediately follow the end of the procedure in which they are declared. I mentioned this earlier.

So, what is the advantage you get from these things? Local derived methods inherit the scope of the procedure within which they are declared. That means that all the procedure's local data variables and routines are visible and available inside the local derived methods. It also enables you to call the procedure's routines from within the method, just as if your code were still within the procedure itself.

This new implementation of scoping is what allowed the designers to take the OOP concept to the hilt in the ABC Templates and ABC Library. All you need to do is run the App Wizard on any dictionary, then look at the generated code to see that most generated procedures now contain very little code -- everything is in local derived methods. And you are still be able to write your embed code as if it were inside the procedure itself. So in this aspect, you are not changing the way you use embeds.

Interfaces

The subject of interfaces is relatively new to Clarion. It is a concept that many good OOP style coders have a little trouble coming to grips with. First, a working definition:

Interface - a collection of methods implemented by a class.

That is accurate enough to start with. However, it does not really convey the concept of what an INTERFACE is or does. I have heard another definition that goes something like "a contract with a class". Technically accurate, but still does not tell you what it is. There are good examples in ABC with the *WindowClass*, but the concept of a window is too vague. How many different windows are there anyway? What does a window do? What makes this particular window so special? Do you have a special window in one of your apps?

The concept of an interface can be difficult to visualize, so let me paint a picture. Instead of a vague window, think of a printer. Any printer will do. We have all seen printers and they do one thing – print stuff. If you worked for a printer company, what would a printer class look like? Let us use this code for our purposes:

```
Printer      CLASS,TYPE
DocName        CSTRING(256)
PrintDoc       PROCEDURE
             END
```

Printers today are more versatile than what the above code represents. They could print in color, number of copies, duplex, etc. If you want, you could imagine a few more properties and methods, but I wish to keep this simple.

The *Printer* class prints a document. Say your marketing department has the results of a survey from your customers and they want more features. So the design department manufactured a new printer with many new abilities. It is a multifunction printer as it can operate as a fax too. Not only that, but also this new device has scanner and copier behaviors.

Here is your dilemma -- do you recode the stable and reliable *Printer* class, thus risking introducing bugs? Or do you keep the working code? Of course, some good copy and paste should preserve the working code if you re-code it. However, what happens about future enhancements? What do you do when the design department comes up with yet another new feature? Do you really want to go through this again?

Declaring the INTERFACE

INTERFACE to the rescue! An INTERFACE looks similar to the CLASS. Here is what the *IFax* INTERFACE might look like:

```
IFax           INTERFACE
TransmitDoc      PROCEDURE
               END
```

I use the capital letter "I" in front of my interfaces so I can tell what it is. That is not a requirement of Clarion. I use this naming convention in my code. Before I get carried

away, a few notes about coding INTERFACES:

- No properties allowed, as the INTERFACE is a behavior.
- All methods declared in an INTERFACE are implicitly VIRTUAL. You may add the VIRTUAL attribute if you wish.
- All INTERFACEs are implicitly TYPEd, however you may add the TYPE attribute if you wish.
- INTERFACEs are not instantiated. By themselves, they do nothing. A class must implement them.

You declare an INTERFACE before any CLASS that IMPLEMENTS them. You may even wish to INCLUDE them in your source. If so, the recommendation is to use INT as the file extension, although this is not required, only customary.

Now that the *IFax* INTERFACE is ready, the *Printer* class needs to know about it. The code now looks like this:

```
IFax                INTERFACE
TransmitDoc           PROCEDURE
GetDoc                PROCEDURE
                    END

Printer             CLASS,IMPLEMENTS(IFax),TYPE
DocName               CSTRING(256)
PrintDoc              PROCEDURE
                    END
```

What does this do anyway? When you implement an INTERFACE, you are adding new behaviors while not affecting the existing code. To put this in other words, the printer knows how to be a fax, but it did not forget how to be a printer. You could also do something like this if you really do not wish to change the *Printer* class:

```
IFax                INTERFACE
TransmitDoc           PROCEDURE
GetDoc                PROCEDURE
                    END

Printer             CLASS,TYPE
DocName               CSTRING(256)
PrintDoc              PROCEDURE
                    END

ExtendPrinter       CLASS(Printer),IMPLEMENTS(IFax),TYPE
PrintDoc              PROCEDURE
                    END
```

Writing Interface Methods

When you IMPLEMENT an INTERFACE, you do need to write the code for the INTERFACE methods. If you do not, the compiler will remind you. You write the code in the same area as you would any other method, using the same mechanics. However, the compiler needs to know which method belongs to a class and which method belongs to the INTERFACE.

Using the above code, you could see a method for an INTERFACE written something like this:

```
ExtendPrinter.IFax.TransmitDoc  PROCEDURE
  CODE
  !Code here.
```

Notice that the class label comes first, then the INTERFACE label followed by the method. Each separated by a period (see dot syntax, discussed earlier).

The Dark Side of Interfaces

You may see that method names of interfaces can be wordy. That is a small price to pay to define a behavior. However, there is another aspect to consider. What happens if an interface has many methods? How do you show which ones you wish to use?

The simple answer is you use all of them. David Bayliss, the designer of the ABC classes and Clarion compiler architect, explains that the problem is that an interface should be an explicit (not implicit) contract between the interface and the class that implements it. In other words, you know what the class should do. In addition, if another programmer implements your interface in his class, then he knows what to expect.

An interface is a common boundary between two objects. If one can choose behaviors, then the interface is implicit, or ambiguous.

The Good Side of Interfaces

When you have an interface, then any later CLASS could implement it. This is yet another way of changing a behavior of a CLASS. In the example I use here, a derived printer class implemented a fax interface. This changed the behavior of the printer yet I changed nothing in the class code itself.

If I wanted to, I could add yet another INTERFACE to a class. In my printer class, I could add an *IScanner* and *ICopier* interfaces to the printer class. This means that a CLASS may IMPLEMENT more than one INTERFACE.

```
Extendprinter   CLASS(Printer),IMPLEMENTS (IFax),|
                                IMPLEMENTS(IScanner),|
                                IMPLEMENTS(ICopier),TYPE
PrintDoc          PROCEDURE
                   END
```

If you plan or need to implement many interfaces in a class, then think about using derivation in your interface declarations.

```
IFax                    INTERPACE(ICopier)
TransmitDoc               PROCEDURE
GetDoc                    PROCEDURE
                        END
```

In the next section, I demonstrate interfaces in action. The purpose of this section is to define and show the rules of what an interface is and does and how to use them.

Summary

You now know the three major OOP buzzwords: Encapsulation, Inheritance, and Polymorphism and how to implement them in the Clarion language. You have also heard the other standard OOP terms: Properties, Methods, Objects, Instantiation, Base Classes, Derived Classes, Interfaces, SELF, PARENT, Constructors and Destructors, Virtual Methods, and Late Binding.

The data in this section lays the foundation to what comes in the next chapters. You will discover that this data applies to ABC, what happens when you use embed points, even the subject of COM is based on this data.

Chapter 3 - Applying OOP in Clarion

Introduction

The last chapter covered the basics of Object Oriented Programming. Its purpose was to get the theory of OOP under your belt. This chapter covers how to apply that data. I plan to do this with actual working code that covers many of the concepts covered. Since there are many possible ways to do this, you may see a concept applied twice, but differently.

This means repeated concepts, but the difference is that working code reinforces these concepts.

Where to Start?

One of the problems with using objects in your applications is trying to find a good starting point. Before you write one line of code, think about what you need and want.

Just as the *FileClass* discussed previously, this object deals with things that are "file- like". Again, what do all files have in common? This is what you usually put in a base class. Always start so simple is it painfully obvious that you are missing functionality. Do not worry about missing things at first. If you can design and code a class that opens and closes a file, you are off to a good start. If you can make this class open and close any file, no matter what, then you are further along and "bang on" the right track.

The point is that an object does not know, nor care what it is dealing with. At least it does not during development time. This means that you hard code nothing. If you need to hard code a bit here and there to get you going, that is fine. Just see if you can retain the function without hard coded values later.

What about existing applications?

The question I think gets asked the most is when one should convert existing applications to OOP. I have seen all types of applications in various stages of development. There is no precise answer as there are too many variables. Where applications are close to release, I can state this is the wrong time to think about converting to objects. I am referring to existing code. In this case, hold off until the next major version of your application.

It is never too late to use objects for code not yet written. This means that applications that started with the Clarion templates and then maintained by hand (a common practice), can benefit from objects. Therefore, that is an example that can apply to any application.

The next type of application is one that has some code written, but release is still way off in the future. This could benefit from using objects as above, but in addition to that, there is

a greater chance to convert existing code to objects. Whether or not this happens depends on the design, the skill set of the developers, and if there time in the budget to squeeze a few of these in. An interesting phenomenon happens here. It may take some time to do a conversion and thus it will not seem worth the effort as it puts the project behind. What is missing from that viewpoint is that when you have an object you can use, that is a bit of code you do not need to write again, so there is a timesaving here. The payoff comes when you start using these objects. Therefore, you could say that coding OOP style is front heavy.

The last type of application is the new one. Decisions are easy at this stage as the real code work has yet to start. One could start a new ABC project and many Clarion developers choose this route. Moreover, they use ABC with success.

Those are three broad scenarios to look at. But you are the one that will have to decide when and how you wish to proceed.

Back to Encapsulation

Unlike the previous chapter where the first discussion of encapsulation occurred, this section shows some actual code use. Again, starting very simply, here is the CLASS (which is encapsulation):

```
PlayWave    CLASS,TYPE
WaveName      CSTRING(FILE:MaxFileName)
Play          PROCEDURE
            END
```

That is a simple class with one property and one method encapsulated in it. For now, this serves our purpose. Notice the *WaveName* property. Based on this label, the variable contains the name of the wave file. FILE:MaxFileName is an EQUATE which happens to be 256. Therefore, this declares a CSTRING variable, 256 bytes long (minus one for the terminating character). Since it is a CSTRING, this variable is as long as needed. This eliminates the need to CLIP it.

However, notice that it makes no mention of which wave file to play. No mention of the file name in the method either.

You may guess, based on the name of the method, it plays the wave file in *WaveName*. This is a correct assumption. However, there is something unusual about the *Play* method. Have you spotted what it is yet? It does not take any parameters. How does the *Play* method know which wave file to play?

Remember, we are talking about encapsulation here. Inspect the following method code listing and see if you can see how this works.

```
PlayWave.Play     PROCEDURE
  CODE
  SndPlaySound(SELF.WaveName,1) ! Call API to play .WAV file.
  RETURN
```

Function Overloading

Since this is code inside of a method, the object name is SELF. Thus, any instance of *PlayWave* works. *PlayWave* is not instantiated due to the TYPE attribute. This means that this class is a definition only. In order for this to work, the *PlayWave* class must be instantiated before you attempt to use it in code.

Before I use this class, this is a good time to bring up that a class definition does support function overloading. The declaration of the *PlayWave* class then becomes something like this:

```
PlayWave        CLASS,TYPE
WaveName          CSTRING(FILE:MaxFileName)
Play              PROCEDURE
Play              PROCEDURE(STRING xWaveName)
                  END
```

Notice the two *Play* methods. One takes a parameter the other does not. Yet, both have the same label. This is function overloading and this is legal in Clarion. The rule is that any procedure you can declare in a MAP statement, you may declare in a class.

The TYPE attribute tells you this is only a definition. Before you may use an object, it must be there first. Thus, you need to instantiate the object the above definition describes. How do you instantiate this class?

One line of code is all you need, which can appear anywhere after the class declaration and before the CODE statement.

```
MakeNoise             PlayWave !Instantiate the PlayWave class
```

When this program starts, the *MakeNoise* object is instantiated. Assuming there is a window declaration with two button controls on it, you could call these methods when these buttons are pressed. The code could look like this:

```
ACCEPT
  CASE ACCEPTED()
  OF ?PlayButton
    MakeNoise.WaveName = LONGPATH() & '\halle.wav'
    MakeNoise.Play()
  OF ?PlayTooButton
    MakeNoise.Play(LONGPATH() & '\halle.wav')
  END
END
```

Notice that the code is calling both methods. The first sets the name of the wave file to play, then calls the method. This works because the code for this method uses a property of the class. The second uses the name of the file as a parameter. This works as well.

This is a clever thing to do with a class. If you function overload two or more methods, this makes your class flexible. This does not always mean that two or more methods do the same task; the overloaded methods may do something different. Which one you do is up to you.

Would you like to inspect the method code? Below are the two methods.

```
PlayWave.Play          PROCEDURE
  CODE
  SndPlaySound(SELF.WaveName,1)
  RETURN

PlayWave.Play          PROCEDURE(STRING xWaveName)
  CODE
  SELF.WaveName = xWaveName
  SndPlaySound(SELF.WaveName,1)
  RETURN
```

Notice that each method has the prototype listed. This is so the compiler knows which method belongs to which declaration. You do not have to use the attributes or return types here (if any). I should mention that some OOP coders do use attributes and return types (if any), but place them as comments at the end of the line.

Also, notice that the name of the declaring class is used. Do not use the name of instantiated objects! See OOP1.PRJ in the code folder for a working example.

How to code large CLASS structures

Here is a little tip when you are coding classes. When you declare a method, you do not have to write *working* code for it right away. You may not know the complete design or functionality yet. Thus, the minimum method code you need to get a clean compile is this:

```
ClassLabel.MethodName                PROCEDURE(<prototype>)
  CODE
```

Using this method (no pun intended), you may declare your class structure any way you want, then simply drop in the minimum method code. Then you can test a few methods at a time, so even large class structures are not a concern. You could even call these "empty" methods in your testing. Nothing happens when you do.

Instantiation and Inheritance

You now have a working class labeled *PlayWave*. As this code progresses, it is getting unwieldy with many declarations. Thus, the *PlayWave* class changes as follows:

```
PlayWave     CLASS,TYPE,  |
                  MODULE('PLAYWAVE.CLW'),|
                  LINK('PLAYWAVE.CLW')
WaveName       CSTRING(FILE:MaxFileName)
Play           PROCEDURE
Play           PROCEDURE(STRING xWaveName)
               END
```

Module and Link

Notice two new attributes to the class definition. These are the MODULE and LINK attributes. The MODULE attribute tells the compiler where the method code is. The LINK attribute means that the external source file is placed in the project settings, without explicitly naming it there.

Looking at the *playwave.clw* file, this is the code in it:

```
  MEMBER()
  MAP
    INCLUDE('SNDAPI.CLW'),ONCE
  END
  INCLUDE('PLAYWAVE.INC'),ONCE

PlayWave.Play   PROCEDURE                     ! Play a WAV file.
  CODE
  SndPlaySound(SELF.WaveName, 1)
  RETURN

PlayWave.Play   PROCEDURE(STRING xWaveName)   ! Play a .WAV file.
  CODE
  SELF.WaveName = xWaveName
  SndPlaySound(SELF.WaveName, 1)
  RETURN
```

The empty MEMBER statement indicates the module is a "universal member module" that you can compile in any program by adding it to the project. In other words, there are no ties to any project.

The MAP statement has the sound API declarations. The ONCE attribute on the INCLUDE statement means that if the contents of this source is already present, then do not include it again. The ONCE attribute makes this type of "dirty" declaration obsolete:

```
    INCLUDE('SomeInclude.inc',_SomeInclude_)
_SomeInclude_       EQUATE(1)
```

The code afterwards is the same method code we have seen already. The only difference is this code is no longer in the main source module. Thus, you may keep your main program logic in one file. Simply INCLUDE whatever you need, to keep this module free of "clutter".

Instantiating multiple objects

This is simple to do in Clarion. Using the *PlayWave* class, you may instantiate new instances of *PlayWave* with a few simple lines of code:

```
Noise1    PlayWave    !Instantiate new object of PlayWave type
Noise2    PlayWave
Noise3    PlayWave
```

If you need many instances of a class, this is the easiest way to do it. In addition, each instance of a *PlayWave* class inherits everything from *PlayWave*. Assuming a window with buttons, the following code in the main body works:

```
ACCEPT
  CASE ACCEPTED()
  OF ?OkButton
    Noise1.WaveName = LONGPATH() & '\f22.wav'
    Noise1.Play()
  OF ?OkButton2
    Noise2.WaveName = LONGPATH() & '\train.wav'
    Noise2.Play()
  OF ?OkButton3
    Noise3.WaveName = LONGPATH() & '\a10flyby.wav'
    Noise3.Play()
  END
END
```

For a working example, see OOP2.PRJ in the code folder.

Manual instantiation

So far, all the examples use simple instantiation. Manual instantiation is just as effective, but you need to keep track of what you are doing. You need manual instantiation if you have references in a class structure.

Assuming the *PlayWave* class is the same, what follows are a few more declarations:

```
TypeQue   QUEUE,TYPE
MyString    STRING(15)
          END

WorkClass       CLASS,TYPE,
                      MODULE('WORKCLAS.CLW'),LINK('WORKCLAS.CLW')
WorkQ             &TypeQue
Noise             &PlayWave
Fi11Que     PROCEDURE,LONG,PROC
             END
```

The *TypeQue* structure is simply a QUEUE definition. The TYPE attribute means the same here as it does on a CLASS structure.

The *WorkClass* declaration is a definition as well. Again, the MODULE and LINK

attributes are present. However, notice that there are two properties in *WorkClass*. They are simply references to other declarations. Therefore, you can see that class structures can accommodate complex structures. By using a reference, it is the same as if the declarations are in the class structure. You are not limited to QUEUE and CLASS structures. You may use a reference in any manner a reference is legal elsewhere in Clarion. This means you may have &WINDOW, &FILE and other complex structures referenced.

The method in *WorkClass* returns a value. The PROC attribute prevents a compiler warning, as PROCEDUREs did not return values in earlier versions of Clarion. This was reserved for FUNCTIONs. FUNCTION is a deprecated language statement.

You can create an instance of *WorkClass*, just like *PlayWave*:

```
Work      WorkClass !Create an instance of the WorkClass object.
```

OK, there is nothing new here. Where do the references come in? If you tried to use them in code at this point, you will get a GPF. The reason is that there is no memory allocated for them -- yet.

Which means you must instantiate them. The NEW statement does this as follows:

```
  ACCEPT
    CASE EVENT()
    OF EVENT:OpenWindow
      Work.WorkQ &= NEW TypeQue       !Create instance of TypeQue
?     ASSERT(~Work.WorkQ &= NULL)
      Work.Noise &= NEW PlayWave      !Create instance of PlayWave
?     ASSERT(~Work.Noise &= NULL)
      IF Work.FillQue()
        ?List1{PROP:From} = Work.WorkQ
        SELECT(?List1,1)
      END
```

The way to do this is to make a reference assignment with the NEW statement. The ASSERT is assuming that it is not NULL. If this is not the case, you can GPF the program, but only if in debug mode. You can spot this by the question mark in column one (which is why they are red in color). When in debug mode; GPFing a program is a fast and easy way to find bugs in your code. Placing ASSERT statements in your code is a good way to "bullet proof" your code.

Since the *FillQue* method returns the number of items in a QUEUE structure, using it with the IF statement acts like a Boolean function. If there were no entries in the QUEUE, the method returns zero, thus the IF statement fails. In Clarion, a zero is false, anything else is true. If it is true, then the *?List* control gets its data from the *Work.WorkQ*. The PROP:From expression is what makes this work. Finally, the SELECT statement selects the first record in the list box.

Do not forget to clean up after yourself

I said earlier to ensure anything you NEW you must DISPOSE. I never stated why. Any object instantiated with NEW is never destroyed automatically. You must do this yourself. If you forget, you have a memory leak.

Thus, the following code destroys the objects:

```
IF ~Work.WorkQ &= NULL      !if not null
  FREE(Work.WorkQ)          !Delete entries, de-allocate memory
  DISPOSE(Work.WorkQ)       !Destroy instance of TypeQue queue
END
IF ~Work.Noise &= NULL      !if not null
  DISPOSE(Work.Noise)       !Destroy instance of PlayWave
END
```

Notice the test of "nullness". If it is already NULL, the code drops through to the next statement. If not, then FREE deletes all entries from a QUEUE and de-allocates the memory they occupied. It also de-allocates the memory used by the QUEUE's "overhead." Then destroy the reference to *Work.WorkQ* by using DISPOSE.

You can see a similar test for the *Work.Noise* object.

For further study, see OOP3.PRJ in the code folder.

Constructors and Destructors

If you ever need to use constructors and destructors in your classes, a good rule of thumb is to place code that always needs to execute in them. An example is instantiating another object in the case of a constructor. If I use a constructor, I use a destructor to clean up what the constructor did.

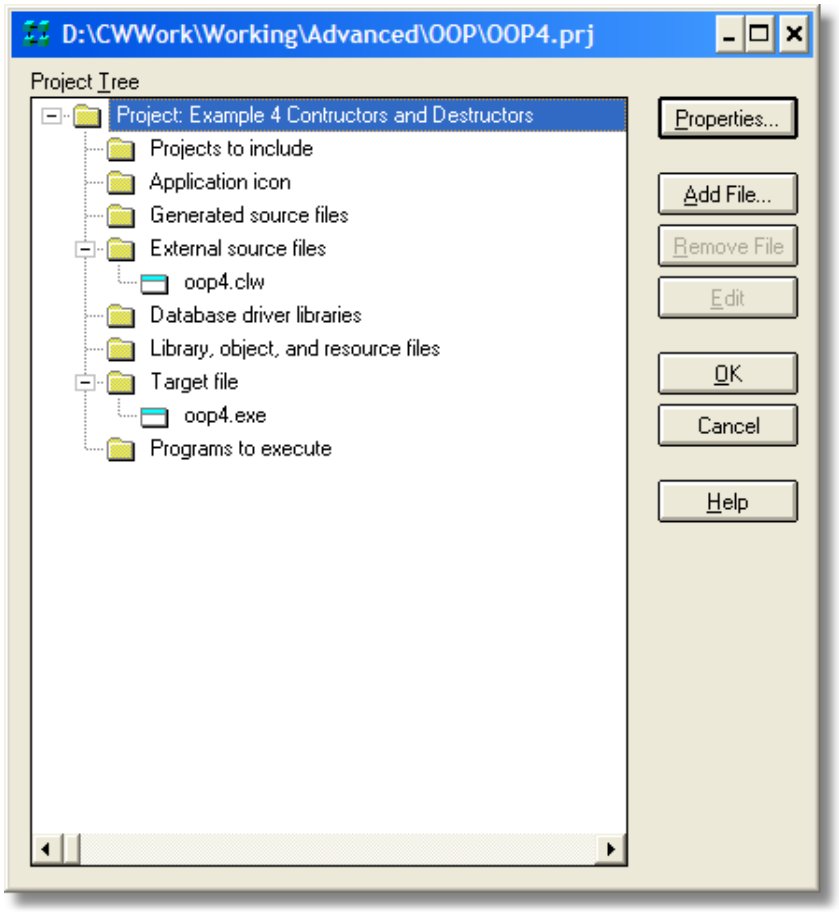
Here is a good example of this. I have this class definition:

```
ConstructClass    CLASS,TYPE, |
                        MODULE('CNSTRUCT.CLW'),|
                        LINK('CNSTRUCT.CLW')
WorkQ               &TypeQue        !Reference to typed queue
Noise               &PlayWave       !Reference to typed class
FillQue             PROCEDURE,LONG,PROC
Construct           PROCEDURE
Destruct            PROCEDURE
                  END
```

It has two properties that are references, one to a queue and the other to another class. Since I need to make reference assignments to both before I can legally use them, the code to do this goes in my *Construct* method. The *Destruct* method merely undoes what *Construct* did.

```
ConstructClass.Construct     PROCEDURE
  CODE
  SELF.WorkQ &= NEW(TypeQue)        !Instantiate the queue
? ASSERT(~SELF.WorkQ &= NULL)       !Assert that it is not null
  SELF.Noise &= NEW(PlayWave)       !Instantiate Playwave object
? ASSERT(~SELF.Noise &= NULL)       !Assert that it is not null

ConstructClass.Destruct      PROCEDURE
  CODE
  IF ~SELF.WorkQ &= NULL            !If the queue is not null
    FREE(SELF.WorkQ)                !Free the queue
    DISPOSE(SELF.WorkQ)             !destroy the queue
  END
  IF ~SELF.Noise &= NULL            !If Noise object is not null
    DISPOSE(SELF.Noise)             !destroy the Noise object
  END
```

Cnstruct.clw is where you find the above code. The LINK attribute on the class tells the linker to add this to the project, even though you do not see it there.



For further study, see OOP4.PRJ in the code folder.

Derivation

The previous example uses a reference property in the class definition. This does give you derivation when the object is instantiated (in the *Construct* method). However, this is not the only way to do this:

```
DerivedClass        CLASS(PlayWave),TYPE
WorkQ                 &TypeQue
FillQue               PROCEDURE,LONG
Construct             PROCEDURE
Destruct              PROCEDURE
                    END
```

As you can see in this example, the reference to the parent class is missing. However, the parameter in the class statement does the same thing.

This makes the workload on the constructor and destructor less as well. This is not much different from the previous example; more of a variation to illustrate there is more than one method to inherit parent classes.

See OOP5.PRJ in the code folder for an example of this.

Overriding

Sometimes, you need to override a parent behavior. However, do not confuse that to mean that overriding is an all-or-nothing thing. Sometimes it is, if that is what you want. However, what if you wish to extend the parent's behavior? You do have to override the method. You do this by making a method with the same label and prototype as the parent method.

However, in the code of the method there is no rule that says you cannot use the parent method. In ABC, this is a common practice. Here is the class to illustrate this:

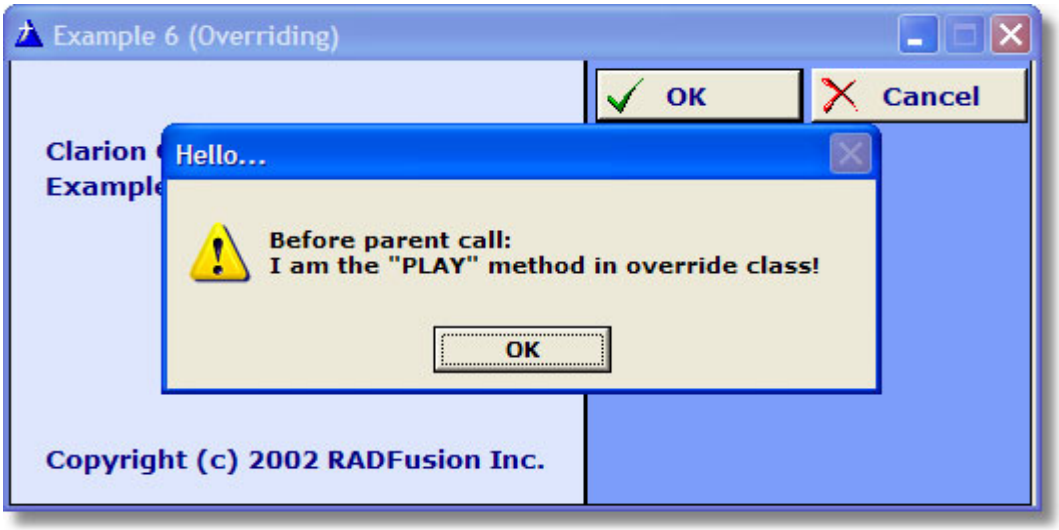
```
OverrideClass     CLASS(PlayWave),TYPE,|
                        MODULE('OVERRIDE.CLW'),|
                        LINK('OVERRIDE.CLW')
WinRef              &WINDOW          !Reference to a window
Control             LONG(0)
FlashSpeed          LONG(0)
Toggle              LONG, STATIC     !Ensure value does not change
Flash               PROCEDURE
Play                PROCEDURE        !Override method in Parent
Init                PROCEDURE
                  END
```

The *Play* method overrides the *Play* method in the *PlayWave* class. You may assume that the parent *Play* method plays a wave file, like the examples before. The *OverrideClass' Play* method needs to do more than simply play a wave file. There is code that displays messages and a few other things. In the source file for the code of this method (see the MODULE attribute for the name of the file), there is this code:

```
OverrideClass.Play          PROCEDURE ()
  CODE
  SYSTEM{PROP:Font,1} = 'Verdana'
  SYSTEM{PROP:Font,2} = 8
  SYSTEM{PROP:Font,4} = FONT:Bold
  MESSAGE('Before parent call: |I am the "PLAY" method in override
class!','Hello...',ICON:Exclamation)
  PARENT.Play()          !Call Play method in PlayWave (PARENT) class
  SYSTEM{PROP:Font,4} = FONT:Italic
  SYSTEM{PROP:Font,2} = 10
  MESSAGE('After parent call: |I am the "PLAY" method in override
class!','Hello...',ICON:Exclamation)
  RETURN
```

Do you see the call to the parent's method? PARENT is like SELF, but defined as whatever the parent is. In this case, it is *PlayWave*. Therefore, the *OverrideClass* never plays a wave file, as there is no code to do so. Instead, it uses another method that does have that code.

In this instance, the method needs to not only play a wave file, but also display messages. In addition, there is some code to change the font of the message boxes. When run, it appears like this:



See OOP6.PRJ in the code folder for an example.

Virtual methods

Perhaps the hardest thing for those studying OOP is how virtual methods work in their code. This is perhaps the strangest concept for procedural, top-down coders to understand. I have had students tell me they cannot understand how virtual methods work because the code jumps all over the place. And, they are right. That is nothing new as the ACCEPT loop

seems to loop a number of times. In the old legacy (pre-C6 Clarion templates), near identical named routines call each other and back. Perhaps this jumping around is fine, after all, it does take place in one source module.

ABC uses many virtual methods. There is more code "action" going on here, so perhaps the confusion stems from the increased activity. It really does not matter, as once you understand how virtual methods work and why you use them it's a walk in the park. Here are two examples. The first carries on the current theme from the example projects.

```
            SECTION('PLAYWAVE')

PlayWave    CLASS,TYPE,MODULE('PLAYWAV2.CLW'),LINK('PLAYWAV2.CLW')
WaveName       CSTRING(FILE:MaxFileName)
Play           PROCEDURE (),VIRTUAL
CallVirtual    PROCEDURE ()
            END

            SECTION('VIRTUAL1')

Virtual1    CLASS(PlayWave),TYPE,MODULE('VIRTUAL1.CLW'),LINK('VIRTUAL1.CLW')
Play           PROCEDURE (),DERIVED
            END

            SECTION('VIRTUAL2')

Virtual2    CLASS(PlayWave),TYPE,MODULE('VIRTUAL2.CLW'),LINK('VIRTUAL2.CLW')
Play           PROCEDURE (),DERIVED
            END

            SECTION('RESTOFPROGRAM')
```

There is now a change to *PlayWave*. Notice the additional *CallVirtual* method. Also, notice the source where you find this method. The two almost identically named classes derive from *PlayWave*.

Notice the *Play* method in each class. The two child methods override the parent. The parent method has the virtual attribute, which is required. The two child methods use the derived attribute. This means "virtual" plus it protects the child methods from function overloading if the parent prototype changes.

Lastly, notice the SECTION statements. This is not required for coding objects, but is rather a clean way of including the definitions in the method source file. Let us look at the source files.

```
  INCLUDE('OOP7.CLW','PLAYWAVE'),ONCE

PlayWave.Play                PROCEDURE ()

  CODE
  MESSAGE('I am Play!','Base Class',ICON:Exclamation)
  SndPlaySound(SELF.WaveName,1)
  RETURN

PlayWave.CallVirtual         PROCEDURE
! Call whatever virtual is currently replacing the dummy PARENT.Play
! method shown above.
  CODE
  MESSAGE('I am CallVirtual!','Base Class',ICON:Exclamation)
  SELF.Play ()                      !This calls either V1.Play or
  MESSAGE('Back at CallVirtual')    ! V2.Play depending on which
                                    ! one called this method.  SELF can
                                    !contain either V1 or V2
                                    ! so a base class is now calling
                                    ! "down" or "forward" to
                                    ! a child or derived class.
```

Notice the INCLUDE statement at the top of the listing. It includes the code starting after the "Playwave" SECTION name. It includes everything until the next SECTION or end of file, whichever comes first.

There are two methods, *Play* and *CallVirtual*. *CallVirtual*, when run, calls *Play* sandwiched by two message statements. They are there only to show what is going on when run and to have more code than simply playing wave files.

Next, the *virtual1.clw* file (*Virtual2.clw* is nearly identical, so no need to look at it).

```
  INCLUDE('OOP7.CLW','PLAYWAVE'),ONCE
  INCLUDE('OOP7.CLW','VIRTUAL1'),ONCE

Virtual1.Play                PROCEDURE ()
  CODE
  PARENT.Play ()
  MESSAGE('Hi, I''m Virtual 1 ','Virtual 1...',ICON:Exclamation)
  RETURN
```

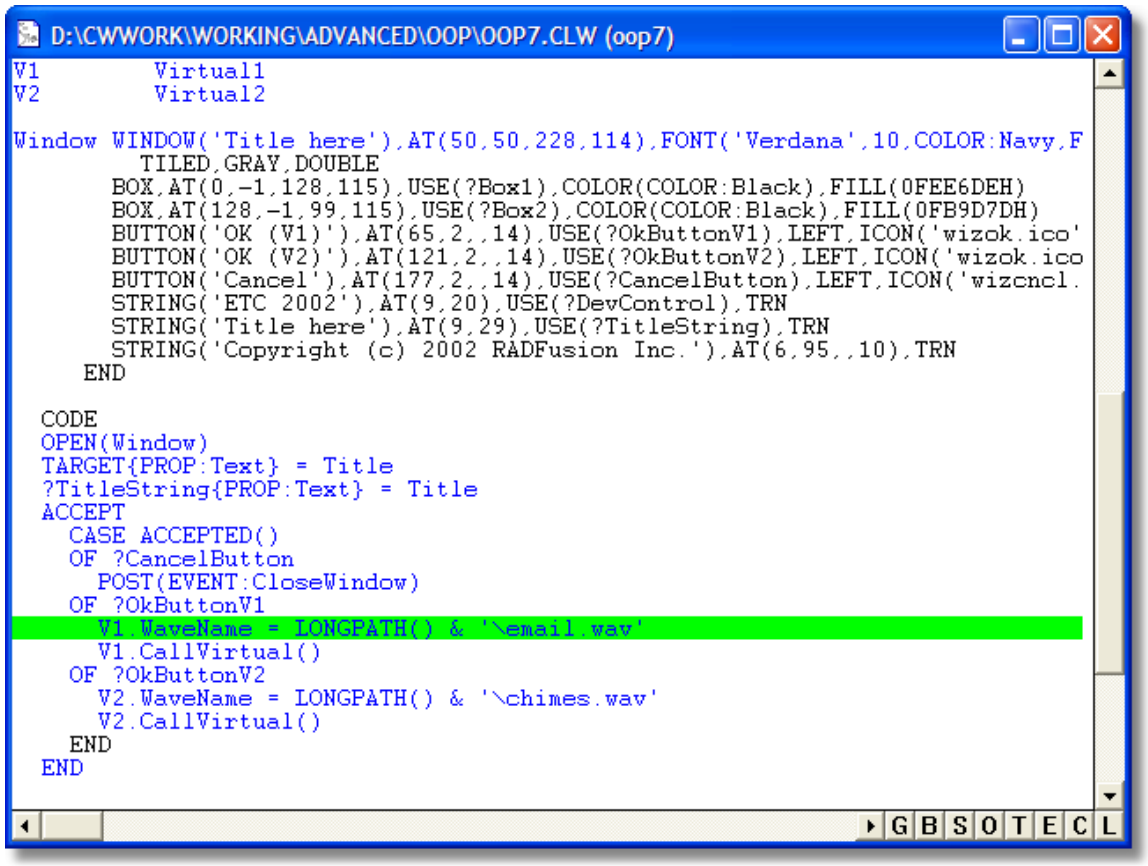
Notice the two INCLUDE statements. Both are needed as the first has the parent definition and the second INCLUDE is the definition of class derived from it.

All this does is call the parent method and show a message. The parent call does run the code to play a wave file. If you comment that line, the virtual methods still execute (just no sound).

The Debugger as Teacher

Running the project does not really show you the calling sequence. I have yet to see a project that does. If you wish to see this execute line-by-line, then the debugger is the best bet. Here is how I would set it up:

First, when the debugger opens the "procedures in" window, choose "_main". The source file for it opens. Simply place a break point on the line of code you wish to see execute. Since the object of interest is a method call, set the break point there.



Press GO and the main window of the application appears. The code to run executes when you press ?OKBUTTONV1. The debugger takes over and you press STEP SOURCE to follow the execution. Since this project is small, you can see what happens in the code. You may need a few loops through that code to get a better understanding of this. It is worth the small amount of time it takes.

The Virtual Apple Pie

Do you remember the Apple Pie example in the previous chapter? Why not use that example with working code to show how virtual methods work? Here is all of the code:

```
  PROGRAM

  MAP
  END

ApplePie          CLASS
PreparePie          PROCEDURE
CreateCrust         PROCEDURE,VIRTUAL     !Virtual Methods
MakeFilling         PROCEDURE,VIRTUAL
                  END

Dutch             CLASS(ApplePie)
CreateCrust         PROCEDURE,DERIVED     !Virtual Methods
MakeFilling         PROCEDURE,DERIVED
                  END

  CODE                                    !Main body of code
  MESSAGE('Lets make a Dutch Apple Pie!')
  Dutch.PreparePie                        !Call the Dutch object's Virtuals
  MESSAGE('Now lets make an Apple Pie!')
  ApplePie.PreparePie
                                          !Code for all methods below
ApplePie.PreparePie    PROCEDURE
  CODE
  MESSAGE('In ApplePie Class - create the crust')
  SELF.CreateCrust                        !What is SELF?
  MESSAGE('In ApplePie Class - make the filling')
  SELF.MakeFilling                        ! and why?

ApplePie.CreateCrust   PROCEDURE
  CODE
  MESSAGE('Creating the Apple Pie crust.')

ApplePie.MakeFilling   PROCEDURE
  CODE
  MESSAGE('Making the Apple Pie filling - yum!')

Dutch.CreateCrust      PROCEDURE
  CODE
  MESSAGE('Creating the crust for Dutch Pie.')

Dutch.MakeFilling      PROCEDURE
  CODE
  MESSAGE('Making the Dutch filling - yum!')
```

In the main code body, there is enough code to make two different apple pies. The main thing to keep in mind is that the *Dutch* object does not have its own *PreparePie* method. It inherited this from its parent. Thus, the *PreparePie* method is the same as the *CallVirtual* method in the previous example (functionally speaking).

When this project runs, *PreparePie* calls "down" or "forward" to the two *Dutch* methods. The only action required by the user when running this, is to press the OK button on each message box.

Moral of the story?

The advantage of virtual methods is that a parent object calls "down" or "forward" to a child class. Think about this for a minute. This also means that you can change the behavior of a parent object and *never lay a finger on the parent's code*. It also means you can alter or extend the default behavior of the parent by making a parent call in your code. You would want to do that if the parent has valid code you may use. This is the normal behavior of ABC.

How to Make Any Kind of Pie

The use of virtual methods is fine and as you can see, you can get a lot done. However, if the next developer that comes along wishes to use your class to make a different type of apple pie, he must use your methods of making apple pies. However, what if they want to use a new apple pie recipe with your class? Will it work? Will they be forced to re-write your class?

The real question is, "Does the Pie Class know how to make various apple pies?"

Where I am going with this is that a pie class should know how to make any pie, apple or otherwise. This is where the interface enters the picture.

A class that implements an interface can now change its behavior without changing the class code.

```
                ITEMIZE,PRE(PIE)
Crust             EQUATE          !The same as PIE:Crust EQUATE(1).
Filling           EQUATE          !The same as PIE:Filling EQUATE(2).
                END

IPieType        INTERFACE         !Supply specifics for any pie type
GetType           PROCEDURE,STRING
GetIngredients    PROCEDURE(BYTE bType),STRING
GetMethod         PROCEDURE,STRING
GetSuggestions    PROCEDURE,STRING
                END

IngredientQ     QUEUE,TYPE
Ingredient        CSTRING(101)
                END

PieClass        CLASS,TYPE       !The pie base class.
CrustQ            &IngredientQ
FillingQ          &IngredientQ
Type               &IPieType       !Reference to the interface
Construct         PROCEDURE
Destruct          PROCEDURE
Init              PROCEDURE(IPieType PT)
Make              PROCEDURE
ShowReceipe       PROCEDURE,VIRTUAL
                END
```

The first part of this code is simply another way of defining equates. The *IPieType* is the interface. The methods are implied virtual methods. These methods describe how one could make any type of pie. It would make sense to get what type of pie one wishes to make. What are the ingredients for a pie is a good thing to know. *GetMethod* describes how to make the pie. Lastly, pies do no one any good if one cannot serve the pie when ready to eat.

Next is the type definition of the *IngredientQ* structure. This holds the list of ingredients.

The *PieClass* is the base class. There are two references to the *IngredientQ* as the ingredients for a filling are different from a crust. The *Type* is a reference property to the interface. This is another way of implementing an interface. There is a constructor and destructor; you may assume these do household chores for the class.

The *Init* method takes a reference to the interface as a parameter. I will explain this shortly. The rest of the class makes the pie and shows the recipe.

Here are the derived classes:

```
PieView              CLASS(PieClass)
GetViewType            PROCEDURE,BYTE
ShowReceipe            PROCEDURE,DERIVED
                     END

PrettyPieClass       CLASS(PieClass),TYPE
Make                   PROCEDURE
ShowReceipe            PROCEDURE,DERIVED
                     END

PrettyPie            &PrettyPieClass
```

Notice the use of the DERIVED attribute on the virtual methods. These two classes also show two different ways of instantiation. That is the code for the pie classes. Notice that the only thing these classes can do is make pies. Yet, nothing here hints at what types of pies one can make. One could make apple, chocolate, pumpkin or even mud pies. What about making different types of pies? We have seen that there are different types of apple pies. So far, nothing here says this code cannot cope.

This brings me to the rest of the declarations. See the following code.

```
ApplePieIngredientQ    QUEUE,TYPE          !Another TYPE queue
Type                     BYTE              !PIE:Crust or Filling
Ingredient               CSTRING(101)
                       END

ApplePie           CLASS,IMPLEMENTS(IPieType)
ListCounter          LONG
IngredientQ          &ApplePieIngredientQ
Construct            PROCEDURE
Destruct             PROCEDURE
                   END

AppleCheeseCake    CLASS,IMPLEMENTS(IPieType)
ListCounter          LONG
IngredientQ          &ApplePieIngredientQ
Construct            PROCEDURE
Destruct             PROCEDURE
                   END
```

Notice there is another queue structure as the design requires that crust and filling ingredients use it. Thus, an ingredient type exists in the definition.

The two classes are identical except for label. Each class implements the *IPieType* interface. The rest of the declaration is just like the previous classes: a reference to a queue structure and the automatic methods for the household chores.

```
  CODE
  PieView.Init(ApplePie.IPieType)  !Pass the Apple Pie interface
                                   !into the PieView object.
  PieView.Make()
```

PieView is the instantiated class. The passed parameter is the INTERFACE. That does not look like much. Inspecting the *Init* method might reveal some information.

```
PieClass.Init     PROCEDURE(IPieType PT)
  CODE
  SELF.Type &= PT              !Remember the Interface for later use.
  FREE(SELF.CrustQ)            !Empty the queues.
  FREE(SELF.FillingQ)
  LOOP                         !Get crust ingredients.
    SELF.CrustQ.Ingredient = SELF.Type.GetIngredients(PIE:Crust)
    IF ~SELF.CrustQ.Ingredient
      BREAK
    END
    ADD(SELF.CrustQ)
  END
  LOOP                         !Get filling ingredients.
    SELF.FillingQ.Ingredient = SELF.Type.GetIngredients(PIE:Filling)
    IF ~SELF.FillingQ.Ingredient
      BREAK
    END
    ADD(SELF.FillingQ)
  END
```

The reference assignment says which INTERFACE this method uses. This is passed via the *PT* variable (which is an *IPieType* variable).

There are two loops here, one for the crust and the other for the filling. The key line of code here is the interface method *SELF.Type.GetIngredients(Type)*. This is where the "magic" happens. Here is the code for this method:

```
ApplePie.IPieType.GetIngredients  PROCEDURE(BYTE bType)
  CODE
  IF ~SELF.ListCounter                    !Queue is sorted
    LOOP SELF.ListCounter = 1 TO RECORDS(SELF.IngredientQ)
      GET(SELF.IngredientQ,SELF.ListCounter) !Get the ingredient
       IF SELF.IngredientQ.Type = bType  !Is what we are looking for?
         SELF.ListCounter -= 1           !Yes, decrement the counter
         BREAK                           !and break out of loop.
       END
    END
  END
  SELF.ListCounter += 1                   !Increment the counter
  IF SELF.ListCounter >  RECORDS(SELF.IngredientQ)
    SELF.ListCounter = 0                  !re-set our counter
    RETURN ''                             !and scram.
  END
  GET(SELF.IngredientQ,SELF.ListCounter)      !Get the ingredient
  IF SELF.IngredientQ.Type <> bType       !Wrong type of ingredient
    SELF.ListCounter = 0                  !re-set our counter
    RETURN ''                             !and scram.
  END
  RETURN(SELF.IngredientQ.Ingredient)     !Return proper ingredient.
```

The queue structure looped in the code was preloaded in the constructors. It simply returns the correct ingredient based on the ingredient type. In this example, it is either a crust or filling type.

You can now see how the *Init* method fills its own *IngredientQ* by calling this interface method. Now the *Init* method is finished, time to make the pie. This is the next line of code in the main body, the making of the pie.

```
PieClass.Make     PROCEDURE   !Call the VIRTUAL ShowReceipe method.
  CODE
  SELF.ShowReceipe()
```

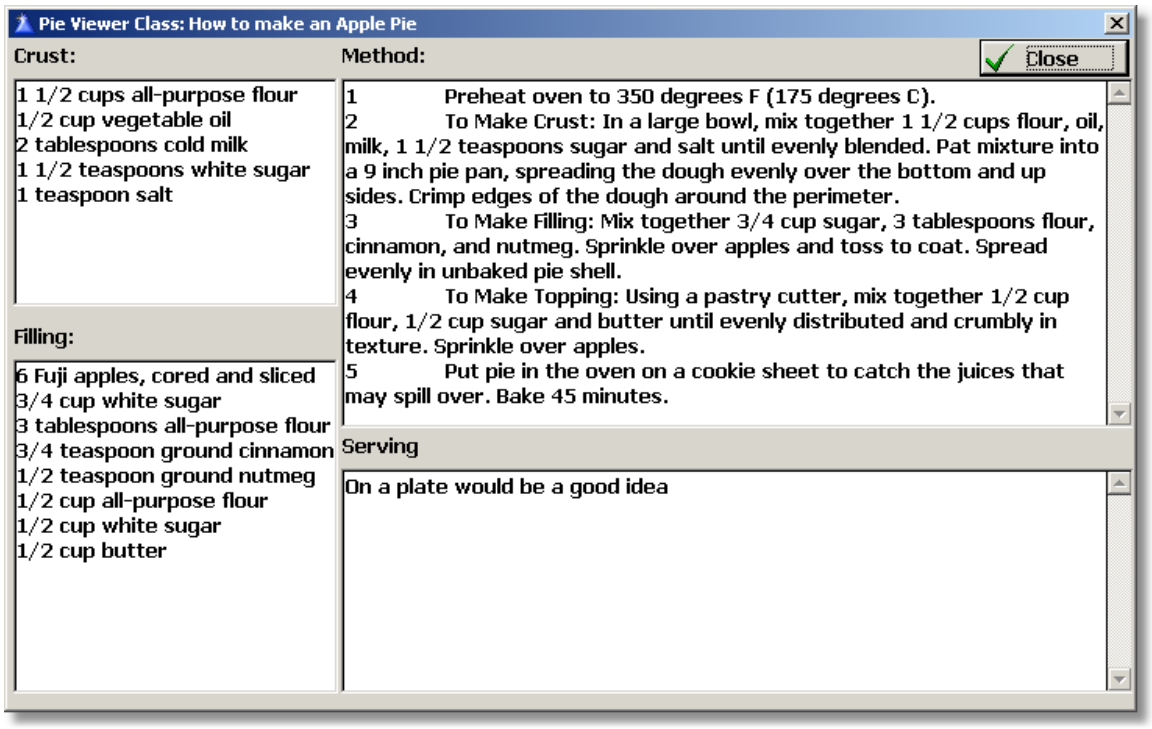
That calls the object's *ShowRecipe* method. This is virtual, thus there is nothing in the *PieClass.ShowRecipe* method. Remember, a parent class calls the derived method instead of its own when they are virtual methods.

Thus, *PieView.ShowRecipe* runs instead. It is the method where the user first sees anything happening. It is the one that offers the choice of which window type they want to use and then opens that window.

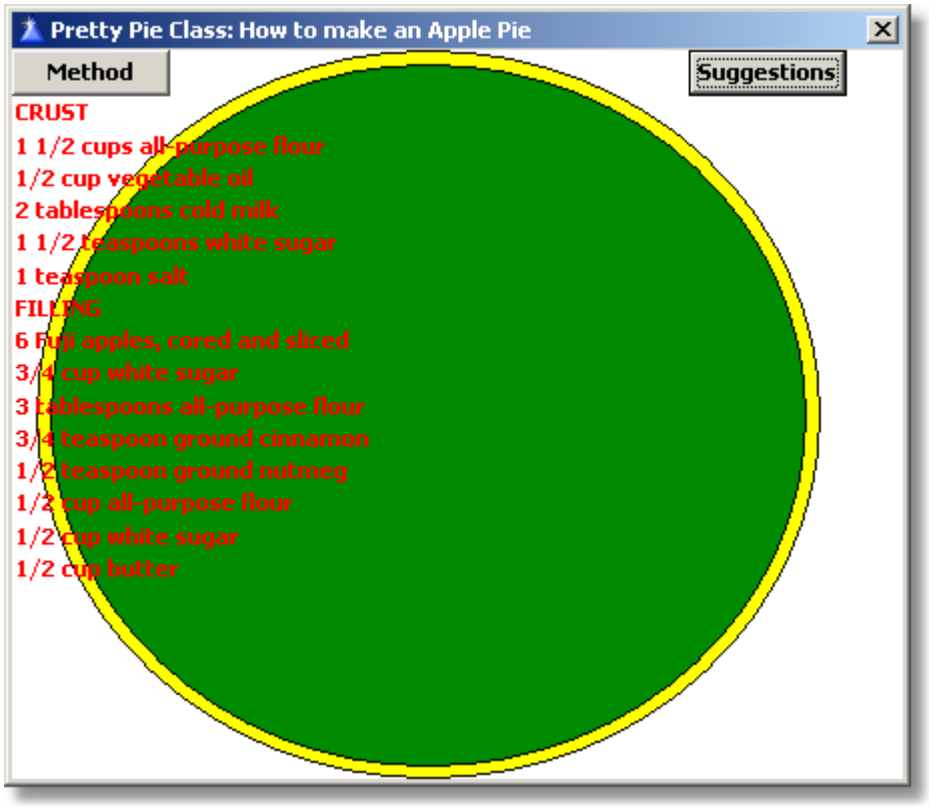
```
CODE
EXECUTE(SELF.GetViewType())                 !Method returns 1 or 2.
  TheWindow &= ThreeDWindow                 !Reference assign if 1.
  TheWindow &= FlatWindow                   !Reference assign if 2.
END
Method = SELF.Type.GetMethod()              !Get the cooking method.
Suggestions = SELF.Type.GetSuggestions()    !serving suggestions.
OPEN(TheWindow)                             !Open chosen window
!Set the window caption.
TheWindow{PROP:Text} = 'Pie Viewer Class: ' & SELF.Type.GetType()
ACCEPT                                      !And away we go.
  CASE FIELD()
  OF ?Close
    CASE EVENT()
    OF EVENT:Accepted
      POST(EVENT:CloseWindow)
    END
  END
END
CLOSE(TheWindow)
```

It first calls *GetViewType* to find out which type of window the user wants to use. The EXECUTE statement then assigns the reference to one of two windows. The *GetMethod* returns the instructions. Remember this is the interface method, so this class "knows" how to get an outside behavior, which you control. The *GetSuggestions* is the serving suggestion for an apple pie. If you made a chocolate pie, you may want to code a different *GetSuggestions* method.

It is at this point the window opens.



There is more to the example. Study PIE.PRJ in the code folder for more information. Look at the *PrettyPie* objects. This uses the same interface; however, the results are quite different.



One Last Concept

What the pie code was illustrating is that the class knows how to make a pie. The interfaces deal with making different types of pies.

Let me give you another concept that may re-inforce how to think with interfaces. Suppose you have a class that deals with washing dishes. You have a method to wash a dish, say a plate. It may involve soaking the plate in a sink full of water and scrubbing it by hand.

What happens when you get an automatic dishwasher interface? You don't soak it in water and scrub it. Different actions, yet the same results -- a clean plate.

Some people use the family dog to wash the plates; I'll leave that interface design to the reader.

Summary

Interfaces are excellent ways to add new behaviors without touching existing code. You do have to write the code for all the methods for a given interface. That is the trade off. I feel that for the extra functionality you get with interfaces, the small price of writing code for all the methods is worth it. Remember, you may still code stub methods for behaviors you do not want.

Study and play with provided code examples. Make changes to these projects. Please break them too. Then fix them. The only real true way to "get" OOP is to write code.

Chapter 4 – ABC and OOP

Introduction

This chapter covers ABC. ABC is an implementation of OOP. Thus, in the study sequence of things, you can see why covering OOP topics first are necessary.

ABC made its debut with the release of Clarion version 4. ABC has evolved over the years. Along the same time line, articles describing how to use various pieces of ABC were penned. The latest publication is by Bruce Johnson of Capesoft fame. Clarion Magazine is another excellent resource. You will need a subscription, but the February 1999 issues are free. In addition, another excellent resource is James Cooke's Clarion Foundry. I would be remiss without mentioning my own site, RADFusion.

This section covers certain areas to give you a better understanding of what is going on under the hood of ABC. In this section, there is a discussion of the problem and its solution (there may be more than one).

Typically, the average Clarion developer can use the template interface to the ABC objects for common tasks like accessing data, developing browse lists and edit forms with little or no difficulty. Just about every business application in the world requires these tasks. ABC handles these aspects smoothly and without the developer having to think about it.

It is the uncommon areas, or exceptions to the rule, that sometimes give developers fits. The other problem area is inexplicable behaviors. If you add to this mix a lack of data (common when learning something for the first time), it magnifies the effect.

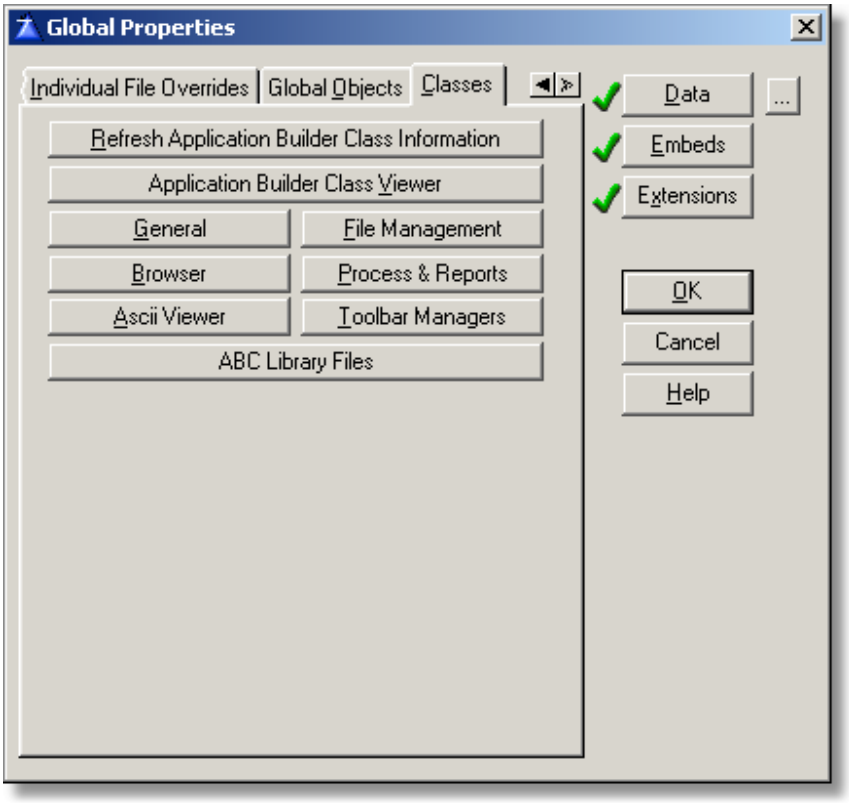
ABC does vast amounts of work for you. There is the old 90/10 rule – ABC does 90% of the work, you must do the last 10%. That last 10% can sometimes seem like the entire workload.

Global

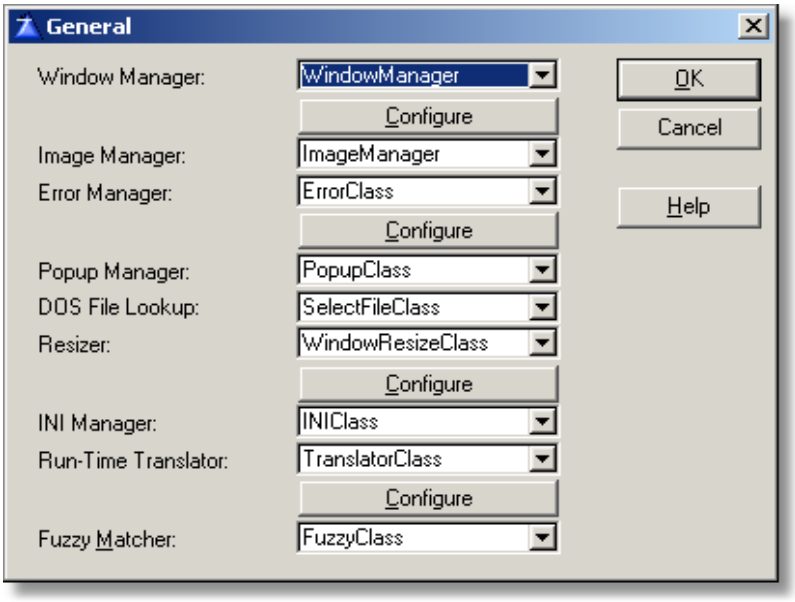
Global objects

These derived objects live in the global area of any application. They come straight from ABC. Any further instances of these objects come from these objects. You can find these objects in any application by pressing GLOBAL, and scroll right until you come to the CLASSES tab. It will look similar to the following figure (you may or may not have data, embeds or

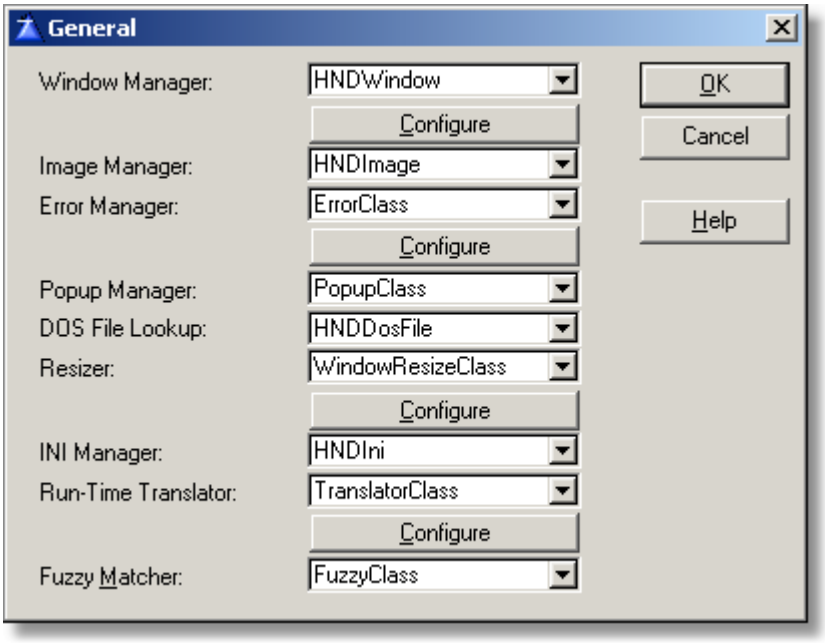
extensions, thus no green check):



The names of the global objects as well as their settings are available here. For example, **press** GENERAL displays this dialog:



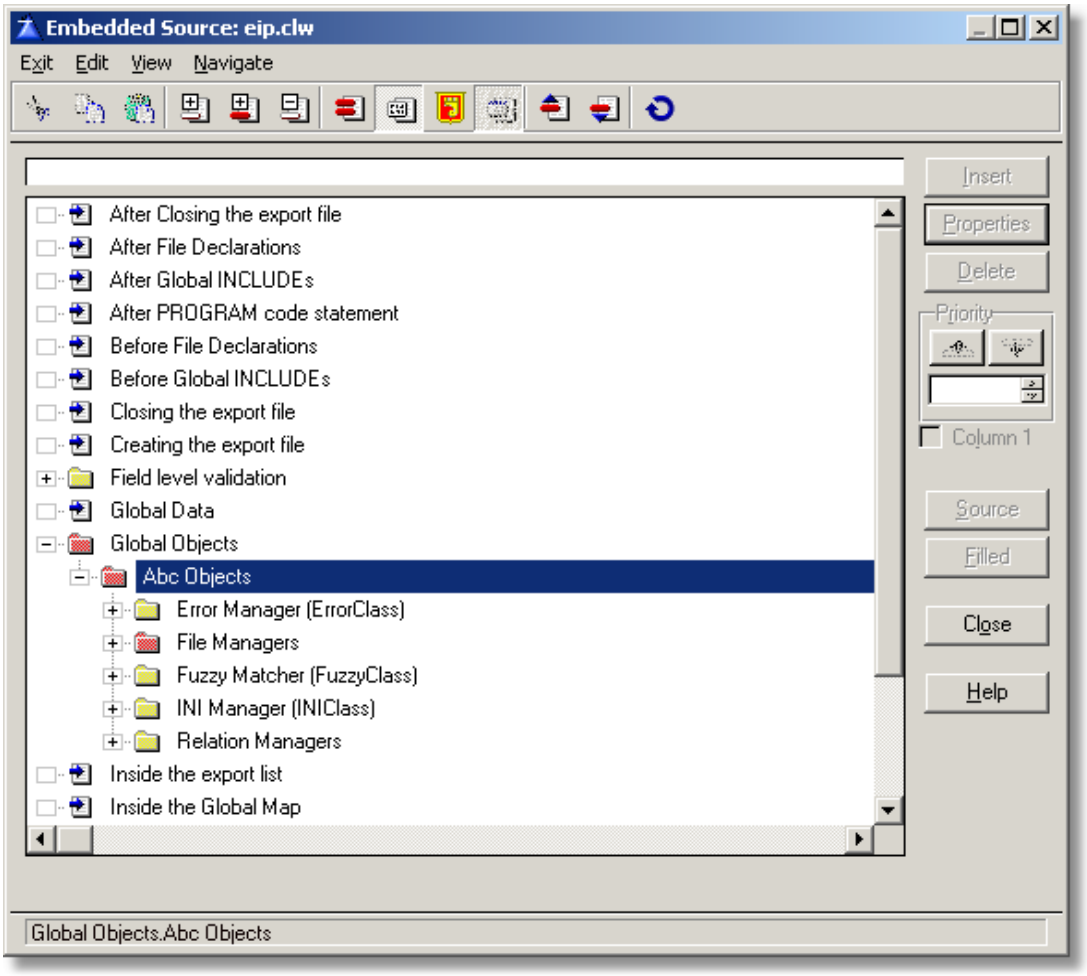
Each class has a drop list. This is so that you may change to a different class instead of ABC's default. For example, here is what some of these setting would look like if you changed some of the defaults to use the Clarion Handy Tools classes:



The other dialogs operate in a similar fashion. The moral of the story is that if you wish to use your own classes for your global objects, ABC allows it.

Global embeds

If you press the EMBED button, you will see a tree list of points where you may add your own code. The following figure shows the ABC global objects.

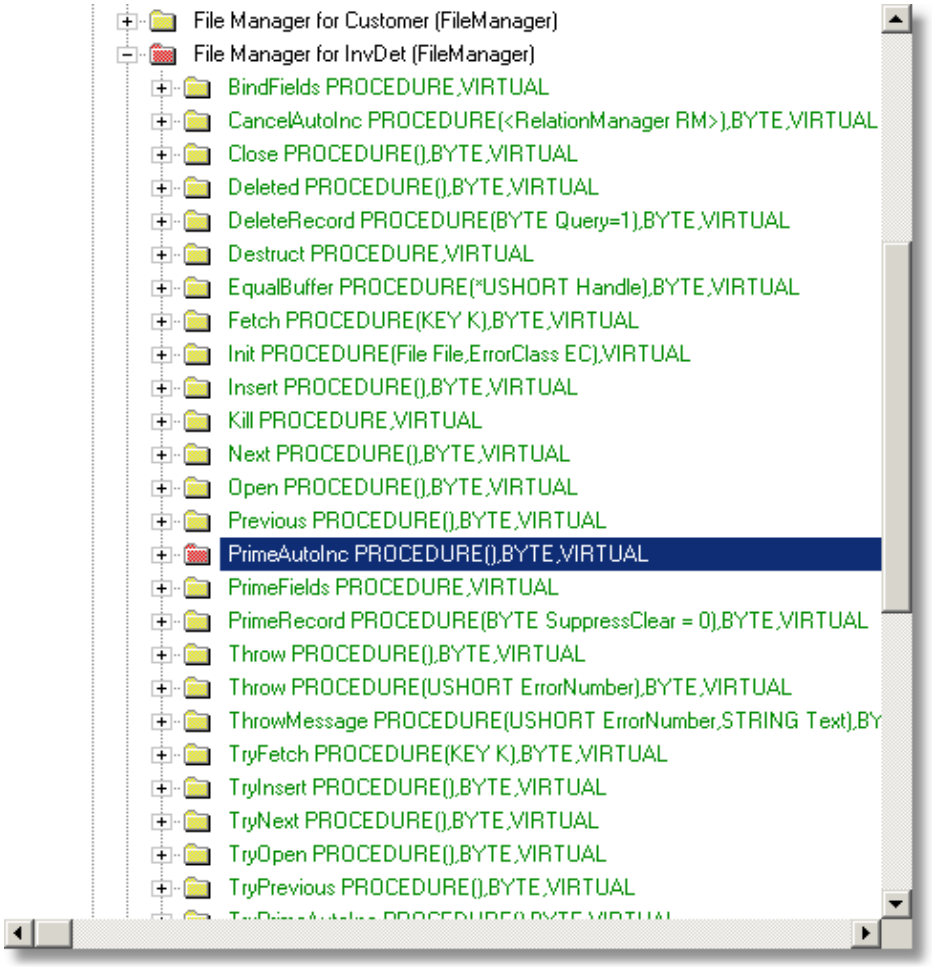


Note: There may be more or less ABC objects visible depending on features needed for the application. For example, if you use the translator class, you would see a *TranslatorClass*. If Fuzzy matching is unchecked in the global properties, it would not appear on this list.

The objects affect the entire application. Any embedded code placed here would then affect the entire application. The reason is that your code changes the way methods work.

If you expand the *File Managers* embed, you will see a file manager object for each file used in your application. While that could make for a busy embed tree for large dictionaries, it does give you control over certain files, while leaving others alone.

Look at the following figure.



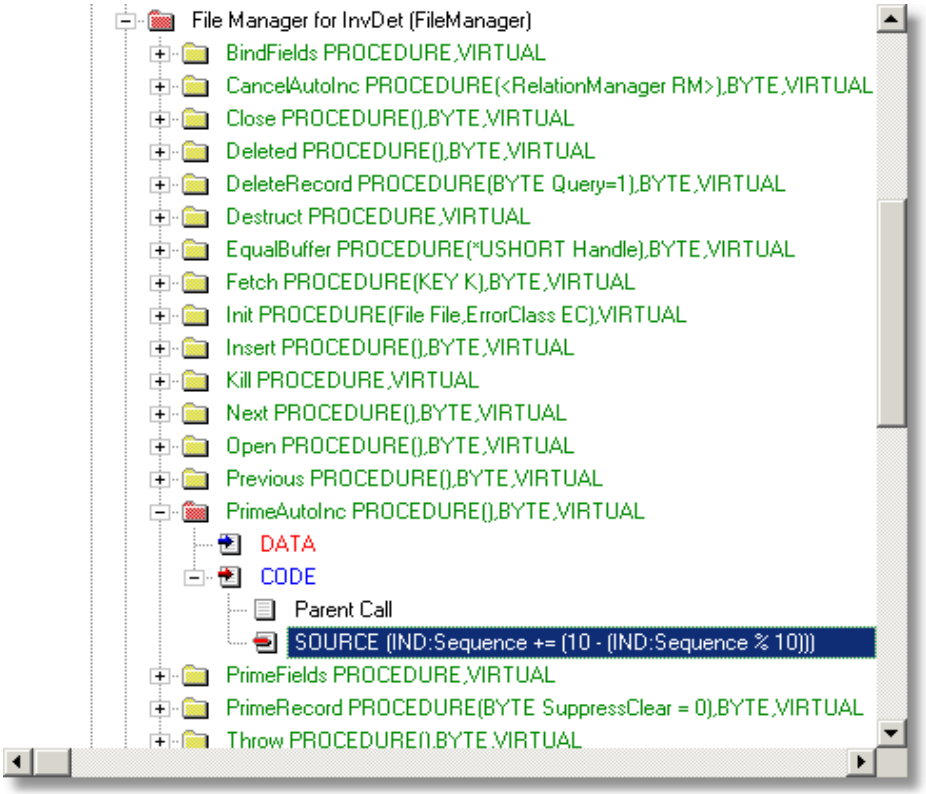
You can see an overriden *PrimeAutoInc* method. The documentation on this method describes it as follows:

"When a record is inserted, the *PrimeAutoInc* method prepares an auto incremented record for adding to the managed file and handles any errors it encounters. If you want to provide an update form that displays the auto-incremented record ID or where RI is used to keep track of children, then you should use the *PrimeAutoInc* method to prepare the record buffer."

What that means is that this method controls how to auto increment a value. Out of the box, it starts at 1 and then adds 1 to the last value used. If you want that behavior, then you have no business changing how this works. If you do not want this behavior, then you must add code to alter or extend how auto incrementing behaves. That is really the only reason you ever should add embedded code.

You may gather that starting at 1 and then adding 1 to the last value is not the behavior wanted by this application and on this file only. So what does this embedded code do?

Look at the following figure:



This is all the code needed that alters the default behavior. In short, instead of starting at 1 and then adding 1 to the last saved value, it starts at 10 and increments by 10. Thus, when adding details to an invoice, the line items are numbered starting with 10, then 20 and so on.

A user could then edit this number to say, 15. This would place the line item between 10 and 20.

How does ABC do files?

A small tour of the global file objects is in order. ABC generates two modules (minimum) that is strictly under its control. They are named *AppNameBC.CLW* and *AppNameBC0.CLW*. Strictly speaking, ABC forces the eight-three convention. Eight characters for the file name, three for the extension. ABC strictly enforces the BC and BC0 part of the file name, so the actual names are the application name up to 6 and 5 characters respectively.

One final note about this naming convention; depending on the number of files in the dictionary, the BC0 could become BC1, BC2 etc. Expect to see this for every 10 files.

The BC module contains code similar to this figure:

```
  MEMBER('eip.clw')

  MAP
    MODULE('EIPBC0.CLW')
EIPBC0:DctInit              PROCEDURE
EIPBC0:DctKill              PROCEDURE
EIPBC0:FilesInit            PROCEDURE
    END
  END

DctInit      PROCEDURE
  CODE
  EIPBC0:DctInit
  EIPBC0:FilesInit

DctKill      PROCEDURE
  CODE
  EIPBC0:DctKill
```

This simply declares a MAP structure and the procedures in it. The code for the procedures must be there as well, and this is visible. The *DctInit* procedure calls two procedures in this case.

In Clarion 6, this code is now found in its own class, specifcially a constructor. This is so that each thread has its own instance of the file and relation managers. The *DctKill* method now lives in the destructor of the *Dictionary* class. When the thread dies, so does that thread's instance of the *File* and *Relation* manager classes.

The procedure names come from the name of the application (EIP for "**e**dit **i**n **p**lace"), the BC0 designation, a colon and the name of procedure. Let's inspect the code.

DctInit

First up is the *DctInit* procedure.

```
EIPBC0:DctInit    PROCEDURE
  CODE
  Relate:Item &= Hide:Relate:Item
  Relate:Config &= Hide:Relate:Config
  Relate:Customer &= Hide:Relate:Customer
  Relate:InvDet &= Hide:Relate:InvDet
  Relate:InvHdr &= Hide:Relate:InvHdr
```

This simply makes reference assignments to a class. That is all this does. The *Hide:Relate:<File>* is derived from *RelationManager*, an ABC class. This means that *Relate:<File>* could be thought of as grandchildren of *RelationManager*.

Each of these "hidden" classes have methods in them, at the minimum an *Init* and *Kill* method. There could be more methods depending on whether there are embeds, thus an automatic override. The class definition for *Hide:Relate:Item* is as follows:

```
Hide:Relate:Item    CLASS(RelationManager)
Init                  PROCEDURE
Kill                  PROCEDURE(),DERIVED
                    END
```

This means there must be code for both methods.

```
Hide:Relate:Item.Init PROCEDURE
  CODE
  Hide:Access:Item.Init
  SELF.Init(Access:Item,1)

Hide:Relate:Item.Kill PROCEDURE
  CODE
  Hide:Access:Item.Kill
  PARENT.Kill
  Relate:Item &= NULL
```

The *Init* method discussion begins in the *FilesInit* section below.

DctKill

Next is the *DctKill* procedure:

```
EIPBC0:DctKill    PROCEDURE
  CODE
  Hide:Relate:Item.Kill
  Hide:Relate:Config.Kill
  Hide:Relate:Customer.Kill
  Hide:Relate:InvDet.Kill
  Hide:Relate:InvHdr.Kill
```

This is simply a collection of procedure calls. For now, you may assume it undoes *DctInit*.

FilesInit

Next is *FilesInit*.

```
EIPBC0:FilesInit        PROCEDURE
  CODE
  Hide:Relate:Item.Init
  Hide:Relate:Config.Init
  Hide:Relate:Customer.Init
  Hide:Relate:InvDet.Init
  Hide:Relate:InvHdr.Init
```

A little bit of explanation is in order here. Each of these procedure calls are really methods. These are really the parent methods, but recall the reference assignments from earlier. If the preceding *DctInit* procedure did not happen (which did the reference assignments), you would be getting GPFs at this point.

If you look back on the code for *Hide:Relate:Item.Init*, this is a method call in another class, which is why SELF would be improper here.

```
Hide:Access:Item    CLASS(FileManager)
Init                  PROCEDURE
Kill                  PROCEDURE(),DERIVED
                    END
```

You can see what the parent class is by the above definition. The code for the methods are as follows:

```
Hide:Access:Item.Init PROCEDURE
  CODE
  SELF.Init(Item,GlobalErrors)
  SELF.FileNameValue = 'Item'
  SELF.Buffer &= ITM:Record
  SELF.Create = 1
  SELF.LockRecover = 10
  SELF.AddKey(ITM:ItemIdK,'Item Id Key',1)
  SELF.AddKey(ITM:ItemNumberK,'Item Number Key',0)
  Access:Item &= SELF

Hide:Access:Item.Kill PROCEDURE
  CODE
  PARENT.Kill
  Access:Item &= NULL
```

While I could get a bit involved with the above code, it is not really necessary. You may safely assume that all the lines starting with SELF are methods and properties derived from *FileManager*. This means you are free to read the help for each.

The last line of the *Init* method is a bit interesting. It is making a reference to the current object (SELF). This is where the *Access:<File>* class comes from that you see in generated code.

I will grant you that these intermediate classes may not be entirely neccessary, but since they deal with setting up objects that deal with relations of files and file management, it does make some sense to move these off to the side. Also, these methods execute only when the program starts and quits. It also serves to keep your source cleaner by having these classes in source files that are off to the side as well.

There isn't any rule in Clarion OOP that says you have to do this, it is merely a design decision of the ABC architects.

The reason why I am showing you this is that if you wish to add code (embeds) for the file objects, they are always global. The best explanation is looking at the simple code in the method. Since I earlier used the *InvDet* file as an example, the focus is on that file.

```
Hide:Access:InvDet      CLASS(FileManager)
Init                      PROCEDURE
Kill                      PROCEDURE(),DERIVED
PrimeAutoInc              PROCEDURE(),BYTE,PROC,DERIVED
ValidateRecord            PROCEDURE(<*UNSIGNED Failed>),|
                                    BYTE,DERIVED
                        END

Hide:Relate:InvDet      CLASS(RelationManager)
Init                      PROCEDURE
Kill                      PROCEDURE(),DERIVED
                        END
```

The above two classes derive from the *FileManager* and *RelationManager* classes. Both are ABC classes. In addition, there is no TYPE attribute on either one, so these are declarations of the classes and instances (meaning ready for use).

Do not put too much stock in the names of these classes. You may never see these anyway, as I already discussed. But the one that is interesting is the *Hide:Access:InvDet* class. Notice the *PrimeAutoInc* method? It is there only because of embedded code in that method. Thus, it overrides the default ABC method.

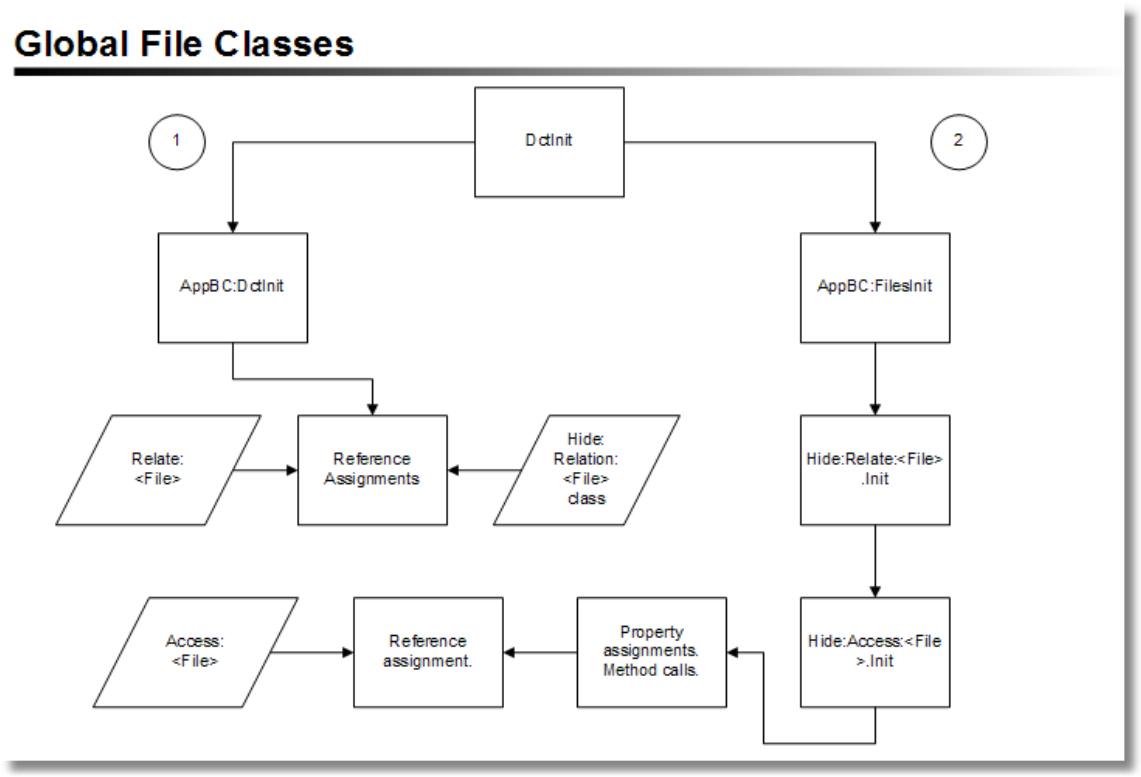
Below is the generated code based on the code in the embed point:

```
Hide:Access:InvDet.PrimeAutoInc    PROCEDURE
ReturnValue         BYTE,AUTO

  CODE
  ReturnValue = PARENT.PrimeAutoInc()
  IND:Sequence += (10 - (IND:Sequence % 10))
  RETURN ReturnValue
```

Remember, this code was placed in this embed for one reason only – to change the way ABC does auto incrementing. This is the only reason you use any embed.

This is true for any global embed you may need. You now know where to find them.

Anything dealing with files declared in the dictionary (including global variables) is in the global section. The rule of thumb is that anything to do with files is global in nature.



Local embeds

There are modular embeds, but in reality there are only two for each module, one for data declarations and the other for code. Therefore, this book skips modular embeds.

For any given type of procedure, there are certain embed points that are popular. The reason for it is that out of the box, ABC does only so much. This is by design and these features are common enough to find in any application.

Embed points have only one purpose: to extend or replace out of the box behavior.

I think most developers understand this. The burden is that they know what they want, but sometimes get into a fog about where and how.

ABC classes in relation to templates

This would be a good time to explain the relationship to ABC classes and ABC templates. The templates are responsible for the following tasks (out of the box):

- Write the needed OOP code to make a local class based on ABC. In other words, they ensure proper derivation.
- Instantiate the derived classes before using them.
- To generate correct code for overridden methods.

That is about all they need to do and they do the above whether or not you add embed code.

To illustrate this, suppose you only create a browse from a wizard and then run it. It works, as there is the data in the list control. The code would be similar to the following:

```
BRW1          CLASS(BrowseClass)      !Browse using ?List
Q               &Queue:Browse         !Reference to browse queue
Init            PROCEDURE(SIGNED ListBox,*STRING Posit,VIEW V,|
                            QUEUE Q,RelationManager RM,WindowManager WM)
ResetSort       PROCEDURE(BYTE Force),BYTE,PROC,DERIVED
              END
```

You can see that it derives only what it needs from ABC classes. The templates can detect what is on the window and they know that to make it work, some code is required.

For example, here is the complete code for the Init method:

```
BRW1.Init     PROCEDURE(SIGNED ListBox,*STRING Posit,VIEW V,|
                        QUEUE Q,RelationManager RM,WindowManager WM)
  CODE
  PARENT.Init(ListBox,Posit,V,Q,RM,WM)
  SELF.SelectControl = ?Select
  SELF.HideSelect = 1
  IF WM.Request <> ViewRecord
    SELF.InsertControl = ?Insert
    SELF.ChangeControl = ?Change
    SELF.DeleteControl = ?Delete
  END
```

Notice the first line of code, the call to the parent class. That refers to the *BrowseClass* in this case. This means there is functional code that is suitable to ensure everything is in place to use objects for a browse.

The rest of the code deals with aspects that are unique to this particular browse. In other words, it extends the base ABC functionality. This same thing happens when you embed anything.

You really do not need to worry or concern yourself with the mechanics of coding objects. Instead, the templates free you from this chore and allow you to concentrate on what you need to do for this particular browse.

In essence, what is this browse doing different from what comes out of the box? That is all you need to concern yourself with. Let ABC do the work.

Let me go over a few procedures and point out some of the common embeds.

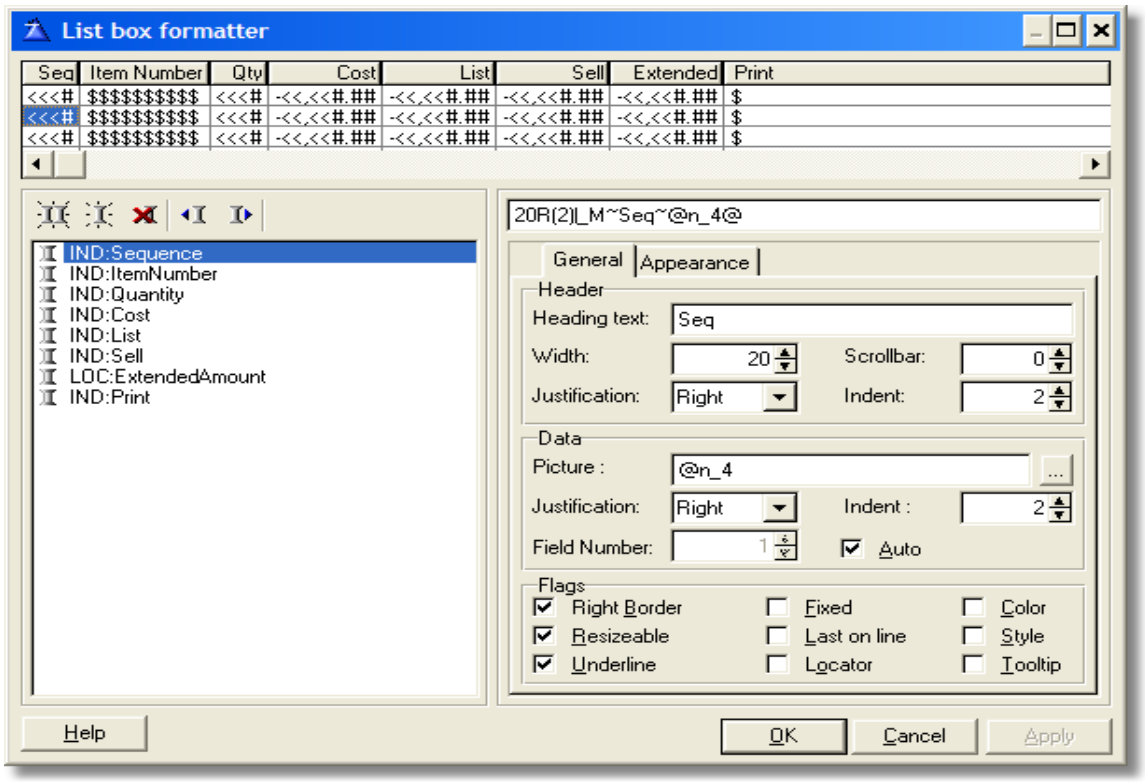
Browse procedures

This section covers some of the common tasks in browse procedures.

Changing the appearance of a list control

This could mean anything that can affect the list control. One common task is adding a green bar effect. This is where each row of the list is alternating colors. Another could be calculating a local variable's contents.

What do these two tasks have in common? In addition, what is common about list controls? Examine the list formatter:



One common task is to add local variables to a list control. This calculates the extended price. Since this is a local variable, you can make two assumptions:

1. It will not get any data by itself. You must put the data there.

2. You will need to do something for each row of the list control. In addition, you have no idea how the list control populates itself, thus the local variable must populate itself at runtime.

The first thing you must determine is how does ABC populate any list control? To find out, you must look at the generated code.

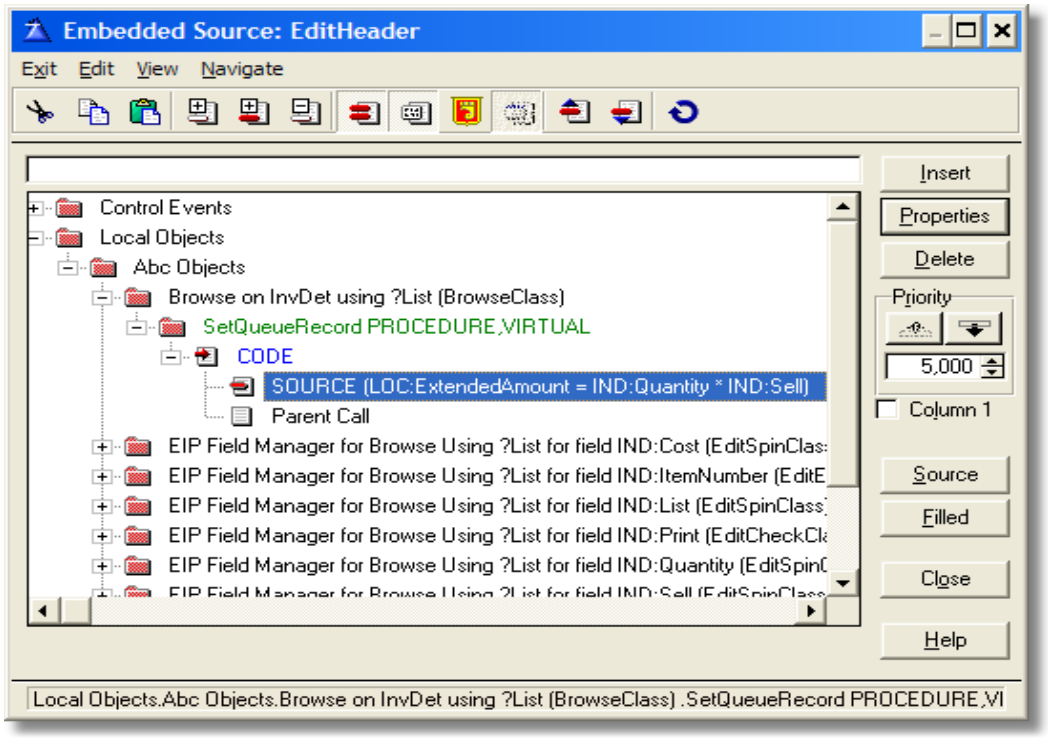
```
Queue:Browse        QUEUE
CUS:Name              LIKE(CUS:Name)
CUS:Number            LIKE(CUS:Number)
CUS:Phone             LIKE(CUS:Phone)
CUS:Contact           LIKE(CUS:Contact)
CUS:CustomerId        LIKE(CUS:CustomerId)
Mark                  BYTE
ViewPosition          STRING(1024)
                    END
```

By looking at this code, one can see that it simply placed everything from the list in a QUEUE structure. One could surmise that ABC somehow places data in this QUEUE and this is what you see in the list. I should note at this point, so do other template-based projects like the Clarion template chain.

Inspecting the Help confirms this:

"The data items displayed in the LIST come from a QUEUE or STRING specified by the FROM attribute and are formatted by the parameters specified in the FORMAT attribute (which can include colors, icons, and tree control parameters)."

Based on this, it is reasonable to guess that an embed point to add code to populate this local variable has something to do with queues.



SetQueueRecord makes sense as list controls display values in QUEUE structures. In the above figure, you can see some source placed there to calculate the extended amount.

At runtime, it could appear as follows:

Seq	Item Number	Qty	Cost	List	Sell	Extended	Print
10	1A2-9Z8	1	19.95	34.95	31.05	31.05	x
20	2B3-8Y7	1	11.33	29.95	25.49	25.49	x
30	3C4-7X6	1	23.95	38.77	35.00	35.00	x
40	4D5-6W5	1	23.95	38.88	36.29	36.29	x
50	5E6-5V4	1	23.95	38.88	36.29	36.29	x
60	6F7-4U3	1	23.95	38.88	33.29	33.29	x
70	1A2-9Z8	1	19.95	34.95	31.05	31.05	x
80	2B3-8Y7	1	11.33	29.95	25.49	25.49	x
90	3C4-7X6	1	23.95	38.77	35.00	35.00	x
100	4D5-6W5	1	23.95	38.88	36.29	36.29	x
110	5E6-5V4	1	23.95	38.88	36.29	36.29	x
120	6F7-4U3	1	23.95	38.88	33.29	33.29	x

What is ABC doing?

In order to answer this, one must look at the code used as a base to get the above behavior. What is the code behind *SetQueueRecord*?

```
BrowseClass.SetQueueRecord PROCEDURE
  CODE
    SELF.Fields.AssignLeftToRight
    SELF.ListQueue.SetViewPosition(POSITION(SELF.View))
```

That does not appear to be doing much, two lines of code. You know that SELF is whatever the current object is (see earlier for the discussion on SELF). Looking at the dot syntax here, there are two object names. This is usually a give away that the *BrowseClass* derives from another class. Open the INC file for the *BrowseClass* (ABBROWSE in libsrc) and *Fields* is a reference to the *FieldsPairClass*. In other words, *Composition*.

This method simply copies the left field to the right field as defined by the *AddPairs* method. The templates take care of coding this for you and the code is as follows:

```
InvDetList.AddField(IND:Sequence,InvDetList.Q.IND:Sequence)
InvDetList.AddField(IND:ItemNumber,InvDetList.Q.IND:ItemNumber)
InvDetList.AddField(IND:Quantity,InvDetList.Q.IND:Quantity)
InvDetList.AddField(IND:Cost,InvDetList.Q.IND:Cost)
InvDetList.AddField(IND:List,InvDetList.Q.IND:List)
InvDetList.AddField(IND:Sell,InvDetList.Q.IND:Sell)
InvDetList.AddField(LOC:ExtendedAmount,InvDetList.Q.LOC:ExtendedAmount)
InvDetList.AddField(IND:Print,InvDetList.Q.IND:Print)
InvDetList.AddField(IND:InvDetId,InvDetList.Q.IND:InvDetId)
InvDetList.AddField(IND:InvHdrId,InvDetList.Q.IND:InvHdrId)
```

Think about this for a minute. There must be some mechanism for this particular browse to know how to populate the items in the QUEUE.

This code is part of the setup for this browse procedure. Thus, you may expect to find it in the *ThisWindow.Init* method of the generated code.

That first line of code in *SetQueueRecord* is the same as coding this:

```
InvDetList.Q.IND:Sequence      = IND:Sequence
InvDetList.Q.IND:ItemNumber    = IND:ItemNumber
InvDetList.Q.IND:Quantity      = IND:Quantity
InvDetList.Q.IND:Cost          = IND:Cost
InvDetList.Q.IND:List          = IND:List
InvDetList.Q.IND:Sell          = IND:Sell
InvDetList.Q.LOC:ExtendedAmount = LOC:ExtendedAmount
InvDetList.Q.IND:Print         = IND:Print
InvDetList.Q.IND:InvDetId      = IND:InvDetId
InvDetList.Q.IND:InvHdrId      = IND:InvHdrId
ADD(InDetList.Q); !Followed by code to check for errors
```

The second line of code in the *SetQueueRecord* method sets the position value for the QUEUE structure. *ListQueue* is a reference to *BrowseQueue*. *BrowseQueue* as the name would imply, is not another QUEUE structure. It is an interface. The *BrowseQueue* interface is a defined set of behaviors that relate to the VIEW and QUEUE that the LIST control uses.

The *SetViewPosition* method sets the POSITION of the VIEW based on the position parameter. The VIEW structure gets the data from the file, so it is important that the display of the QUEUE be in accord with the data in a VIEW.

What this means is that ABC is doing a task that always happens in any file-based browse. In addition, all you are doing is adding one line of code to compute a local variable. You need do nothing else, as all you want is the computation of a local variable in addition to populating the list box with data.

Let ABC do the grunt work, you merely add the few lines of code needed to fufill the design requirements of your application.

Event processing

All event processing in Clarion is conditional. In other words, when a certain event triggers, then execute some code; otherwise do not bother. ABC has many event-related embeds. You can recognize these simply by name. The first part of the name is *Take*. This means to grab hold of, or inspect or process something.

For example, take a break. This mean you are on a break or interrupt an activity. Or take a look, meaning to inspect something. While that is not the name of an ABC event embed, it applies. You could think of it as inspecting an event. Thus, common event processing such as *NewSelection* would be *TakeNewSelection*.

Each different type of procedure has these *Take* embeds that apply. *TakeNewSelection* appears on any window with a list control. It can appear on a form if there is a list control on it. Alternatively, it could appear on any window with a drop list, drop combo or spin box control. If not, then you do not see such an embed.

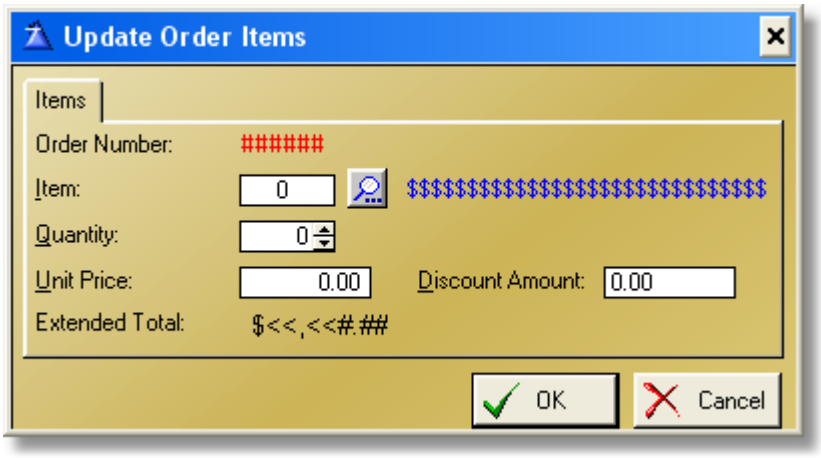
This means that the templates are smart enough to give you what you *might* need, but don't give you anything you *never* need.

You still have the usual control event processing and this makes it simple to determine if you need to use that embed. Again, the templates only give you the event embeds that apply to that control.

For example, you will never see a *NewSelection* embed point for an entry or radio control, as these controls do not generate a *NewSelection* event.

When to use an ABC embed or a control specific embed

Look at the following window:



You want the *Extended Total* to display any time the *Quantity* or *Unit Price* or *Discount* amounts change. The code would be as follows:

```
ITE:Total = (ITE:Quantity * ITE:Price) - ITE:DiscountAmount
```

This is a simple task. However, do you want to use one embed or three or four embeds to do this?

You could add this code to each of the control's EVENT:Accepted embed points. That is three embeds, where is the fourth? The *Quantity* control is a spin box, so it could generate EVENT:NewSelection if the user presses one of the spin buttons. Therefore, you need a copy of the code in that embed too.

OK, three embeds, as you can certainly call a ROUTINE to do the calculation. That eases the maintenance as you have only one spot to change the expression, if you ever need to.

How about using one embed point? Before ABC, this was not possible. Looking at the window manager embed tree, you can scroll down the list until you find the *Take* embeds. They are, in alphabetical order, *TakeAccepted*, *TakeCloseEvent*, *TakeCompleted*, *TakeEvent*, *TakeFieldEvent*, *TakeNewSelection*, *TakeRejected*, *TakeSelected*, and *TakeWindowEvent*.

Out of these possible choices, you know one is correct. There are actually two embeds that would satisfy the requirement of one embed. Your only decision is which one is the best?

Whenever any control on a window triggers an event, any event, that is a field event. If you notice, there is an embed with that name! It does not mention which event. In addition, since a field event is an event, there is an embed with that name too.

So, for example, when the user moves the window across the desktop, or resizes the window, those actions trigger events. Therefore, *TakeEvent* may not be the best choice. That leaves only *TakeFieldEvent*.

Nothing to it! That was simple, but that is about as complex as it comes. On a final note, all ABC procedures have these event processing embeds. Which embeds appear when varies on the controls, thus the complexity of the procedure depends on the embeds presented to you.

On a final note, look at what the ABC templates coded for you:

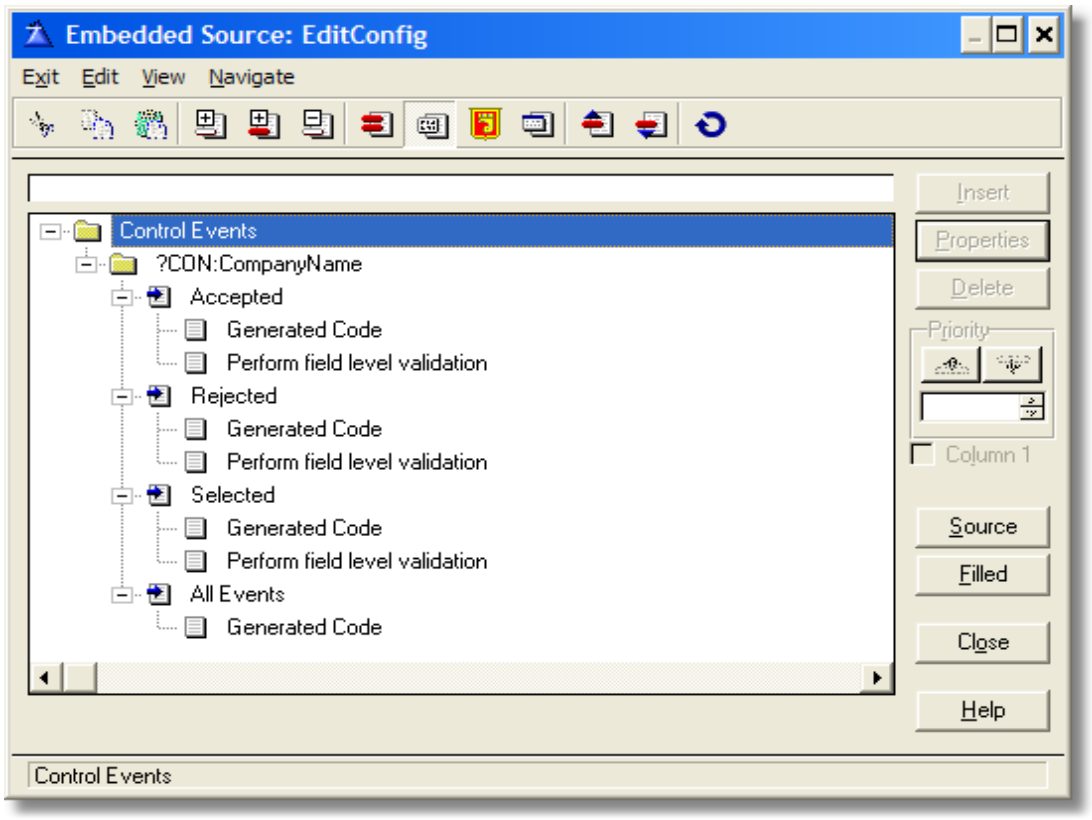
```
ThisWindow          CLASS(WindowManager)
Ask                   PROCEDURE(),DERIVED
Init                  PROCEDURE(),BYTE,PROC,DERIVED
Kill                  PROCEDURE(),BYTE,PROC,DERIVED
Open                  PROCEDURE(),DERIVED
Reset                 PROCEDURE(BYTE Force=0),DERIVED
Run                   PROCEDURE(),BYTE,PROC,DERIVED
Run                   PROCEDURE(USHORT Number,BYTE Request),BYTE,PROC,DERIVED
TakeAccepted          PROCEDURE(),BYTE,PROC,DERIVED
TakeFieldEvent        PROCEDURE(),BYTE,PROC,DERIVED
                    END
```

The templates generate the proper class definition for you, based on your embeds. This means that for any embed you use, it overrides the parent class' method. The code for the overridden method looks like this:

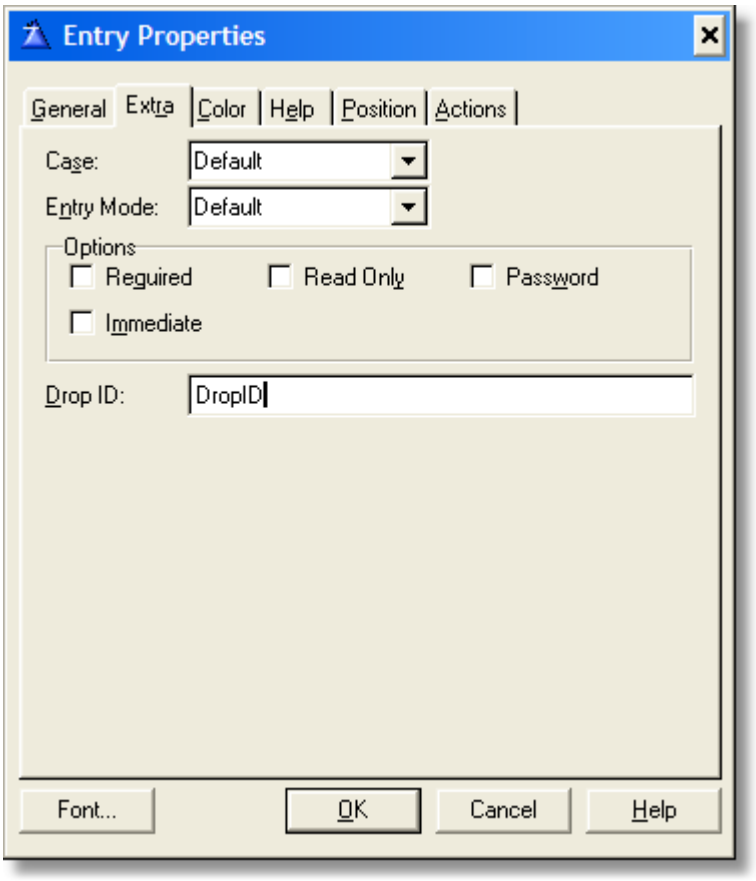
```
ThisWindow.TakeFieldEvent PROCEDURE

ReturnValue          BYTE,AUTO

Looped BYTE
  CODE
  LOOP
    IF Looped
      RETURN Level:Notify
    ELSE
      Looped = 1
    END
    !!Update the extended pricing information
    ITE:Total = (ITE:Quantity * ITE:Price) - ITE:DiscountAmount
    ReturnValue = PARENT.TakeFieldEvent()
    RETURN ReturnValue
  END
  ReturnValue = Level:Fatal
  RETURN ReturnValue
```

That is really all there is to know about any of these *TakeEvent* embed points. In essence, if you wish to execute some code whenever a particular event happens, regardless of which control triggered it, then use those embeds.

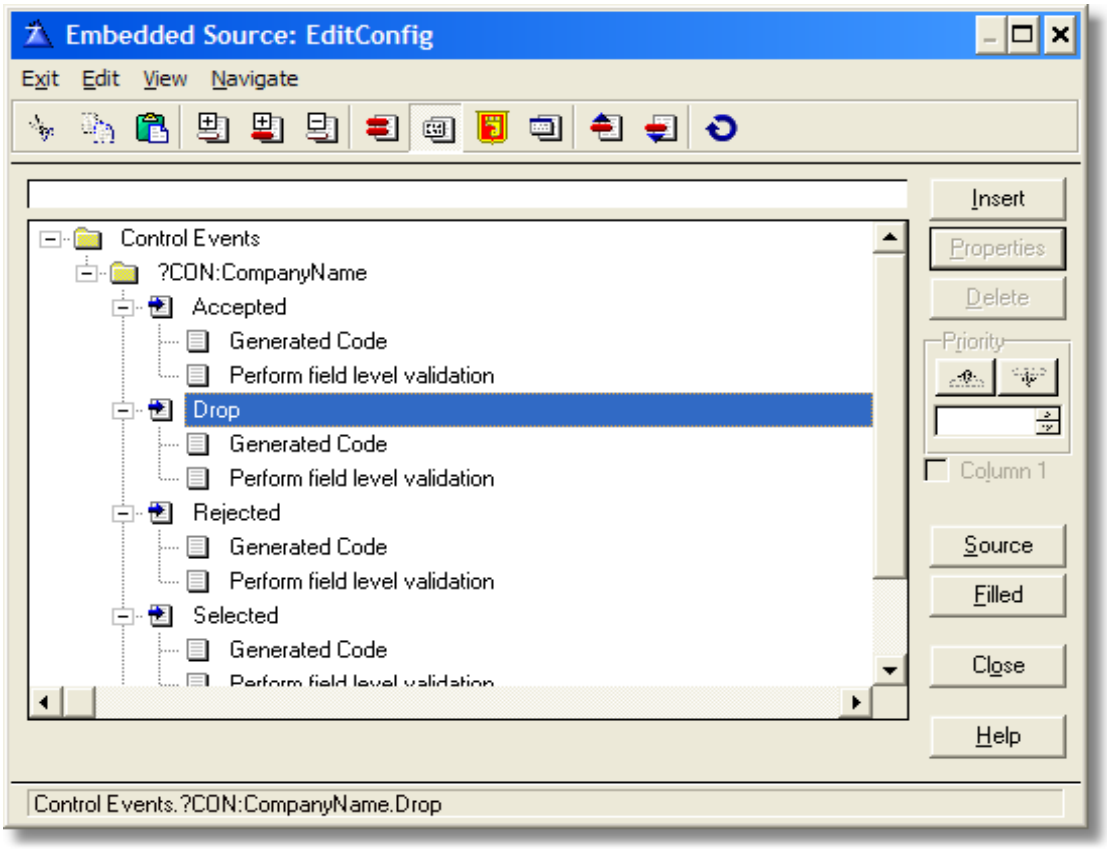
If you do care which control triggers an event, then use that control's embeds. The best way is via the window formatter. Just **RIGHT-CLICK** on the control, **choose EMBEDS** and all embeds that are appropriate for that control show up. This is what an entry control's event embeds look like:



To give you an idea of the dynamic nature of these embeds, remember, you only get event embed points when they are valid. Suppose you gave this entry control a drop ID?



Look what happens to the embed tree now:



Therefore, you see any events that are applicable for a control show in this list. Thus you can see that some event embeds appear only when you activate a feature. By default, drop events are not processed until a control gets a drop ID.

Working with ABC classes

From time to time, you need to work with ABC classes directly due to need. In my travels as an instructor, the single most misunderstood class is the *ErrorClass*. The class itself is fine except for one small sticking point. Developers insist on knowing what error was detected.

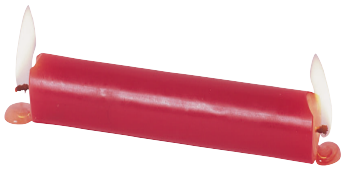
I believe this came about because many Clarion developers (including yours truly) were burned badly in the past when not checking for an error when returning from a statement. In addition, many of us are upbraided by our peers and even clients when the need to check for an error condition is missing from code. There are only so many times a developer is willing to go through this before the lesson finally sinks in. Once that happens, any developer is quite reluctant to let go of a good practice.

For years I've told Clarion developers to stop checking for errors themselves when using ABC. This statement earns me looks from others like I was from Mars. Let me repeat that. When using ABC, one does not need to check for errors. I did not say your application does not check for errors, it does. But if you code for it, you are checking for an error twice! When I say "checking for errors" I mean check for the usual errors, like "record mistmatch", "record not found", "file not open" and the other common error conditions.

By common error conditions, I mean only the error codes Clarion knows about out of the box. Errors dealing with files and accessing files. If Clarion knows about it, so does ABC. This is the error checking I am referring to. You do not have to code for these as ABC already knows about them. In addition, it knows which ones are fatal (like error 47) and which ones are not (error 35 or 33). And it can display a proper error message informing the user what happened. In addition, all the usual notification messages, like the record was changed by another station. This means that not only can ABC report errors, but it can determine the degree of severity.

That in essence is my total point about the *ErrorClass*. Do not code for error 47s or error 35s and other common data errors. ABC has your back covered on these. Therefore, it does not matter one bit that the parts of the *ErrorClass* where the actual error is known is a PRIVATE attribute. However, I must agree with the vast majority of Clarion developers that these properties do not have to be so restricted. I just don't agree with their reasons. A PROTECTED attribute is sufficient in case you wish to really change the logic of the *ErrorClass*, which seems to be a second hobby in the Clarion community. Absent that, a method that returns the ErrorCode would also suffice.

However, I must confess I've discovered one design where the error condition must be known. It is in the case where your code must make a decision based on the error. Since ABC only returns the level of severity, this is not precise enough. For example, if upon opening a file, is an error 47 (record mismatch) detected? If so, call the conversion procedure.



That is something the pre Clarion 6 ABC *ErrorClass* cannot do. In Clarion 6, there are two new methods that return the error code and error text.

The default behavior is to close the application as that is a fatal error. This is to protect the file's contents from corruption. I won't argue with that reasoning as that is quite valid. However, so is the design to run the conversion process, something useful that is at odds with ABC.

Is there a compromise or middle ground here? There must be, otherwise I would not bring this up. Remember, ABC is an OOP implementation. It is meant to be derived and overidden. First, an inspection of the code in the *ErrorClass* is in order.

The ErrorClass

The *ErrorClass* is simple considering what it does. There are several major functions the *ErrorClass* performs:

- Trapping errors.
- Reporting the errors if instructed to do so.
- Logging the errors to a file.
- Reporting the details of an error (which file and field triggered the error).
- How much error history to store if logging is active.
- Informing the other classes of the severity of the error.

There are several key methods one should know very well. The first is *ErrorClass.AddErrors*. This method does not add new bugs to your application! This method installs your custom error group (including translated error messages). This means that the *ErrorClass* can process your error conditions and levels of fatality. Use this method when you wish to add your own error messages for processing.

ErrorClass.SetFatality changes the level of fatality. It takes the error *ID* of the message you wish to change as the first parameter. The *ID* is part of the *ErrorEntry* structure. The second parameter is the new fatality level. This is usually an equate.

The *ErrorClass.Throw* method may be considered the heart of the *ErrorClass*. Look at this method's code:

```
ErrorClass.Throw  PROCEDURE(SHORT Id)
  CODE
    SELF.SetErrors
    RETURN SELF.TakeError(Id)
```

Just two lines of code, but what these two lines do is the point. For those that want to trap specific errors in their applications, *SetErrors* is the method of most interest:

```
ErrorClass.SetErrors    PROCEDURE
  CODE
    SELF.SaveErrorCode = ERRORCODE()
    SELF.SaveError = CLIP(ERROR())
    SELF.SaveFileErrorCode = CLIP(FILEERRORCODE())
    SELF.SaveFileError = CLIP(FILEERROR())
```

It uses Clarion statements to store error information. It is a public method, meaning you may call it anytime you wish; but since it does not return anything, you may be thinking it is useless for your task of returning the error state. In that regard, it is. What I am pointing out are the properties used by this method to store the errors.

```
SaveError                CSTRING(255),PRIVATE    ! Clarion error message
SaveErrorCode            LONG,PRIVATE            ! Clarion error code
SaveFileError            CSTRING(255),PRIVATE    ! File error message
SaveFileErrorCode        CSTRING(255),PRIVATE    ! File  error code
```

These properties store the error state. However, when some see the PRIVATE attribute, they get turned away. In one sense, it is a good idea to make these private to the class as you cannot really predict if or when a new error state may arise. It also implies that the class takes all responsibility for the proper use of any error states. There may be a good argument that these properties should be PROTECTED instead. While that has a ring of good sense to it, it also has the ring that the developer may have to assume more responsibility for the proper use of these states. That is something that could defeat the design of the class. Instead of going off into hypothetical situations, lets get back to the original problem -- getting the error states, even when PRIVATE.

Since these properties are indeed PRIVATE, all that means is that these properties are for the *exclusive* use of the class that defined them. Is there a method that uses these properties? Indeed there is! Take a look at the *SubString* method:

```
ErrorClass.SubsString        PROCEDURE
BuildString        CSTRING(2000)
ErrorPos           USHORT,AUTO
  CODE
    BuildString = SELF.Errors.Message
    Replace('%File',SELF.FileName,BuildString)
    Replace('%ErrorCode',SELF.SaveErrorCode,BuildString)
    IF SELF.SaveErrorCode = 90
      Replace('%ErrorText',Self.SaveFileError & |
              ' (' & Self.SaveFileErrorCode & ')',BuildString)
    ELSE
      Replace('%ErrorText',Self.SaveError &  |
              ' (' & Self.SaveErrorCode & ')',BuildString)
    END
    Replace('%Error',SELF.SaveError,BuildString)
    Replace('%FileErrorCode',SELF.SaveFileErrorCode,BuildString)
    Replace('%FileError',SELF.SaveFileError,BuildString)
    Replace('%Message',SELF.MessageText,BuildString)
    Replace('%Field',SELF.FieldName,BuildString)
    Replace('%Procedure',SELF.GetProcedureName(),BuildString)
    Replace('%Category', SELF.Errors.Category, BuildString)
    IF INSTRING('%Previous',BuildString,1,1)
      ErrorPos = POINTER(SELF.Errors)
      IF SELF.SetId(SELF.Errors.Id,ErrorPos-1)
        Replace('%Previous','',BuildString)
      ELSE
        Replace('%Previous',SELF.Errors.Message,BuildString)
      END
      GET(SELF.Errors,ErrorPos)
    END
    RETURN BuildString
```

The *Replace* procedure is not part of this class. It is a declared procedure in the MAP statement in *ABERROR.CLW*. *ErrorClass.SubsString* returns the error number and the error message. So this means that all you have to do is grab the string? Not exactly. This method is PROTECTED. This means that it is not open to anyone calling this method.

But wait, you are not turned away. All this means is that you may call the method from a class derived from the *ErrorClass*. And if you think about this from an encapsulation point of view, this makes perfect sense.

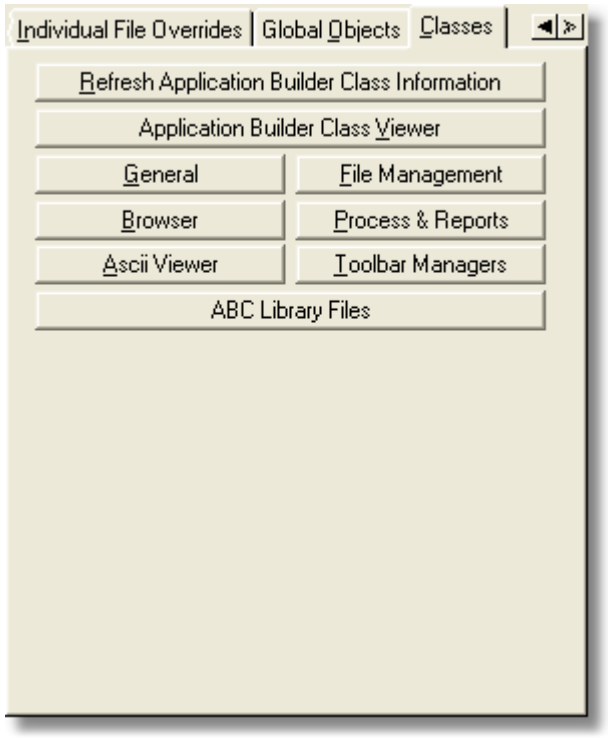
Suppose you were to code a new class, let's call it *ErrorMgr*. Here is the CLASS definition in a new source file, *ErrorMgr.inc*:

```
!ABCIncludeFile(EM)

      INCLUDE('aberror.inc'),ONCE

ErrorMgr     CLASS(ErrorClass),TYPE,|
                  MODULE('ErrorMgr.clw'),|
                  LINK('ErrorMgr.clw','_ABCLinkMode_'), |
                  DLL(_ABCDLLMode_)
GetErrStr      PROCEDURE, STRING,VIRTUAL
GetErrNum      PROCEDURE, LONG, VIRTUAL
            END
```

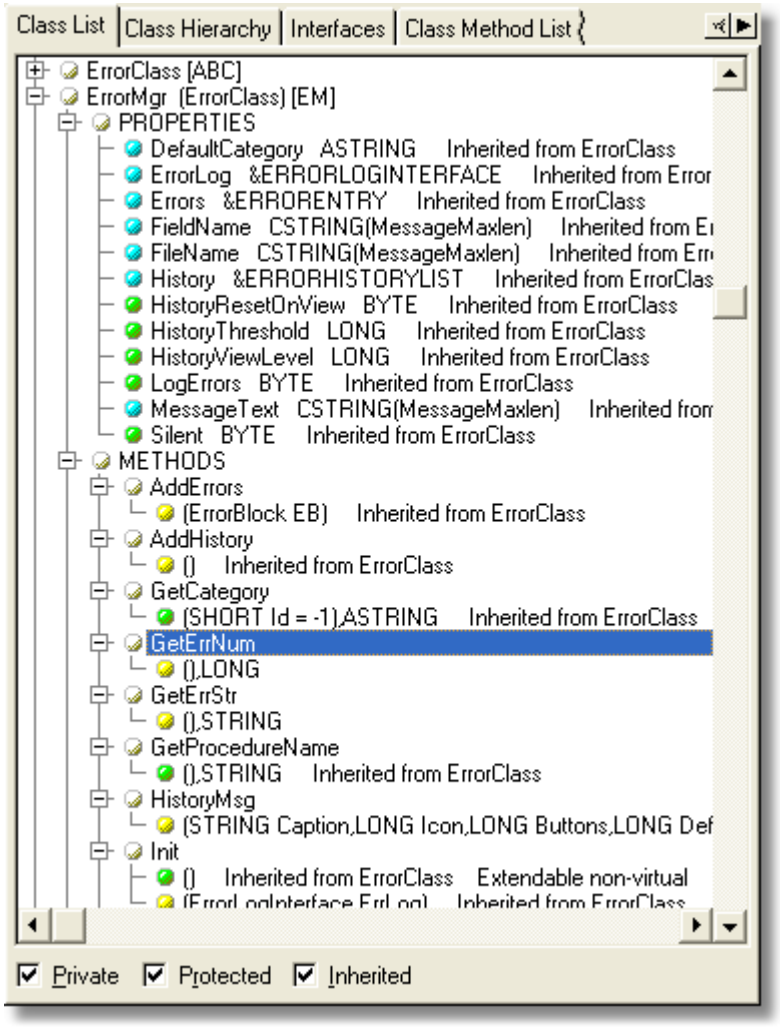
There you have it, a simple derived error manager. Of course, the code for the methods in *ErrorMgr.clw* now follows.

```
      MEMBER
      MAP
      END
      INCLUDE('ErrorMgr.inc'),ONCE

ErrorMgr.GetErrStr       PROCEDURE
  CODE
  RETURN SELF.SubsString()   !Return entire error string

ErrorMgr.GetErrNum       PROCEDURE
CurrentString      CSTRING(2000)
CurPos             LONG
EndPos             LONG
RetVal             LONG

  CODE
  CLEAR(RetVal)
  CurrentString = SELF.SubsString()
  CurPos = INSTRING('(',CurrentString,1,1)
  IF CurPos
    CurPos += 1
    EndPos = INSTRING(')',CurrentString,1,CurPos)
    IF EndPos
      EndPos -= 1
      RetVal = CurrentString [ CurPos : EndPos ]
    END
  RETURN RetVal
```

To use this class, both files must be saved in libsrc. Either start Clarion or **press** REFRESH APPLICATION BUILDER CLASS INFORMATION in any class dialog to load the class in the reader.



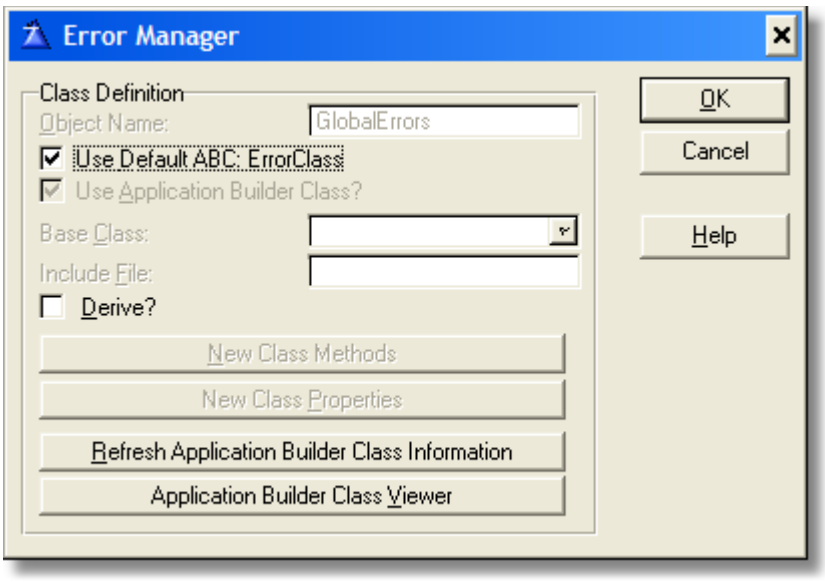
If you wish to see this class in the reader, **press** APPLICATION BUILDER CLASS VIEWER. The *ErrorMgr* class should look like this:



You can see the two methods in this class as well as all the properties and method inherited from the *ErrorClass*. **Right click** on the list and **choose** SHOW SYMBOL KEY for what the colors mean.

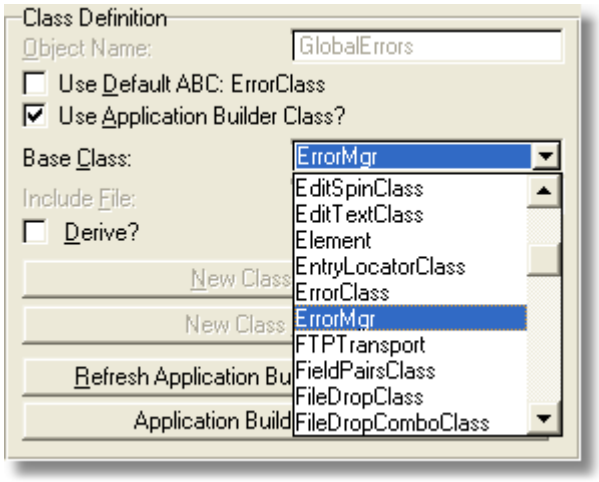
Installing your Custom Classes

But how does one use this class in an application? The ABC template designers considered this. **Choose** the GLOBAL OBJECTS tab. **Press** ERROR MANAGER. The following dialog displays:



You can see that the default error manager is *GlobalErrors*. This derives from *ErrorClass* and is the template default and is thus disabled. **Uncheck** the USE DEFAULT ABC: ERRORCLASS box. The USE APPLICATION BUILDER CLASS box enables as does the BASE CLASS drop list.

Select *ErrorMgr* from the drop list. **Press** OK until you are back at the application tree.



This becomes the new class that forms the *GlobalErrors* class which is local for your application. More importantly, any code, which includes source embeds already present, does not have to change as the class name remains unchanged.

Using Custom Classes in an Application

The next step is to actually use the custom class. As a reminder, the original problem was that the design needed to know if an error 47 (record mismatch) occured while trying to open a file. This is normally a fatal error causing the application to shut down. However, the design needs to know if this happened rather than shutdown the application, but instead call a conversion process to handle this situation. This means some embedded code is required.

Depending on the design, the code could be placed anywhere in the application. However, since error 47s occured when trying to open a file, the best place to add the code needed is whenever the application attempts to open a file. Where are files usually opened? Keep in mind that the *LazyOpen* flag (defer opening files) may or may not be in use, thus the placement of the embed must consider this. Also, you may not need this logic for every file in your dictionary.

Thus, a good choice is when your application opens the file. A good early spot is the application frame. Lets say it is the *Customer* file. In the embed tree, simply walk down the tree until you find the Window Manager. You will see there is an *Init* method.

So the embed in the *WindowManager ➢Init* method becomes something like this (the actual code will vary depending on the file in use and where the code is placed):

```
!Drop severity level
GlobalErrors.SetFatality(MSG:OpenFailed, LEVEL:Notify)
GlobalErrors.Silent = True          !Make the class mute about errors
IF Access:Customer.TryOpen()        !Attempt to open a file
  IF GlobalErrors.GetErrorNum = 47      !Call method to test for 47
    RunConversionProcess            !If true, run a convertor procedure
  END
ELSE
  IF Access:Customer.UseFile()      !If LazyOpen turned on
    IF GlobalErrors.GetErrorNum = 47    !Do the same test
      RunConversionProcess          !and run the convertor if needed
    END
  END
END
!Restore the fatality level
GlobalErrors.SetFatality(MSG:OpenFailed, LEVEL:Fatal)
GlobalErrors.Silent = False         !Give it back its voice
Access:Customer.Close               !Close the file
```

See the example application, *Error47.app* in the code folder.

Or you may place this logic anywhere it makes sense. The first thing you must do is tell the *ErrorClass* that the open failed condition is no longer fatal, by dropping the severity level to notify. Also, mute the message handling by setting the *Silent* property to True. Then try to open the file. If there is an error, the *TryOpen* method will detect it and tell the *ErrorClass* which error.

Keep in mind that the object currently in use is really the child class, not the default error handler. This means your *GetErrorNum* method is a valid call as well as the normal *ErrorClass* method calls. And more importantly, no changes to existing code generated by the template is required. And you did not need to edit the *ErrorClass*. That is power of derivation and inheritance!

Thus, if the *GetErrorNum* method detects an error 47, then call a procedure to run the conversion. Otherwise, restore things back to the way they were.

That is how you may detect which error occurred when you need to make logical decisions depending on the error. Andrew Guidroz wrote an excellent article in Clarion Magazine on this topic. If you have the printed copy of this book, then go to www.clarionmag.com. In the search control enter either “errorclass” or “author:Guidroz” (without the quotes). Subscription is required (and highly recommended).

On a final note, if you install the next version of Clarion, your code does not break as you have not changed the ABC classes, only their behavior. A future version of the *ErrorClass* may render this requirement obsolete, but it will still work!

In Clarion 6, there are two new methods that do return the error code and error message.

This is why I always frown when someone insists on editing the shipping classes. The next time they install a patch or newer version, they need to make the same edits again. One may get clever to minimize any impact of editing ABC classes, but it is still extra work and you really do not have to bother.

Chapter 5 – Coding Objects

Introduction

This chapter covers coding objects. This is different from the previous chapters. The goal is to take generated legacy style code and convert it into a class.

This duplicates the times where one may use code that is always the same. Thus, it would be ideal to become a class in its own right. The goal of this chapter is simply to convert working code to a class. It won't have any template support. That is covered in the next chapter.

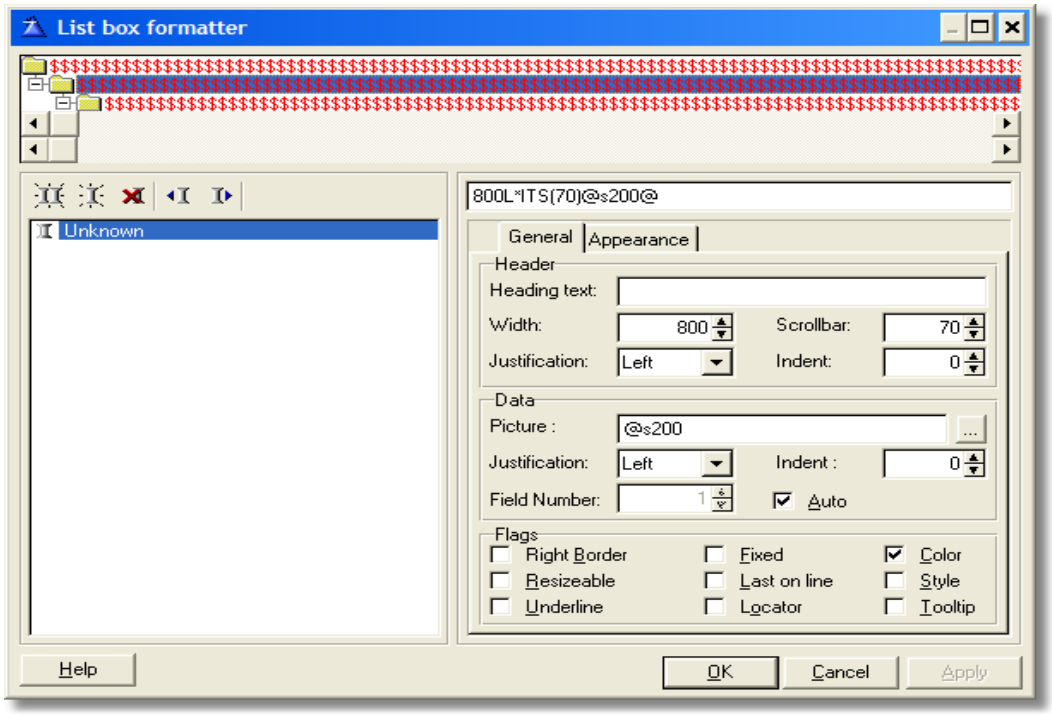
As a secondary goal, this chapter attempts to expose to the reader some of the steps in picking up some working code and converting it to a reusable class.

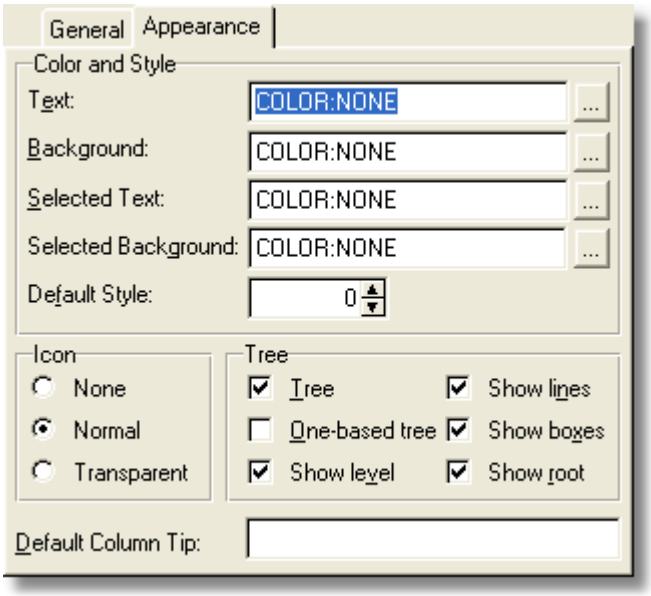
Design Considerations

The first thing you should have in mind when writing a new class is simple. Just ask yourself, "Could I *reuse* this code in other applications?" If you answered in the affirmative, then you have a valid reason. Another good reason would be if you find yourself using routines, or a ROUTINE that is repeated throughout your application, but with minor changes to each.

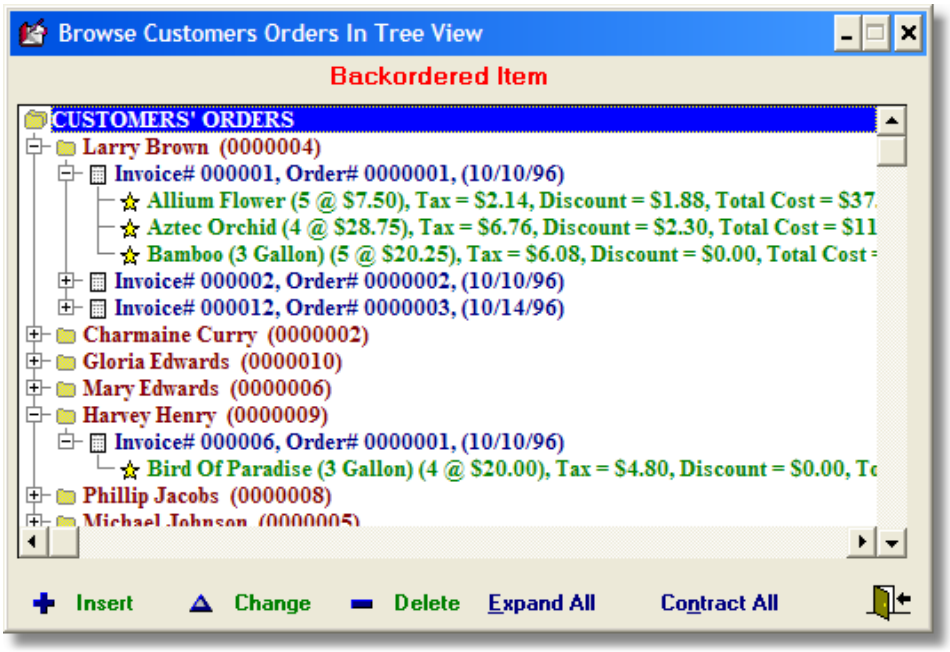
The next consideration is if you have an example of working code. If you do, then life is easy. There really is not much to change in this aspect. If you do not having an example of working code, this just means that you should pay more attention to the design. This chapter uses a working example that any Clarion developer should already have.

This example is the *Invoice* example application that ships with Clarion. Load this application and open the window formatter for the procedure *BrowseAllOrders*. If you RIGHT-CLICK on the list box, then **choose** LIST BOX FORMAT... you see these views:





These two views are enough to start with. The tree list displays colors and icons. At runtime, this is what you see:



This is functional and each item in the list has edit procedures attached to them. The code generated by the *Relation Tree* control template is written into routines for each file in the tree list. By that I mean they are the same routines, just minor differences. Thus, this is a good candidate for a new class. As an aside, Clarion as shipped does not have a relation tree object. This includes ABC, and it is almost identical to the one produced by the Clarion template chain.

The goal is simple -- create a class that has the same functionality as this one.

ABC Relation Tree vs Relational Object Tree

The ABC (and Clarion based chain) version works, but it relies on the templates to manage all of the code. The only real differences are that the ABC version makes some ABC method calls to open files, get the data, etc. Both template chains use routines to do the work, and depending on the files in the tree, produces similar named routines.

This is how the templates work, so you don't want all of that code. The reason is that such code requires one to be a template developer as well as a Clarion developer. That tells you right away that there is little or no code re-use, one of the main goals of OOP.

When you start thinking of how to write better and tighter code, you need to think in abstract concepts.

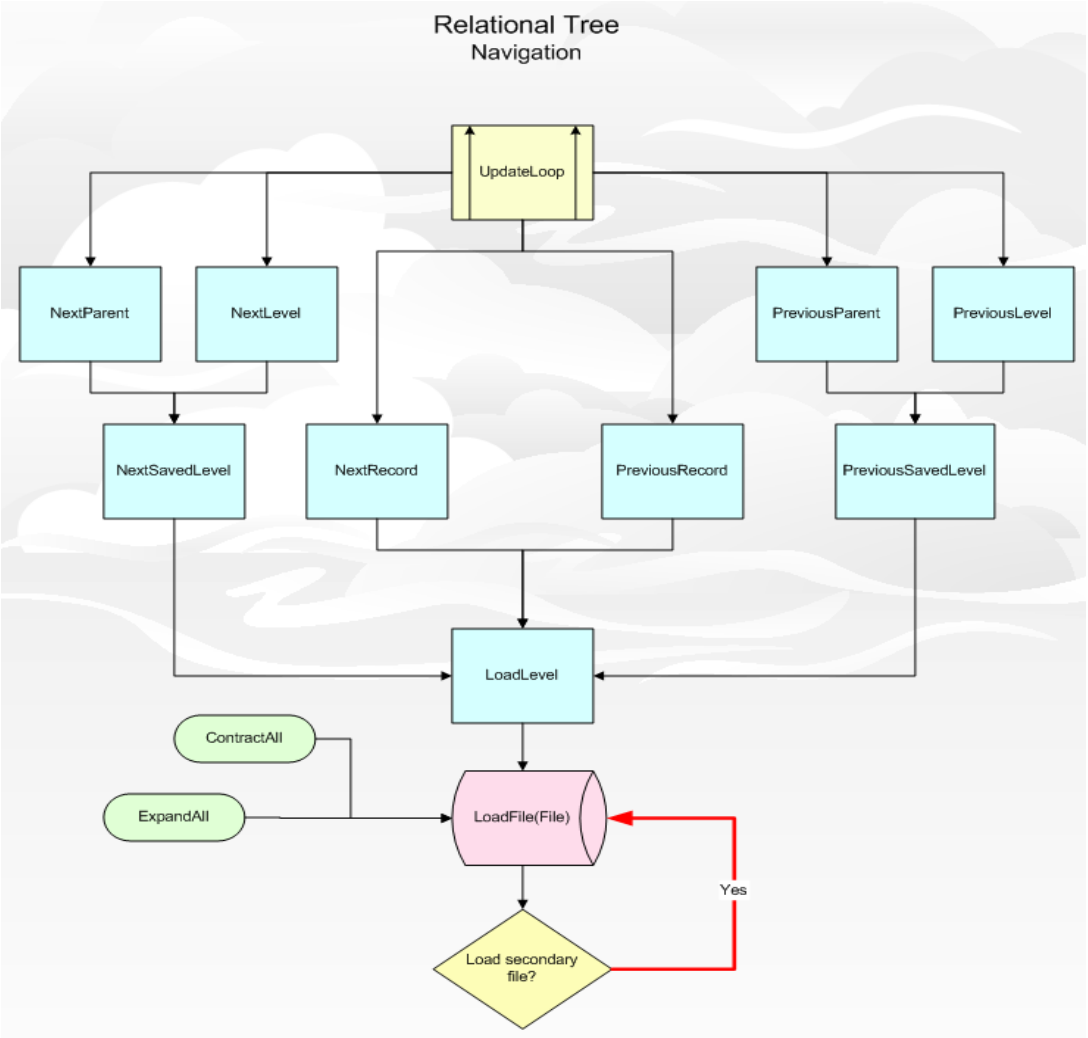
Any class should work equally well in hand-coded projects, not just template driven apps. The only difference is that project developers must handle all the declarations and instantiation themselves. Other than that, there should never be any differences between a project and an application; the end result should be the same.

Designs

To convert an existing design to a new one, you must have a grasp of the old design. This could be broken down into two parts, the edits and navigation. Therefore, I've made some simple charts of each of the major components.

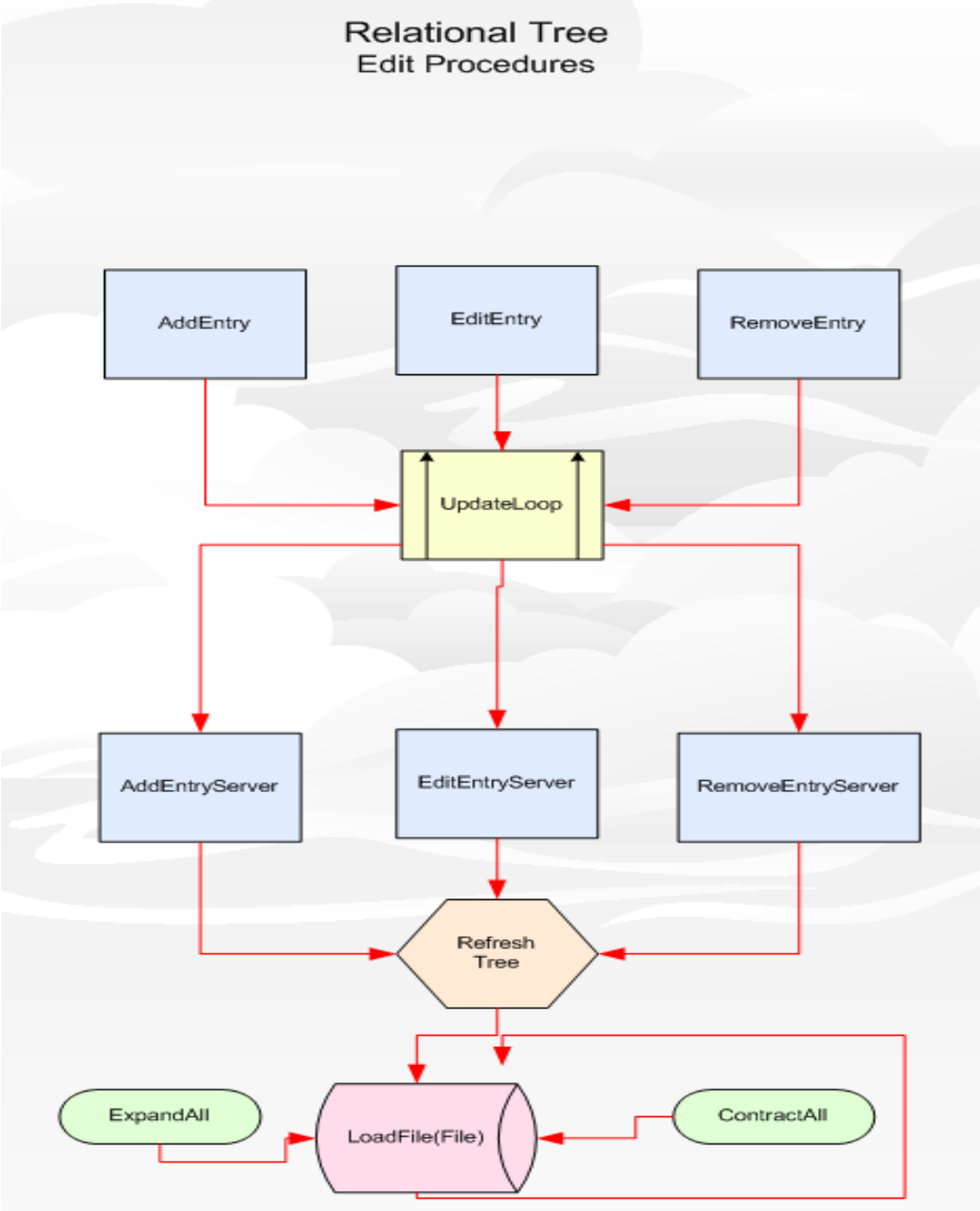
Navigation

This illustration shows how the navigation works currently.



Edits

This illustration shows the current edit functions.



A Fast Way to Code a Class

Where does one start with something like this? Let's examine the generated code. To ease this step, you should have only *BrowseAllOrders* in its own module. Thus, you don't see anything that is "non-tree". The easiest way is to **choose** from the main menu, APPLICATION ➢ REPOPULATE MODULES. **Choose** 1 procedure per module and then regenerate the source. Open up any editor and load the module with the tree code in it. You can see what the module name is by either opening the procedure dialog or select the module view.

You'll need to open a new source file too. This is where the class code goes. Save the file name as *CBTree.inc* and save it in libsrc. CB meaning "Clarion Book". You'll be switching between the open module and the CBTree file.

Add a comment on line one. !ABCIncludeFile(CB). This comment is seen by the ABC class reader. The *(CB)* portion of the comment means that this class isn't linked in by any project that does not use this tree class. You may enter anything as a parameter. If you left the parameter off, then all projects link in the class. I'll explain how this works later.

Let's examine the module code. Near the top you see a few data declarations and two queue structures. You'll concentrate on the QUEUE structures first.

Here are the generated QUEUEs from ABC:

```
Queue:RelTree     QUEUE,PRE()              ! Browsing Queue
REL1::Display       STRING(200)            ! Queue display string
REL1::NormalFG      LONG
REL1::NormalBG      LONG
REL1::SelectedFG    LONG
REL1::SelectedBG    LONG
REL1::Icon          SHORT
REL1::Level         LONG                   ! Record level in the tree
REL1::Loaded        SHORT                  ! Inferior level is loaded
REL1::Position      STRING(1024)           ! Record POSITION in VIEW
                  END

REL1::LoadedQueue       QUEUE,PRE()        ! Status Queue
REL1::LoadedLevel         LONG             ! Record level
REL1::LoadedPosition      STRING(1024)     ! Record POSITION in VIEW
                        END
```

Simply copy them as-is and paste in the code in the *CBTree.inc* file.

Change the code so the source looks as follows in your *CBTree.inc* file:

```
!ABCIncludeFile(CB)

QRelTree            QUEUE,PRE(),TYPE        ! Queue for Relation Tree
Display               STRING(200)           ! Queue display string
NormalFG              LONG                  ! Normal foreground color
NormalBG              LONG                  ! Normal background color
SelectedFG            LONG                  ! Selected foreground color
SelectedBG            LONG                  ! Selected background color
Icon                  SHORT                 ! Icon image
Level                 LONG                  ! Flag to indicate if this
                                            ! node is expanded (positive)
                                            ! or contracted (negative)
Loaded                SHORT                 ! File level is loaded in
                                            ! tree or not
Position              STRING(1024)          ! Record POSITION
                    END

LoadedQ             QUEUE,PRE(),TYPE        ! Status Queue (is a
                                            ! file loaded?)
LoadedLevel           LONG                  ! Record level
LoadedPosition        STRING(1024)          ! Record POSITION
                    END
```

I'm not too wild about the use of the colon in data labels (despite being legal), except for field labels separating them from the file prefix. Thus, they are removed. I think this makes the code easier to read, as well as write. In addition, the labels of the structures could stand shortening for the same reasons.

I've also taken the liberty of adding more comments. In this book, the comments are wrapped for readability, but in the accompanying code, they are on one line. I know "documentation" is a four-letter word in most programmers' vocabularies, however I feel this is a necessary evil.

The *QRelTree* is a QUEUE that controls the display of the tree list. The presence of records with a level greater than the current level tells the list box that there is a child file loaded. This number can be positive or negative (expanded or collapsed). The *LoadedQ* keeps track of which child file is loaded, that is, if there is one.

The Start of the Relation Tree Class

It is now time to begin the CLASS structure. Let's label it *RelationTree*. It is a CLASS declaration. Place it under the QUEUE definitions.

The code for the methods you will write later are in *CBTree.clw*. Thus, you need to add the MODULE attribute with *CBTree.clw* as a literal parameter. In order to save yourself from adding this file to the project tree, add the LINK attribute, same text parameter and another parameter with the variable that flags how this is linked to your application. To follow the ABC example, name this variable *_CBLinkMode_*. And lastly, add the DLL

attribute with its flag parameter of *_CBDLLMode_*. To finish this, add END to the next line and align it with CLASS.

Your source should appears as follows (wrapped here to provide readability, but the entire CLASS declaration can be on one line):

```
RelationTree            CLASS,MODULE('CBTree.clw'),|
                              LINK('CBTree.clw',_CBLinkMode_),|
                              DLL(_CBDLLMode_)
                        END
```

As a general tip, when you code a structure, always code the END statement right away. Then move up one line and press enter to open a new line. This way, you won't forget to add the END statement later, which leads to compiler errors.

Adding Properties

The next step is to add some properties. With existing code, this is not difficult. Go back to the generated code and you'll see some data definitions before and after the generated queues. Copy and paste these declarations before the END statement of the CLASS. In keeping with the naming style, remove the *REL1:* portion of the labels. I've added some comments where needed.

Your definition should now look like this:

```
RelationTree            CLASS,MODULE('CBTree.clw'),|
                              LINK('CBTree.clw',_CBLinkMode_),|
                              DLL(_CBDLLMode_)
SaveLevel                 BYTE,AUTO       ! Current level
Action                    LONG,AUTO       ! Edit action
CurrentLevel              LONG            ! Current loaded level
CurrentChoice             LONG            ! Current highlighted record
NewItemLevel              LONG            ! Level for a new item
NewItemPosition           STRING(1024)    ! POSITION of new record
LoadAll                   LONG            !Flag to load all levels
                        END
```

The class is starting to take shape. However, there are two properties missing. What about our QUEUE structures? You cannot legally define a QUEUE structure in a CLASS, which is why they are declared outside of the CLASS.

After the last property declaration, open a new line and add the references to the two QUEUE declarations. There are other properties needed and they are listed here.

```
QRT             &QRelTree           ! Reference to the QRelTree type
LDQ             &LoadedQ            ! Reference to the LoadedQ type
IC              SIGNED,PROTECTED    ! FEQ for list control
BaseFile        &FILE,PROTECTED     ! Base file in passed VIEW
WinRef          &WINDOW,PROTECTED   ! Reference to current window
VCRRequest      LONG(0)             ! VCR action
InsertButton    SIGNED              ! FEQ for Insert Button
ChangeButton    SIGNED              ! FEQ for Change Button
DeleteButton    SIGNED              ! FEQ for Delete Button
```

Some of these properties are PROTECTED. This is so that derived classes can access them, but not by any code outside of methods belonging to this class family. If only this base class should have access to them, then you would add the PRIVATE attribute to these properties.

If you really are not sure, then use the PRIVATE attribute. Later as needs arise, you could change it to PROTECTED or add new methods to this CLASS that return the values of these properties. The actual properties are still encapsulated regardless of what you do.

Adding the Methods

The next step is adding the method declarations. Since there are two references, you cannot use these until a reference assignment is done. This is a good reason to use a constructor. Therefore, add one and its label must be *Construct* with a prototype of PROCEDURE. There is the first method. This method automatically executes when this class is instantiated, regardless of how it is instantiated.

Since a Constructor now exists, a Destructor would not be a bad idea. Make a new line and give the Destructor the label *Destruct* and a PROCEDURE prototype. The Destructor is now defined. Its purpose is to "undo" what the Constructor does. This method automatically executes when this class is destroyed, regardless how it is destroyed.

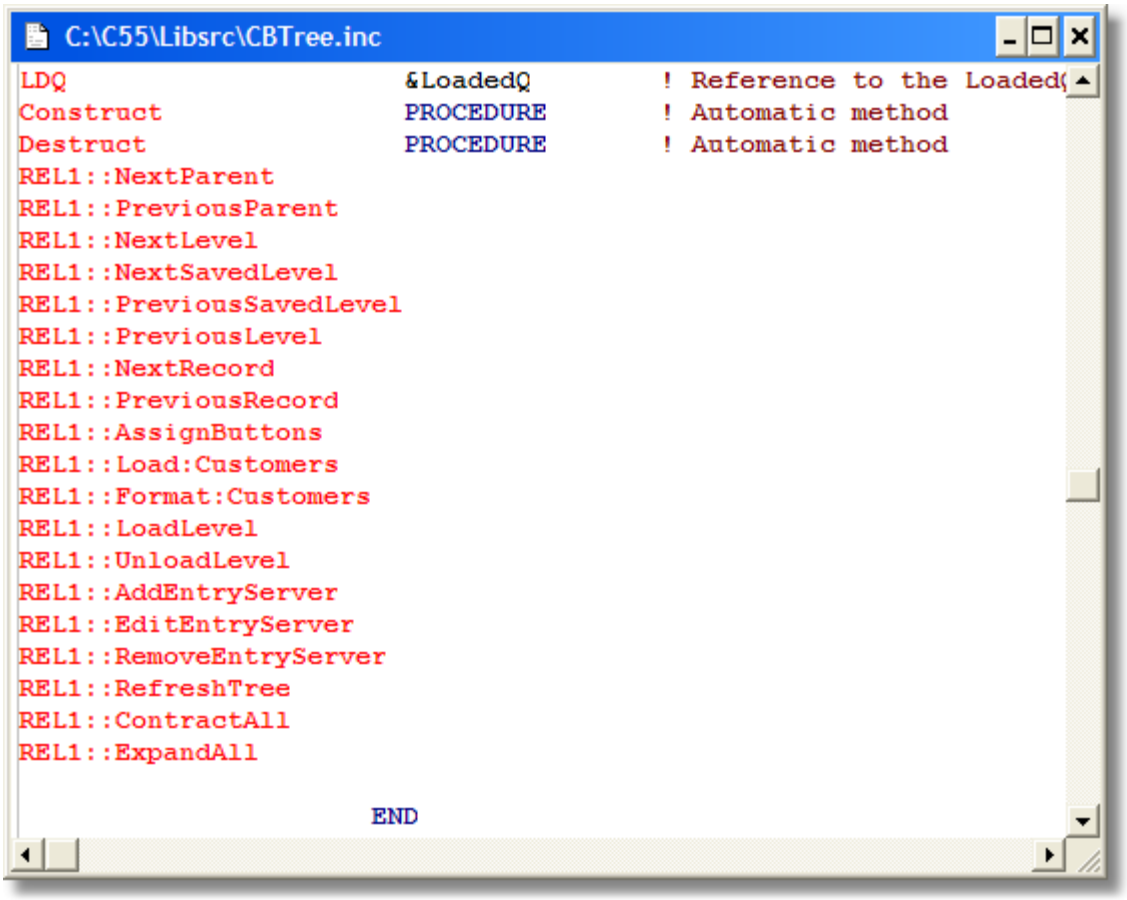
The code for both of these methods follows shortly.

You may be wondering where you'll get the code for the remaining methods. If you look at the generated code, do a search for ROUTINE. You are interested only in the *REL1::<whatever>* routines.

For now, you are only interested in the routine labels. You are interested in the code, but that step is for later. You are not interested in any parameters, at least not yet. To get things started, simply copy the labels and paste them under the last method, which should be *Destruct*. Don't worry about the names for the moment, nor the prototypes.

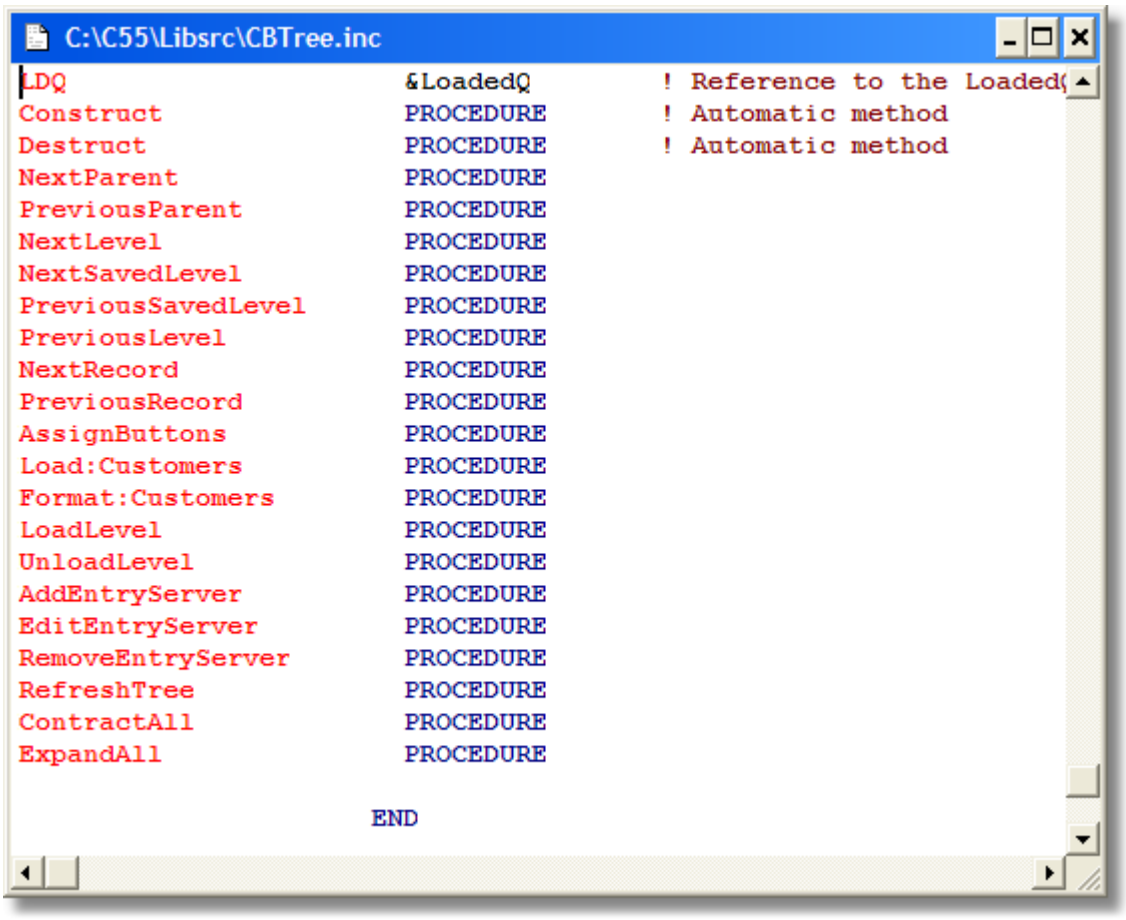
You'll soon bump into the routines that are specific to a file, such as *REL1::Load:Customers* and *REL1::Format:Customers*. For simplicity's sake, just copy it as is. Do the same for the rest of these routines until you get to the next file, *REL1::Load:Orders*. You skip this and all other such labels with file names in them. Continue to copy the routine names that do not refer to any file.

The source should look like as follows:



The next step is to remove the *REL1::* portion of the label. Use whatever edit method you wish to do this. To make this a simple edit, use a column delete action. Unfortunately, the Clarion editor does not support this. But other editors, such as *Textpad,* do. After that step, ensure each method has the PROCEDURE prototype.

The source should now appear as follows:



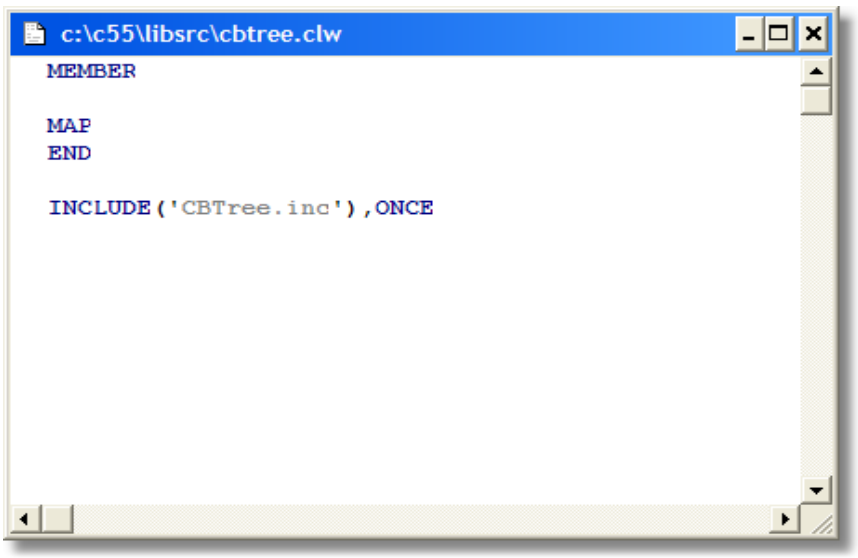
The class is taking on more form now. There are two methods that need changing. These are the ones labeled *Load:Customers* and *Format:Customers*. Set these aside for now as these two methods will require some thought. More on that later, but save your work so far.

The Code for the Methods

So far, the only thing you've done is define the class. There are methods defined, yet no code yet exists for these methods. At this stage, this class is not compilable. With your handy-dandy editor of choice, create a new file named *CBTree.clw* and ensure it is saved in *libsrc*.

At the top of the file, ensure you write your MEMBER statement. Make sure it is empty (no parameters) as this code is not tied to any project. Since this is actually a source file, be sure to add the MAP END statements. If you neglect this step, you'll get compiler errors on valid Clarion code. MAP END ensures Clarion's library of commands are seen by the compiler.

Next, you need to code the INCLUDE statement. It should look like the following figure:



The ONCE attribute is really not required as this is the only time the header definitions are included. However, using the ONCE attribute never hurts, thus it is safe to always use it.

Writing the code

This is the fun part, actually writing the code for the methods declared in the CLASS structure. No matter how big a CLASS may be, writing the code for each method takes only a few seconds to a few minutes. Here are the steps for the fastest way I know to code methods for a class.

1) Go back to the INC file and highlight all of the methods declared in it. Copy the labels (names) of the methods and the prototypes.

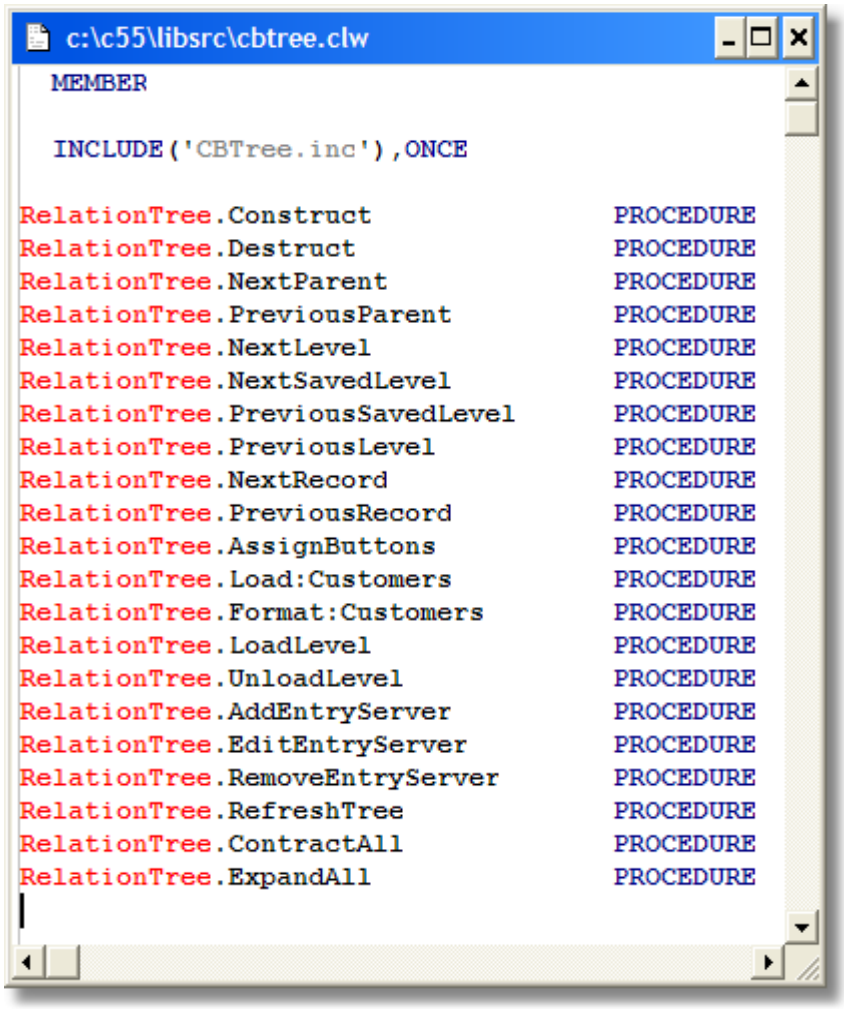
2) Copy them to the clipboard.

3) Switch to the CLW file.

4) Paste the declarations at the bottom of the source.

5) Open the search and replace feature of your editor. This works best if you have one space in column one and your editor can do column search and replace. Search for the single space and replace it with "*RelationTree.*" (Don't forget the ending period!)

Your source should appear like this:



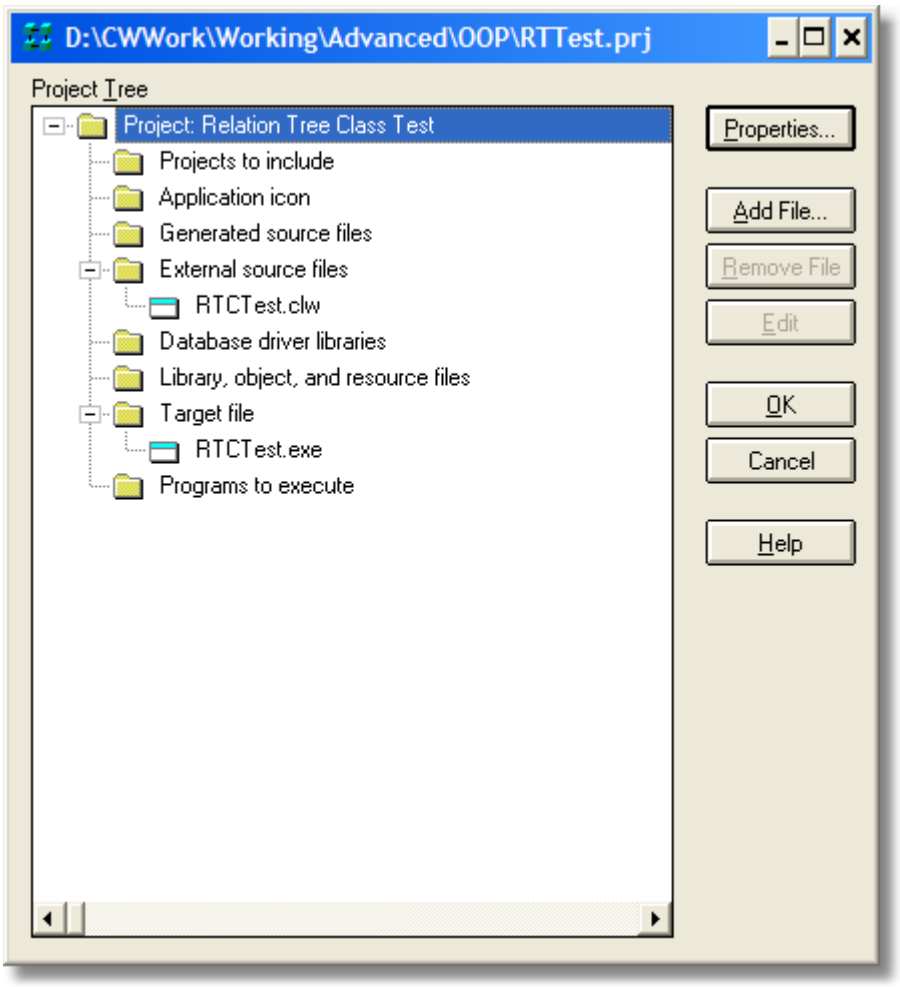
1) Open a new line under the first method (the *Construct* method).
2) Press SPACE twice and then enter CODE and then press ENTER.
3) Copy the CODE line (with its CR/LF) and paste after each method listed.

When done, your source now should look similar to this:

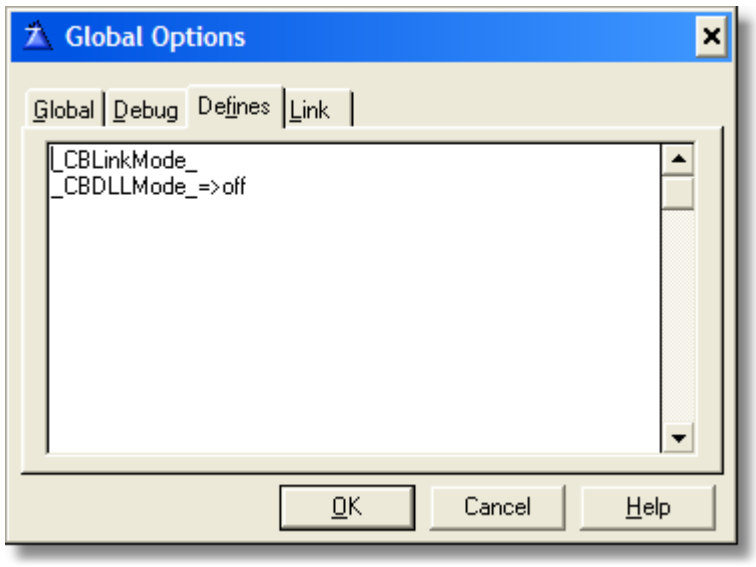
Be sure to save your work at this point. You now have a class that can compile clean. It still does not do anything (not yet). You should let the compiler check your work at this stage.

A New Project

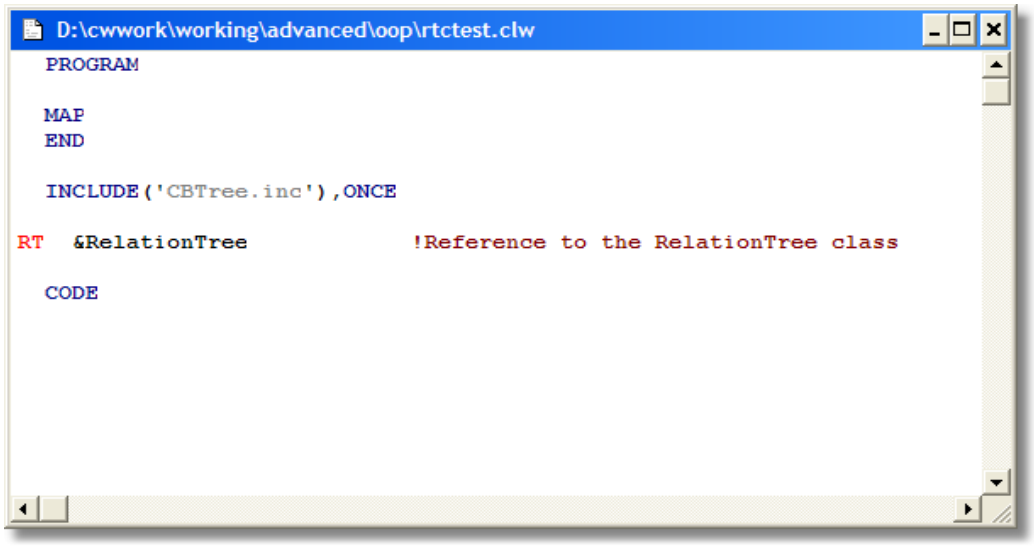
Start a new project. You can do this by **choosing** FILE ➢ NEW ➢ PROJECT from the menu, or use the pick list dialog and make a new project from there. It does not matter what you name the project, but make it something meaningful, like *RTTest*. A description is optional, but I would suggest something like *Relation Tree Class Test*. Enter a name for the file, like *RTCTest.clw*. The EXE name is filled in for you. **Press** OK to save your choices and the project tree displays.



If a define is not explicity set to => OFF, it is on. **Press** PROPERTIES and then **choose** the DEFINES tab. Be sure to add these variables and their settings as follows:



Press OK when you are done and return to the project window. **Highlight** *RCTTest.clw* and **press** EDIT. You should now have an empty source file. Add code to match the following figure:



You can now press the compile button and it should make the EXE. The EXE won't do anything as there isn't any code to tell it what to do. This comes later. The test at this stage is that it compiles clean. If you did not get a clean compile, go back and review the previous steps or use the errors window to fix the problem. Usually, it is a simple typo.

Summary

What you just did was a simple exercise that you can use to code a skeletal CLASS structure. There are two purposes to this exercise:

1) Getting you more familiar with a CLASS structure by easily hand coding it.

2) Using the labels of the code you wish to convert to a CLASS, thus increasing your familiarity with the existing code.

Generic class

The main point to keep in mind when coding classes is that nothing is hard coded as far as the data it manipulates. If you look at the generated code from the example *Invoice* application, there are many references to *?RelTree*, the field equate for the list control. What is needed is a way to tell this class which list control it should recognize.

This is what the *LC* property is for. *LC* means *List Control*. Since it really holds the field equate for the list, the data type is SIGNED. Finally, since only this class (meaning any instances of it) should deal with this value, the PROTECTED attribute is present.

Note: It really does not matter what order properties and methods list themselves in a class structure. If you group them together, then you have an easier time maintaining the class.

Now that the class is taking shape, let's address the constructor and destructor.

Automatic constructors and destructors

A *constructor* is a special method that executes when an object is instantiated, regardless of how it's instantiated. A *destructor* is a method automatically executed regardless of how an object is destroyed. You never need to call these yourself as these are called for you.

The *RelationTree* uses two QUEUE structures and before you may use them, they must be instantiated. If you recall, both definitions have the TYPE attribute. Thus, it makes little sense to require a programmer to do the reference assignments for these structures before they use the object. It is also dangerous to forget to always do this. Let the

constructor do the work, not the programmer. Thus, the *Construct* method has these lines of code:

```
RelationTree.Construct      PROCEDURE
  CODE                            !Automatic constructor
  IF SELF.QRT &= NULL             !If no reference exists
    SELF.QRT &= NEW QRelTree      !Instantiate Data Queue
?   ASSERT(~SELF.QRT &= NULL,'Cannot instantiate QRelTree')
  END
  IF SELF.LDQ &= NULL             !If no reference exists
    SELF.LDQ &= NEW LoadedQ       !Instantiate Loaded Queue
?   ASSERT(~SELF.LDQ &= NULL,'Cannot instantiate LoadedQ')
  END
```

The *destructor* simply undoes what the *constructor* did:

```
RelationTree.Destruct       PROCEDURE
  CODE                            !Automatic destructor
  IF ~SELF.QRT &= NULL            !If property is not null
    FREE(SELF.QRT)                !Free queue's resources
    DISPOSE(SELF.QRT)             !and dispose of it
  END
  IF ~SELF.LDQ &= NULL            !If property is not null
    FREE(SELF.LDQ)                !Free queue's resources
    DISPOSE(SELF.LDQ)             !and dispose of it
  END
  IF ~SELF.WinRef &= NULL         !Reference to window still valid
    SELF.WinRef &= NULL           !Remove the reference
  END
```

You now have two methods that automatically do the "grunt" work. If you notice in the *Destruct* method, code exists to dereference the other properties. However, the constructor does not assign these references. It can't. Constructors cannot take parameters to pass in the *Window*, *List* and *File* parameters. Thus another method that can take these parameters handles this.

Notice that the constructor could call a method to do this, but how can it know about the current window or file structure? It can't. This is where the *Init* method comes in.

A Note About Init and Kill

I've heard discussions arguing in favor of and against using methods named *Init* and *Kill*. In essence, they are considered alternate construct and destruct methods. Except they are never automatically called, you must call them.

In Favor of Init and Kill

The argument in favor of *Init* and *Kill* is that these are simply two other methods, nothing special about them at all. So why use them? Unlike the automatic constructor and destructor methods, *Init* and *Kill* may take parameters and return values. And they may be called anytime your design requires it. They could even call *Construct* and *Destruct*, if your design calls for it. If this is the case, then investigate the use of REPLACE as an attribute for the constructor and destructor (covered in Chapter 1). In this case, the logical use is to restart an object. One could argue in favor of even using this technique, but that is drifting beyond the scope of this book.

Not in Favor of Init and Kill

You have the automatic constructor and destructor. Why have another set of methods that at first glance appear to mimic *Construct* and *Destruct*? If you use the automatic methods, why should you even bother with *Init* and *Kill* methods? *Init* and *Kill* are not automatically called, you must write the code to call them. In most cases, I would say you won't need them. But it would depend on your design and of course what code discipline you follow. That is also outside the scope of this book and I will defer such decisions to the developer.

Another argument about *Init* and *Kill* methods is you see these methods throughout ABC. Whether the decision is for or against depends on how you feel about ABC. *Init* and *Kill*, by themselves are nothing special, they are not reserved words nor do they have any special meaning in Clarion.

My opinion on this matter is that I have no qualms about using *Init* or *Kill* when I have automatic methods (*Construct* and *Destruct*). If there is no good reason to use them I don't, if there is a good reason to use them, I do. This varies depending on the design.

How much is that List in the Window?

The next method you need to look at is one that does not yet exist. Remember, you must be able to use this class in any given application. Thus, nothing is hard coded. So what major design feature is missing at this point? The actual list control itself!

It gets worse. Where does a list control live? A window. Without a window, a list control cannot exist. So how does one write code for a window that does not yet exist? And by extension, a list control that cannot yet exist? Just how does one code for this?

The answer is quite simple and it requires a new method. I suppose I could name it *Init*, but I think *InitTree* is better. You now need to add this method. Open a new line in the class definition and give this method the label *InitTree* . It is a PROCEDURE with a (*WINDOW xWin, SIGNED xList,*FILE xFile),LONG,PROC prototype. As a finishing touch, add the VIRTUAL attribute. I'll explain why this is a virtual method shortly.

The next step is to ensure the code for the method actually exists or the compiler complains if you tried a compilation at this point. The easiest way is to copy the entire prototype line from the INC file and switch to the CLW file. You can paste the code anywhere amongst the other method code. To make this simple, you may scroll to the bottom of the file and paste it there. Or make it the first method shown. Another standard is the same order as declared. Or alphabetical. In other words, it really does not matter where you place the code.

Once you have pasted the code where you want, remove the VIRTUAL attribute. The only thing you need in the method code is the label of the method and its prototype. Attributes and return values are not needed in the method code section. Open a new line and add the word CODE.

Fill in the rest of the code so your method appears as follows:

```
RelationTree.InitTree  PROCEDURE(*WINDOW xWin,|
                                 SIGNED xList,|
                                 *VIEW xFile)
RetVal    LONG,AUTO

  CODE
   RetVal = False
   SELF.WinRef &= xWin        !Reference to window
  IF SELF.WinRef &= NULL
    RetVal = True
    RETURN RetVal
  END
  SELF.LC = xList             !Store the FEQ
  SELF.BaseFile &= xFile      !Set primary file
  IF SELF.BaseFile &= NULL
    RetVal = True
    RETURN RetVal
  END
  SELF.WinRef $ SELF.LC{PROP:From} = SELF.QRT !list gets data from?
  SELF.RefreshTree()          !and populate it with data
  RETURN RetVal
```

Notice the use of SELF. This means "whatever the current object is".

The *WinRef* property is a reference to the current window. After the reference assignment, it is tested for "nullness". If for some reason it is NULL, the method returns to the caller with a return value.

The *BaseFile* property is a reference to the passed primary file. This is also tested for "nullness" and if it is NULL, it quits this method and returns a value.

The list control field equate is assigned to the *LC* property. The *QRT* property (assigned by the *Construct* method) is where the list control gets its data. Next a call to *RefreshTree()* (discussed later).

The final line of code returns a value, in this case, a zero or false value, meaning no errors.

I should point out that the variable, *RetVal* declared in this method is local to this method. It is for the use of this method only, despite any rules of derivation. Variables declared in this fashion are considered implicitly PRIVATE.

Now is the time to bring up why this is a VIRTUAL method. This method expects to be overridden. When you derive from this class, you may want to override or extend this method. In this case simply write your code. At the appropriate time in the execution sequence, you have the option of calling *PARENT.InitTree* in your derived method. Or don't call the Parent method if you want to completely replace the functionality.

Remember, this class calls its derived children *instead* of its own methods to do work. This is the power of virtual methods. You have the choice of extending a method by calling the parent in your overridden method, or not calling it at all as you are replacing *all* functionality of the parent method. It is up to you.

Of course, having a template wrapper to write the code for you depending on the options in the template is the best way to proceed. This design allows for this and this is the subject of the next chapter.

You could add more code here, but it would limit what you could do with this class. For example, you could add this code:

```
SELF.LC{PROP:At,1} = xW{PROP:At,1} * 0.05   !horz left corner
SELF.LC{PROP:At,2} = xW{PROP:At,2} * 0.10   !vert left corner.
SELF.LC{PROP:At,3} = xW{PROP:At,3} * 0.50   !Width of list control
                                            ! as a percent of
                                            !window area.
SELF.LC{PROP:At,4} = xW{PROP:At,4} * 0.75   !Height of list control
                                            !as a percent of
                                            !window area.
SELF.LC{PROP:Format} = '1000L*IT@s200@'     !Format string to tell
                                            ! it is a tree with
                                            ! color & icon support.
SELF.LC{PROP:Alrt,255} = CtrlRight          !Alert keystrokes.
SELF.LC{PROP:Alrt,255} = CtrlLeft
SELF.LC{PROP:Alrt,255} = MouseLeft2
SELF.LC{PROP:VScroll} = True                !Vertical scroll bar
SELF.LC{PROP:HSCROLL} = True                !Horizontal scroll bar
SELF.LC{PROP:VCR} = True                    !VCR navigation
SELF.LC{Prop:IconList,1} = '~file.ico'      !List of icons
SELF.LC{Prop:IconList,2} = '~folder.ico'
SELF.LC{Prop:IconList,3} = '~invoice.ico'
SELF.LC{Prop:IconList,4} = '~wizpgdn.ico'
SELF.LC{Prop:IconList,5} = '~wizdown.ico'
SELF.LC{Prop:IconList,6} = '~star1.ico'
SELF.LC{Prop:Selected} = 1
```

However, you can see this would limit the list control in its placement, appearance and size. There is nothing wrong with this code per se, and it may indeed be fine for many list controls. There is nothing really wrong with doing this anyway, as any derived method may override these settings.

However, this is best done in a derived child class, with templates writing the above, based on what is known at the time. In other words, specific for that particular list control.

The point is that one can think up many useful things to do with code, but this is a base class, so minimal functionality is always best. In this example, only the code that must always be there is present. The property statements above could be there, but none are required. This does not mean you may not add functionality like this later. All without losing any existing functionality.

You must resist the temptation to do too much. When coding base classes like this, only the irreducible minimum code should be in it. Even if this means a loss in functionality! I know how strange that sounds, but keep in mind the derived class is where the missing functionality is. The more one derives, the more specific your code gets.

Keep Method Code Simple as Possible

Let me illustrate. If you are writing a method that opens a FILE, then write code that opens a FILE. Easy enough, any Clarion developer knows how to do that.

```
MyFileClass.Open  PROCEDURE(*FILE MyFile)
  CODE
  OPEN(MyFile)
```

That is a no-brainer. Nice and simple. However, no Clarion developer would use only that code as it is dangerous. What if there is an error during the open? And what type of error? Not all errors with opening files are fatal. Gets complex in a hurry, doesn't it?

Many Clarion developers can write code that could test for and handle error conditions, but now you are no longer dealing with a method that opens files as error checking has nothing to do with a method that opens a file. It would make more sense to call a method that does error checking for you. To strengthen this argument, any classes that trap and report errors must be able to handle other errors, not just from the limited number of errors that could arise from attempting to open a file. Thus, a call to a class that handles errors makes sense.

You still get your error checking, but you keep distinct functionality separate.

```
MyFileClass.Open  PROCEDURE(*FILE MyFile)
  CODE
  OPEN(MyFile)
  MyErrorClass.ErrorCheck() !Was there an error?
```

Bottom line -- always keep code painfully simple, even at the price of omitting code that could be useful. This useful code may be best suited to live in another class, even a derived one. A nice bonus for you is that maintaining such code is easy as you do not have to wade through lines and lines of code.

If you wish to do more with file management, then you know which class to go to. The same goes if you have a nifty idea about handling errors.

The RelationTree Class Methods

The rest of this chapter is a reference to the rest of the methods. It takes you through the other methods in the class. Each method's purpose is discussed, followed by the code.

Following the code, a brief discussion of what the code does. The code that comes with this book is fully commented, but omitted in the following pages.

RefreshTree()

This is a method that is called often in the class. Its main purpose is to load the tree with fresh data. You would call this method anytime you want or need to re-load the tree.

```
RelateTree.RefreshTree          PROCEDURE()
  CODE
```

This method is a VIRTUAL. What is a determining factor on making a method virtual or not? One good rule of thumb is if the method is used within the class. In other words, do other methods call this one? If so, then this is a good candidate for the VIRTUAL attribute.

Another reason is that this is a stub method, meaning there is no code in the base class. You define methods like this knowing there is always a derived method later. Since refreshing the list requires doing something with the local QUEUE and re-loading a FILE, this can't be known when you code the base class. However, you do have this data when a derived local class exists. Also, this fits well with template wrappers as the templates know how to code this method.

Another reason you may want to code a stub method is that the method is needed, but there is no way to code this without breaking the abstract rule, but other methods must call it (like *Init*).

There are always exceptions -- I've never been able to come up with rules set in concrete. Therefore, the above rules are guidelines.

LoadLevel()

This is another virtual stub method.

UnloadLevel()

This is another virtual stub method.

NextParent()

This method determines the next parent level of the tree.

```
RelationTree.NextParent              PROCEDURE()
  CODE
  IF ~SELF.WinRef{PROP:Active}
    SELF.WinRef{PROP:Active} = True
  END
  GET(SELF.QRT,CHOICE(SELF.LC))
  IF ABS(SELF.QRT.Level) > 1
    SELF.SaveLevel = ABS(SELF.QRT.Level) - 1
    SELF.NextSavedLevel()
  END
```

If the window is not the active window, then the window containing the tree control is set to the active window. It then gets a record from the QRT structure based on the current choice. If the level is greater than 1, take 1 away and save that value in the *SavedLevel* property. Then call the *NextSavedLevel* method (see).

PreviousParent()

This method determines the previous parent level based on the current level.

```
RelationTree.PreviousParent          PROCEDURE()
  CODE
  IF ~SELF.WinRef{PROP:Active}
    SELF.WinRef{PROP:Active} = True
  END
  GET(SELF.QRT,CHOICE(SELF.LC))
  IF ABS(SELF.QRT.Level) > 1
     SELF.SaveLevel = ABS(SELF.QRT.Level) - 1
    SELF.PreviousSavedLevel()
  END
```

First it determines if the window is active and if not makes it active. Next, it gets the record from *QRT* based on the current choice (highlighted row).

If the level is greater than 1, it subtracts one from whatever the current value is and puts it into the *SaveLevel* property. The *PreviousSavedLevel* (see) method is called.

The significance of 1 means that the current level is not a root item. Subtracting 1 from the current level is by definition, a parent node.

NextLevel()

This method finds the next level that is the same as the current one.

```
RelateTree.NextLevel                          PROCEDURE
  CODE
  IF ~SELF.WinRef{PROP:Active}
    SELF.WinRef{PROP:Active} = True
  END
  GET(SELF.QRT,CHOICE(SELF.LC))
  SELF.SaveLevel = ABS(SELF.QRT.Level)
  SELF.NextSavedLevel()
```

It first determines if the window is active and if not makes it active. Next, it gets the record from *QRT* based on the current choice (highlighted row). It then puts the current level value into the *SaveLevel* property. The *NextSavedLevel* (see) method is called.

PreviousLevel()

This method finds the previous level that matches the current level.

```
RelateTree.PreviousLevel              PROCEDURE
  CODE
  IF ~SELF.WinRef{PROP:Active}
    SELF.WinRef{PROP:Active} = True
  END
  GET(SELF.QRT,CHOICE(SELF.LC))
  SELF.SaveLevel = ABS(SELF.QRT.Level)
  SELF.PreviousSavedLevel
```

It first determines if the window is active and if not makes it active. Next, it gets the record from *QRT* based on the current choice (highlighted row).

It then puts the current level value into the *SaveLevel* property. The *PreviousSavedLevel* (see) method is called.

NextSavedLevel()

This method determines the next level that matches the current level. It reads the QUEUE structure to determine this.

```
RelateTree.NextSavedLevel                PROCEDURE
SavePointer   LONG,AUTO
  CODE
  LOOP
    LOOP
      GET(SELF.QRT,POINTER(SELF.QRT) + 1)
      IF ERRORCODE()
        RETURN
      END
    WHILE ABS(SELF.QRT.Level) > SELF.SaveLevel
    IF ABS(SELF.QRT.Level) = SELF.SaveLevel
      SELECT(SELF.LC,POINTER(SELF.QRT))
      RETURN
    END
    SavePointer = POINTER(SELF.QRT)
    SELF.LC{PROPLIST:MouseDownRow} = SavePointer
    SELF.LoadLevel
    GET(SELF.QRT,SavePointer)
  END
```

There are two LOOP structures. The first or outer LOOP encompasses the entire method. The next LOOP structure or inner LOOP first checks to see if the *Level* value in the QUEUE is greater than the *SaveLevel* property value. This is done with the WHILE statement. If it is greater, then another iteration of the LOOP. During any iteration, if there is no record by matching key available in the QUEUE (which raises an ErrorCode value), the method quits.

If the value of the *Level* is not greater than the *SavedLevel* value, the next line determines if it matches. Notice the use of the ABS function here. Since the *Level* value can be negative, this function forces a positive (without saving this value). The highlight bar is then placed on the row in the list control and the method quits.

If the *Level* value is less than the *SavedLevel* value, the current pointer value is saved and then passed to the list control. The *LoadLevel* method is then called. After returning from this method, any changes to the current QUEUE record are retrieved.

PreviousSavedLevel()

The method determines the previous level that matches the current level. It reads the QUEUE structure to determine this.

```
RelateTree.PreviousSavedLevel              PROCEDURE
SaveRecords   LONG,AUTO
SavePointer   LONG,AUTO
  CODE
  LOOP
    LOOP
      GET(SELF.QRT,POINTER(SELF.QRT) - 1)
      IF ERRORCODE()
        RETURN
      END
    WHILE ABS(SELF.QRT.Level) > SELF.SaveLevel
    IF ABS(SELF.QRT.Level) = SELF.SaveLevel
      SELECT(SELF.LC,POINTER(SELF.QRT))
      RETURN
    END
    SavePointer = POINTER(SELF.QRT)
    SaveRecords = RECORDS(SELF.QRT)
    SELF.LC{PROPLIST:MouseDownRow} = SavePointer
    SELF.LoadLevel()
    IF RECORDS(SELF.QRT) <> SaveRecords
      SavePointer += 1 + RECORDS(SELF.QRT) - SaveRecords
    END
    GET(SELF.QRT,SavePointer)
  END
```

There are two LOOP structures. The first or outer LOOP encompasses the entire method. The next LOOP structure or inner LOOP first checks to see if the *Level* value in the QUEUE is greater than the *SaveLevel* property value. This is done with the WHILE statement. If it is greater, then another iteration of the LOOP. During any iteration, if there is no record by matching key available in the QUEUE (which raises an ErrorCode value), the method quits.

If the value of the *Level* is not greater than the *SavedLevel* value, the next line determines if it matches. Notice the use of the ABS function here. Since the *Level* value can be negative, this function forces a positive (without saving this value). The highlight bar is then placed on the row in the list control and the method quits.

If the *Level* value is less than the *SavedLevel* value, the current pointer value is saved and then passed to the list control. Also saved is how many records are in the QUEUE. The *LoadLevel* method is then called. After returning from this method, determine if *LoadLevel* added any new records to the QUEUE. If so (as the number of records in the QUEUE won't match the value of *SavedRecords*), increment the pointer. Get the current QUEUE record based on the pointer key value.

NextRecord()

The method finds the next record in the list box and moves the highlight to it.

```
RelateTree.NextRecord                PROCEDURE
  CODE
  IF ~SELF.WinRef{PROP:Active}
    SELF.WinRef{PROP:Active} = True
  END
  SELF.LoadLevel
  IF CHOICE(SELF.LC) < RECORDS(SELF.QRT)
    SELECT(SELF.LC,CHOICE(SELF.QRT) + 1)
  END
```

The method first determines if the window is active and if not, makes it active. It then calls the *LoadLevel* method.

After returning, it performs a check to see if the highlighted row is less than the number of record in the QUEUE. If so, it increments the pointer by one and this value is sent to the list control. In effect, moving the highlight one row down.

PreviousRecord()

This method finds the previous record in the list and moves the pointer to it.

```
RelateTree.PreviousRecord          PROCEDURE
SaveRecords   LONG,AUTO
SavePointer   LONG,AUTO
  CODE
  IF ~SELF.WinRef{PROP:Active}
    SELF.WinRef{PROP:Active} = True
  END
  SavePointer = CHOICE(SELF.LC)-1
  LOOP
    SaveRecords = RECORDS(SELF.QRT)
    SELF.LC{PROPLIST:MouseDownRow} = SavePointer
    SELF.LoadLevel
    IF RECORDS(SELF.QRT) = SaveRecords
      BREAK
    END
    SavePointer += RECORDS(SELF.QRT) - SaveRecords
  END
  SELECT(SELF.LC,SavePointer)
```

The method first determines if the window is active and if not, makes it active. Next, it saves the value of the current position minus one.

A LOOP structure then determines the number of records in the QUEUE and this value is saved. The *SavePointer* value is then used to position the highlight. The *LoadLevel* method is then called.

After returning from this method, check to see if the number of records still matches the *SavedRecords* value. If so, then the LOOP terminates. If not, increment the pointer by adding the difference of the number of records now present to the previous value and another iteration of the LOOP is performed. After the LOOP terminates, the new *SavePointer* value is passed to the list control, selecting the matching row based on the *SavePointer* value.

Virtual Stub Methods

These are more methods that have no code in them. These are placeholders for virtual methods. At the base class level, there is no way to know precisely how to code them as they are too specific. In other words, once this class is locally derived, then there is enough information to actually code the methods.

AssignButtons()

This method is to assign the navigation buttons from the toolbar, if a toolbar is a feature in the application. The resulting code should be similar to this:

```
RelationTree.AssignButtons          PROCEDURE
  CODE
```

The templates discussed in the next chapter write the method code in the child class.

AddEntryServer()

EditEntryServer()

RemoveEntryServer()

These three methods control the editing of the highlighted item. For each method, there is an associated button control (INSERT, CHANGE, DELETE). If the control is either hidden or disabled, then the method should RETURN.

Since the templates fill in the data about the backend VIEW structure, the code needed for each is determined by the templates. These methods are called from the edit methods, described below.

Edit Methods

There must be a way to edit the highlighted item in the tree as well. To keep edit tasks simple, there are several methods used. The following methods set the edit action.

AddEntry()

```
RelationTree.AddEntry                PROCEDURE
  CODE
  SELF.Action = InsertRecord
  SELF.UpdateLoop()
```

EditEntry()

```
RelationTree.EditEntry               PROCEDURE
  CODE
  SELF.Action = ChangeRecord
  SELF.UpdateLoop()
```

DeleteEntry()

```
RelationTree.DeleteEntry             PROCEDURE
  CODE
  SELF.Action = DeleteRecord
  SELF.UpdateLoop()
```

Each of the above methods sets the *Action* property and then calls the *UpdateLoop* method.

UpdateLoop()

This method is responsible for any edits and any toolbar navigation. If no edits are enabled and there are no toolbar navigation buttons, this method is never called.

```
RelationTree.UpdateLoop              PROCEDURE
  CODE
  LOOP
    SELF.VCRRequest = VCR:None
    SELF.LC{PROPLIST:MouseDownRow} = CHOICE(SELF.LC)
    CASE SELF.Action
    OF InsertRecord
      SELF.AddEntryServer()
    OF DeleteRecord
      SELF.RemoveEntryServer()
    OF ChangeRecord
      SELF.EditEntryServer()
    END
    CASE SELF.VCRRequest
    OF VCR:Forward
      SELF.NextRecord()
    OF VCR:Backward
      SELF.PreviousRecord()
    OF VCR:PageForward
      SELF.NextLevel()
    OF VCR:PageBackward
      SELF.PreviousLevel()
    OF VCR:First
      SELF.PreviousParent()
    OF VCR:Last
      SELF.NextParent()
    OF VCR:Insert
      SELF.PreviousParent()
      SELF.Action = InsertRecord
    OF VCR:None
      BREAK
    END
  END
```

This code calls the actual method to do the edits. It also serves the navigation for the VCR events. The tree could be navigated by the toolbar VCR controls. Notice the *VCRRequest* is set to *VCR:None*. This is an equate for zero. The three possible edit methods return from their calls, with a *SELF.VCRRequest*. Thus, the CASE statement for it. *SELF.VCRRequest* is a property of this class; be sure to add it as a LONG(0).

Another note about this VCR business. In the INC file, be sure to add this line before any data declarations:

```
INCLUDE('ABTOOLBA.INC'),ONCE
```

This file contains all of the equates needed to make a clean compile. However, if you try it at this time, you get a link error about the ASCII driver not found. This comes from the *ErrorClass*, which is a parent class for many ABC classes, including the toolbar. This comes from the file declaration for logging errors as the DRIVER attribute is part of the declaration.

To remedy this, simply place the ASCII driver in your project tree. You now get a clean compile.

Contract and Expand

These are the methods that control the expanding and contracting of the tree.

```
RelationTree.ContractAll                PROCEDURE
  CODE
  FREE(SELF.QRT)
  FREE(SELF.LDQ)

RelationTree.ExpandAll                  PROCEDURE
  CODE
  FREE(SELF.QRT)
  FREE(SELF.LDQ)
  SELF.LoadAll = True
```

Of all the methods, these two are really incomplete as far as functionality goes. The final line of code should have a call to load a given file. The reason this code is deliberately missing is because the templates will know which file to load. Also, the plan is for the templates to place a call to the PARENT object, which executes the above code first. The other design plan is that the templates will extend this class by adding new methods to the derived declaration.

Chapter 6 – Writing Template Wrappers

Introduction

To continue with the OOP theme, the goal in this chapter is to write a template wrapper for the CLASS created in the previous chapter. What this means is that the *TreeClass* is fine for what it does, but a template can certainly make implementing and using the class easier in application projects. For those not familiar with templates, coverage of basic template commands is appropriate. Thus you can see how a template evolves.

The target audience of this chapter is all template programmers, regardless of skill level.

The purpose is to describe how to implement ABC compliant templates that generate global, or procedure local objects (or new class types). You may wish to revisit this chapter many times as your abilities rise. It provides some clever insight into how to author ABC compliant templates and why. It also contains some clever ways to get access to symbol values otherwise unavailable.

There are not many template coders in the Clarion world. You could blame the structure of the templates themselves for this. Unlike the Clarion language, you must "hold by the hand" and tell the templates to do specific actions. In this regard, they are viewed as primitive by comparison.

On the other hand, there are template statements that do a lot in one line of code. Therefore, they could be viewed as advanced by comparison.

Templates also have commands that could be best described as synonyms. There are differences, but they are subtle. This gives rise to confusion as one starts to wonder which command is the most appropriate. That is just one point on the learning curve.

The template language is similar to playing chess. It is easy to learn, difficult to master. The rules are simple, but one must understand the subtleties to really appreciate them. Studying the template language is not a waste of time. The payoff comes later. Templates are viewed by some to be superior to the Clarion language in that they can generate more than just the Clarion language. In that respect, they are correct.

There are those that use templates to generate COBOL, C++, Perl, and ASP (as Softvelocity has done). PHP and JHP are others that you may see soon. They can even generate .NET languages such as C#.

My biggest complaint with templates is the lack of tools to assist the template developer. There is no debugger or dialog formatter. It is purely hand coded. The template writer tool from Softvelocity is a good step in the right direction, but it is limited. It is, however, an excellent tool for getting started if you wish to start learning the language.

The *Clarion Handy Tools* by Gus Creces has tools to assist the template coder. Plus there is template code in ABC that is useful for debugging class wrappers. There are tools out there, but a template debugger is sorely lacking. Consider this my open letter to the community to author one. I'll be your first customer.

Templates and Objects

Objects can be generated either application globally, or locally to a procedure. Currently, there is no support for generating objects into module data. Additionally, any object can now be generated as a new TYPE only.

Once you implement an object using the procedures described in this chapter, the developer can:

- Change the object name, for objects declared inside procedures only.
- Change the base class of any object.
- Embed code in any public/protected method of any object.
- Add new methods and properties to any object.

Class reader

For an ABC class type to be available to the user and generator, the Class Reader must have read it. In other words, the header file (normally .INC) containing the class declaration must have been processed. This will happen automatically, once per session, if the header file exists in the *libsrc* directory and it contains the text !ABCIncludeFile as the first text in the file.

The header reader will ignore any file that does not contain this comment, so its classes will not be available – this usually results in generation time error messages and badly generated code. Header file reading is triggered by a call to %ReadABCFiles – covered later.

Automatic header reading happens once per session. You may need to force a reread or refresh, for example, if you change the header files while the environment is active. If so, you may **press** the **REFRESH APPLICATION BUILDER CLASS INFORMATION** button available anywhere %ClassPrompts or %GlobalClassPrompts is inserted, or on the global classes tab.

Definition: Symbols. The template name for variables, which are identified by a leading % mark.

Writing a new template

When I start a new template, I usually add it to a base or root template. This is a template with a TPL extension. The reason is that when I need a template, I can simply use the #INCLUDE statement. This loads templates with a TPW extension. The template registry function in Clarion's IDE looks only for TPL type files and by default, in the *%ROOT%\template* folder, although these files may be anywhere on your system. You just need to walk the folder tree to find them everytime you register a template or add another entry in the RED file for other template folders.

The reason for a base template is simple. I can add whatever templates I wish to it. When Softvelocity issues a new release of Clarion, then I am not forced to edit their templates.

I always state a new template with the #TEMPLATE statement like the following:

```
#TEMPLATE(CBook,'Clarion Book Template'),FAMILY('ABC')
```

> **Note**: There is no color syntax for templates in the Clarion editor. This makes template code difficult to read. Thus, I am using a purple color for statements and a teal color for symbols. In the *extras* folder on the code CD, I've included some C55EDT.INI settings you may use to add color syntax support for your environment.

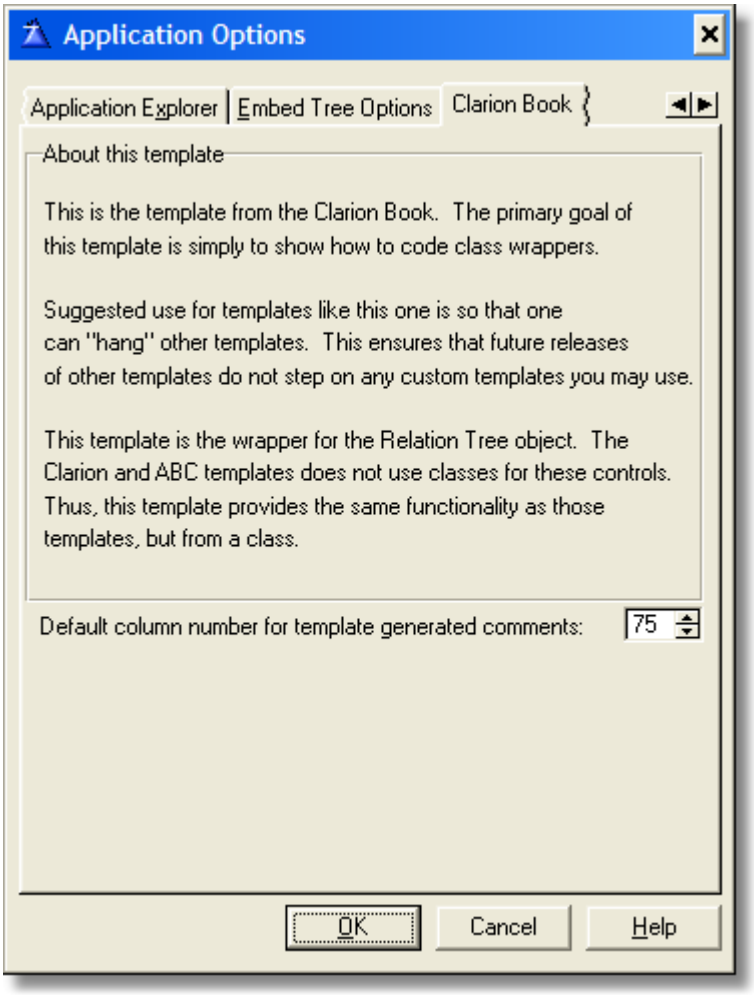
The first parameter is the name of the template, followed by a required description. The FAMILY attribute is required if you want to restrict the template to a certain template family. If left off, the template defaults to the Clarion template chain. This template is for ABC only.

The #SYSTEM statement

The next lines, I would use #SYSTEM. This is a good command that allows any dialogs to show in the SETUP ▸ APPLICATION OPTIONS dialog. The template code would look like this:

```
#SYSTEM
#TAB('Clarion Book')
  #BOXED('About this template'),AT(5)
    #DISPLAY('')
    #DISPLAY('This is the template from the Clarion Book.’)
    #DISPLAY(‘ The primary goal of this template is')
    #DISPLAY(' simply to show how to code class wrappers.')
    #DISPLAY('')
    #DISPLAY('Suggested use for templates like this one’)
    #DISPLAY(‘ is so that one can "hang" other templates.')
    #DISPLAY('This ensures that future releases ')
    #DISPLAY('of other templates do not step on any custom’)
    #DISPLAY(‘templates you may use.')
    #DISPLAY('')
    #DISPLAY('This template is the wrapper for the Relation’)
    #DISPLAY(‘Tree object.  The Clarion and ABC templates does ')
    #DISPLAY('not use classes for these controls.')
    #DISPLAY('Thus, this template provides the same’)
    #DISPLAY(‘ functionality as those templates, but')
    #DISPLAY('from a class.')
    #DISPLAY('')
  #ENDBOXED
  #PROMPT('Default column number for template generated comments: ',
            SPIN(@N2,50,99)),%ColumnPos,DEFAULT(75),AT(205,,25)
#ENDTAB
```

This code produces a dialog like the following figure:



#APPLICATION vs #EXTENSION

A common question is what is the difference between an #APPLICATION and #EXTENSION statement. It is quite simple. Use #APPLICATION when you are coding a new family of templates. If you are coding a template to "attach" or "extend" an existing template set, then #EXTENSION is the choice. Since this chapter is about coding object wrappers to use with ABC compliant classes, you want #EXTENSION.

An #EXTENSION could be an application level template or a procedure level template, depending on whether or not you add the appropriate APPLICATION or PROCEDURE attribute. Since the template use here is for a control, neither template is appropriate. It is applicable on a certain use, which I cover later. I mention these two template types in order to keep these in mind whenever you may need to use them.

#CONTROL Template

A beter choice would be a #CONTROL template. This is why there is an #INCLUDE statement in the main template file for it.

The code looks like this, which is really on one line, wrapped for readability (which may appear in your TPL file or an included TPW file):

```
#CONTROL(RelationalTree,'Relational Tree Object List
Box'),PRIMARY('Relational Tree Object List
Box',OPTKEY),DESCRIPTION('Tree structure related to ' &
%Primary),MULTI,WINDOW,WRAP(List)
```

The name of the template and its description is obvious. The PRIMARY attribute means a primary file for the set of controls must be placed in the procedure's Table Schematic. If you use this attribute, the description is required. The OPTKEY parameter means the key label is not required.

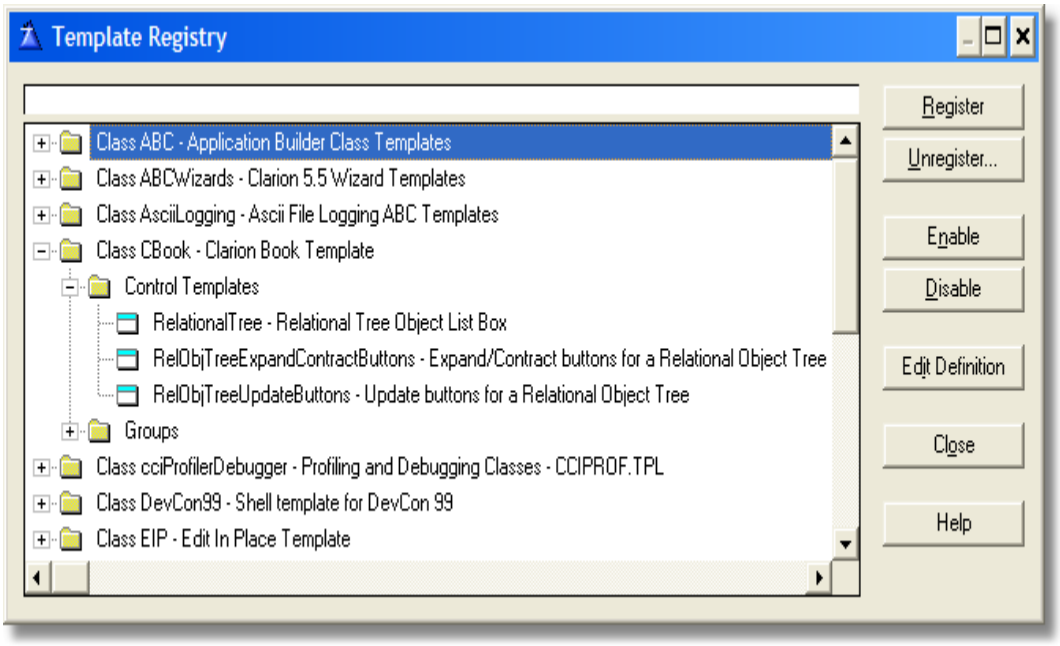
DESCRIPTION specifies the display description of a #CONTROL that may be used multiple times in a given application or procedure. In this case, you'll see which file this tree list is for.

MULTI specifies the #CONTROL may be used multiple times in a given window.

WINDOW tells the Application Generator to make the #CONTROL available in the Window Formatter.

WRAP specifies the #CONTROL template is offered as an option for the control when the *Translate controls to control templates when populating* option is set in *Application Options*.

When registered, the template appears as follows (your registry will vary depending on the templates you have registered):



Loading ABC classes in memory

A #GROUP is a bit of reusable template code. You can insert it almost anywhere in your template code. The advantage is that you may re-use template code instead of coding it again.

To use a #GROUP, use the #INSERT statement (there are other statements that do the same thing, but I am sticking with #INSERT for now).

You must ensure that all ABC compliant classes are loaded into memory. This is done by this line of template code:

```
#INSERT(%OOPPrompts(ABC))
```

The above example shows the optional family parameter. It is optional in that this template is an ABC family member. Thus, if left off, the template system expects this group to be in this template set and will complain if it is not found there. The following is the #GROUP code:

```
#GROUP(%OOPPrompts)
  #BOXED(''),AT(0,0),WHERE(%False),HIDE
    #INSERT(%OOPHiddenPrompts(ABC))
  #ENDBOXED
#!
#GROUP(%OOPHiddenPrompts)
  #PROMPT('',@S64),%ClassItem,MULTI(''),UNIQUE
  #BUTTON(''),FROM(%ClassItem,'')
    #PROMPT('',@S64),%DefaultBaseClassType
    #PROMPT('',@S64),%ActualDefaultBaseClassType
    #PROMPT('',@S255),%ClassLines,MULTI('')
  #ENDBUTTON
```

The #INSERT statement places code in a #GROUP where #INSERT executes. Using #GROUP serves two major purposes:

- Keeps template code clean
- Allows re-use of template code, thus eliminating re-typing the same code or copy/paste.

The above two groups belong to ABC. You call these groups by adding *(ABC)* after the group name. That is the family argument for a group name and is not needed if the group belongs to the current template. If you always use it, then you will never get errors about missing template code, unless you use a wrong family member.

Use the family name with group calls when calling a #GROUP *not* of your template set. This keeps things straight and you know if a group belongs to your template set (with no parameter) or a specific template set. Or just always use it. Either way, the choice is yours.

Setting up Class Items and OOP Defaults

It is very important that *two* identical calls to %SetClassDefault are made, one from the #PREPARE section and one in the #ATSTART section.

The #PREPARE sets up defaults for the user if they enter the prompts section. The #PREPARE structure sets up template prompts. You can think of it as setting the value for prompts (or buttons) before they are even populated on a dialog. It is a good way to ensure that these controls have default values.

#ATSTART catches the instance where the developer never uses the prompts section of a template, but simply generates code, using the defaults. The #ATSTART structure processes any code in it before code generates. You may think of it as an initialization procedure before code generation.

Thus, one allows the developer to change the class, the other allows the developer to generate working code regardless if they changed the class or not.

The following code sets up defaults for the *Relation Tree* object:

```
#PREPARE
  #CALL(%ReadABCFiles(ABC))
  #CALL(%SetClassDefaults(ABC),'RTree' & %ActiveTemplateInstance,
        'RTree' & %ActiveTemplateInstance,'RelationTree')
#ENDPREPARE
#ATSTART
  #CALL(%ReadABCFiles(ABC))
  #CALL(%SetClassDefaults(ABC),'RTree' & %ActiveTemplateInstance,
        'RTree' & %ActiveTemplateInstance,'RelationTree')
#ENDAT
```

The above is a small snippet of what is really in the #ATSTART statement in the template. The rest of the code is there to define symbols, set up values, etc.

One interesting aspect of the code is this section:

```
  #FOR(%Control),WHERE(%ControlInstance = %ActiveTemplateInstance)
    #SET(%TreeControl,%Control)
    #SET(%TreeQueue,EXTRACT(%ControlStatement,'FROM',1))
  #ENDFOR
```

The #FOR statement loops through the controls on the window that match the current instance. This is provided as it is possible to place more than one such control on a window.

The first #SET statement assigns the value. The 2nd parameter passes its value to the first. This is done so you know the name (or label) of the control. This makes it easy to use in later template code, plus you do not have to issue the #FOR loop again.

The second #SET assigns the value of the FROM attribute of the LIST control. This is done via the EXTRACT statement. EXTRACT "string slices" though a control's attribute, looking for a specific match. The FROM attribute names a QUEUE that holds the data that is seen on a LIST. If you want to see how this works, you can add an #ASSERT and build a string as follows:

```
  #ASSERT(~%TreeQueue,'TreeQueue: ' &
          %TreeQueue & ' ControlStatement: ' & %ControlStatement)
```

This produces the following string when you generate source (emphasis added):

```
(TEST.B1$) Error:  ASSERT: TreeQueue: QTree
           ControlStatement: LIST,AT(23,17,284,100),
           USE(?RTree),HVSCROLL,
           FORMAT('800L*IT@s200@'),FROM(QTree)
```

Adding Global Prompts

Sometimes you may need global instances of a CLASS. For a control, this is not really appropriate as they are always local. However, this does present a problem. In ABC, all classes are considered global, with local derivations. These are always set up in the global prompts, thus they are available.

Here's the rub; the *RelationTree* class is in an app when a control is placed in a local procedure. This works fine if you plan to have only one executable. What about DLL and LIB projects? The custom with Clarion is that a root or global DLL is made, often with no procedures. Therefore the RelationTree class is not available for export, a requirement for DLL use.

If you do not add a global extension, the *RelationTree* class is not available for export. This produces the "unresolved external" link error.

Therefore, a global extension template is required. It is quite simple.

```
#EXTENSION(GlobalTree,'Global extension for DLL/LIB use only')
          ,APPLICATION
```

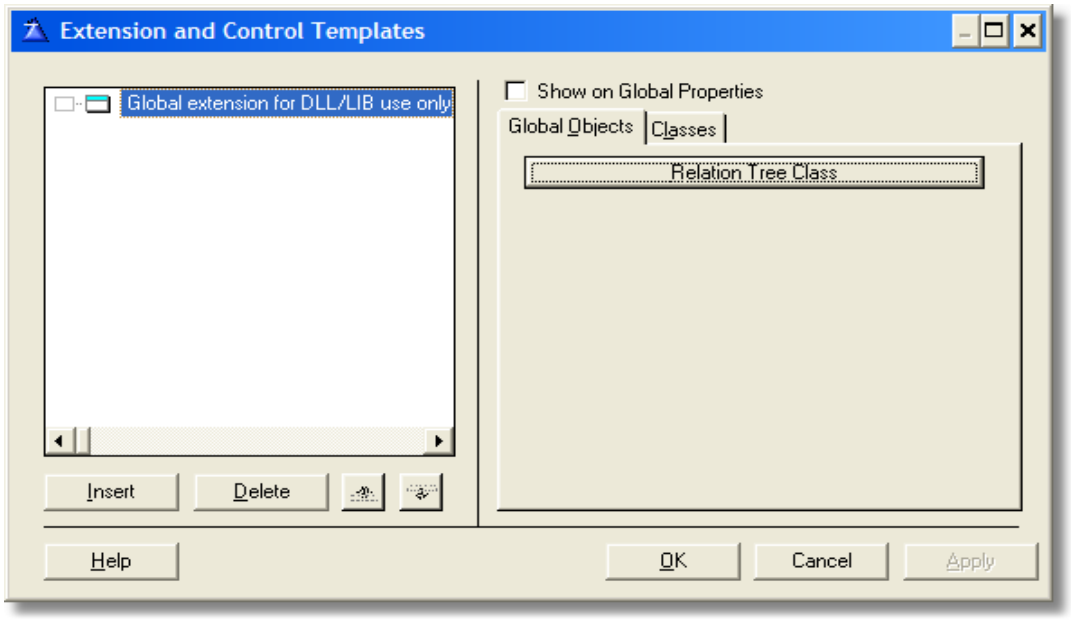
This declares the global extension template. The APPLICATION attribute is key to this.

```
#PREPARE
  #CALL(%ReadABCFiles(ABC))
  #CALL(%SetClassDefaults(ABC),'RTree' &
        %ActiveTemplateInstance,'RTree' &
        %ActiveTemplateInstance,'RelationTree')
#ENDPREPARE
#ATSTART
  #CALL(%ReadABCFiles(ABC))
  #CALL(%SetClassDefaults(ABC),'RTree' &
        %ActiveTemplateInstance,'RTree' &
        %ActiveTemplateInstance,'RelationTree')
#ENDAT
#INSERT(%OOPPrompts(ABC))
```

You've seen this code before, it is the same as what was discussed previously. The same reasons as before exist for why this code is needed here. You also need to have the same code for the prompts, with one minor exception:

```
#TAB('Global &Objects')
  #BUTTON('&Relation Tree Class'),AT(,,170)
    #WITH(%ClassItem,'RTree' & %ActiveTemplateInstance)
      #INSERT(%GlobalClassPrompts(ABC))
    #ENDWITH
  #ENDBUTTON
#ENDTAB
```

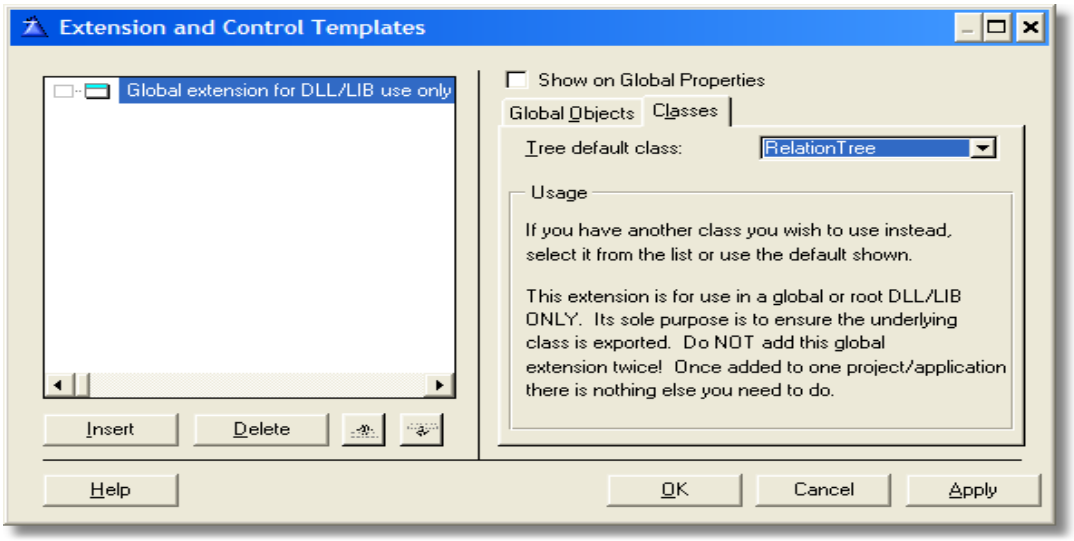
The key is calling %GlobalClassPrompts. This creates a single instance of the CLASS. Since you really cannot create multiple instances of a global object (and why would you?), the intent is to either use the global instance (like ABC's *GlobalError* object derived from *ErrorClass*) or you intend to have multiple instances locally. And this fits well if you need to ensure you have a *RelationTree* class that is exportable.



Of course, there is another tab. This is for the name of the base class:

```
#TAB('C&lasses')
  #PROMPT('&Tree default class:',FROM(%pClassName)),
           %ClassName,DEFAULT('RelationTree'),REQ
  #DISPLAY()
  #BOXED(' Usage ')
    #DISPLAY()
    #DISPLAY('If you have another class you wish to use instead, ')
    #DISPLAY('select it from the list or use the default shown.')
    #DISPLAY()
    #DISPLAY('This extension is for use in a global DLL/LIB ')
    #DISPLAY('ONLY.  Its sole purpose is to ensure the underlying')
    #DISPLAY('class is exported.  Do NOT add this global')
    #DISPLAY('extension twice!  Once added to one application,')
    #DISPLAY('there is nothing else you need to do.')
    #DISPLAY()
  #ENDBOXED
#ENDTAB
```

This produces the following dialog:



For more information on using this template, see the next chapter.

Exporting the class

You need only one more bit of template code to ensure the class is exported properly:

```
#AT(%BeforeGenerateApplication)
  #CALL(%AddCategory(ABC),'CB')
  #CALL(%SetCategoryLocation(ABC),'CB','CB')
#ENDAT
```

This not only sets things in motion for exporting, it places the correct flags and sets their values properly under the *Defines* tab in the project editor.

Adding Local Prompts

You need to add a set of prompts for each instance of the object(s). These prompts enable the user to change the object name (unlike a global object), change the base class and add new methods and/or properties at design time.

For *local* objects this is done by inserting the #GROUP (%ClassPrompts) inside a uniquely defined #WITH clause. For example;

```
#TAB('Local &Objects')
  #BUTTON('&Relation Tree Class'),AT(,,170)
    #WITH(%ClassItem,'RTree'& %ActiveTemplateInstance)
      #INSERT(%ClassPrompts(ABC))
    #ENDWITH
  #ENDBUTTON
#ENDTAB
```

Note, that these should be populated onto a GLOBAL_OBJECTS tab and a suitably named button should surround each inserted prompt set. The second parameter of the #WITH statement wrapping each #INSERT(%ClassPrompts) is key to the whole system. It becomes the 'tag' used to get the generator's model of a specific instance of an object. For this reason, it *MUST* be unique within any given scope. Also, it is possible to have more than one tree list on a window.

The key to this is the symbol %ActiveTemplateInstance. This is a built-in symbol. The Clarion documentation defines this as "The instance numbers of all control templates used in the procedure." Since this is dependent on another built-in symbol, %ActiveTemplate, it is unique for each tree control you may place on a window.

Global Symbols and Objects

To begin, global symbols contain the session default class names for all new objects. These symbols should use the FROM() type to allow the user to select a class from a list of known classes.

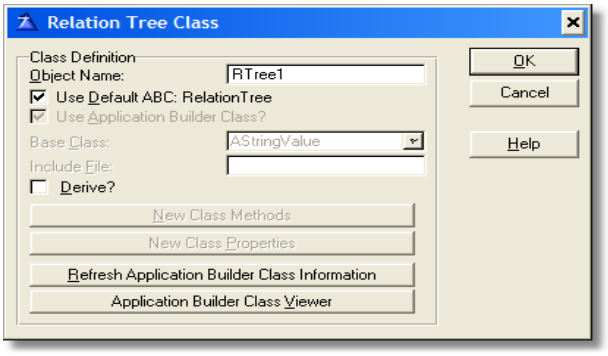
%pClassName is the symbol that contains all known classes. Bear in mind that any default values supplied for class names are case sensitive and must match *exactly* the class label as defined in the header file.

You do this in the #APPLICATION section, or in any #EXTENSION with the APPLICATION attribute.

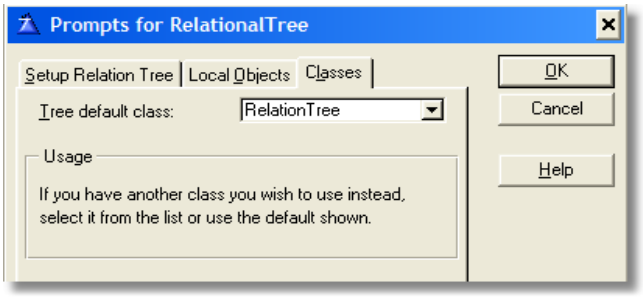
For consistency, and to ensure that the generator merges 'pages' together nicely, these should appear on a tab labeled *Classes* and buttons should be used to group logically similar/related class types together.

```
#TAB('Local &Objects')
  #BUTTON('&Relation Tree Class'),AT(,,170)
    #WITH(%ClassItem,'RTree' & %ActiveTemplateInstance)
      #INSERT(%ClassPrompts(ABC))
    #ENDWITH
  #ENDBUTTON
  #BUTTON('&Library Files'),AT(,,170)
    #BOXED('Library Files')
      #INSERT(%ABCLibraryPrompts(ABC))
    #ENDBOXED
  #ENDBUTTON
#ENDTAB
#TAB('C&lasses')
  #PROMPT('&Tree default class:',
            FROM(%pClassName)),%ClassName,DEFAULT('RelationTree'),REQ
  #DISPLAY()
  #BOXED(' Usage ')
    #DISPLAY()
     #DISPLAY('If you have another class you wish to use instead, ')
     #DISPLAY('select it from the list or use the default shown.')
    #DISPLAY()
  #ENDBOXED
#ENDTAB
```

This produces the following dialogs:



The Classes tab takes on this appearance:



Now that the prompts have been set up, they must be given their default values. It is important to realize that developers are *never* required to enter any of the classes or global object prompts to generate an application that works.

I have snuck in a third tab, this is the same dialog as the one you find in the Clarion and ABC template chains for the tree lists.

A List of Objects

The templates 'maintain' a list of objects that are currently in scope from the developer's perspective. This is currently used by the *CallABCMethod* and *SetABCProperty* groups. It is therefore important that objects are added to the known object list in the %GatherObjects embed point. Each object tag should be passed to %ObjectList in turn, for example:

```
#AT(%GatherObjects)
  #CALL(%AddObjectList(ABC),'RTree'& %ActiveTemplateInstance)
  #ADD(%ObjectList,%ThisObjectName)
  #SET(%ObjectListType,'RelationTree')
#ENDAT
```

The #CALL statement calls a #GROUP. The #GROUP code is placed where the #CALL is placed. In this regard, it is similar to #INSERT with the NOINDENT attribute.

Adding Local Declarations

In order to have code generated correctly in your procedures, the local instance must be instantiated. You do this with the %LocalDataClasses embed point.

```
#AT(%LocalDataClasses),WHERE(%ControlTemplate='RelationalTree(CBook)')
  #INSERT(%GenerateClass(ABC), 'RTree' & %ActiveTemplateInstance,
          'Local instance and definition'),NOINDENT
#ENDAT
```

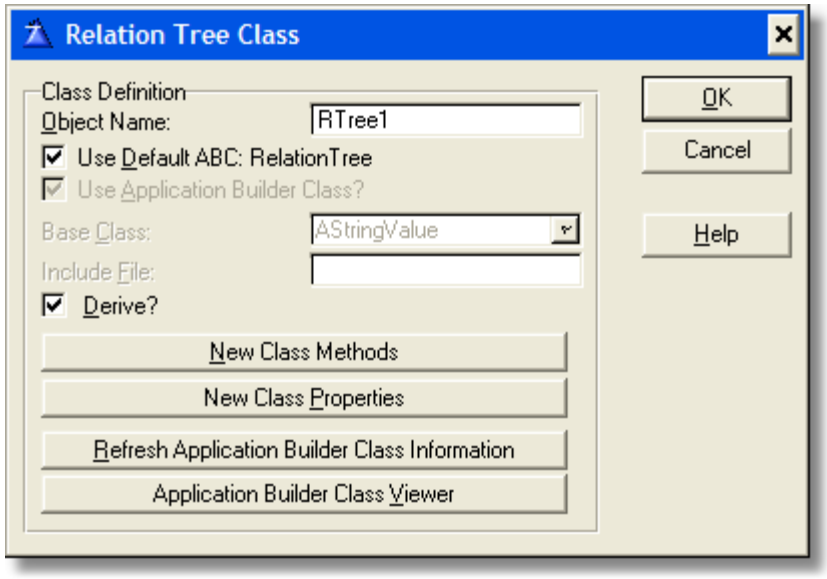
Notice the WHERE clause. %ControlTemplate is the internal multi-valued symbol that contains the names of control templates populated on a window or report. What this says is the following code generates when a specific #CONTROL template is present (which it is) and ignore other control templates. The %ActiveTemplateInstance generates a CLASS definition for every instance of the *TreeControl* placed on the window.

The #INSERT statement generates compilable code for the local instance. Notice the NOINDENT attribute. I like to indent my template code. However, if I left off this attribute the data declaration generates in the column where the #INSERT appears, in column three. That is invalid for a data declaration. Alternatively, you could use #CALL instead of #INSERT(),NOINDENT.

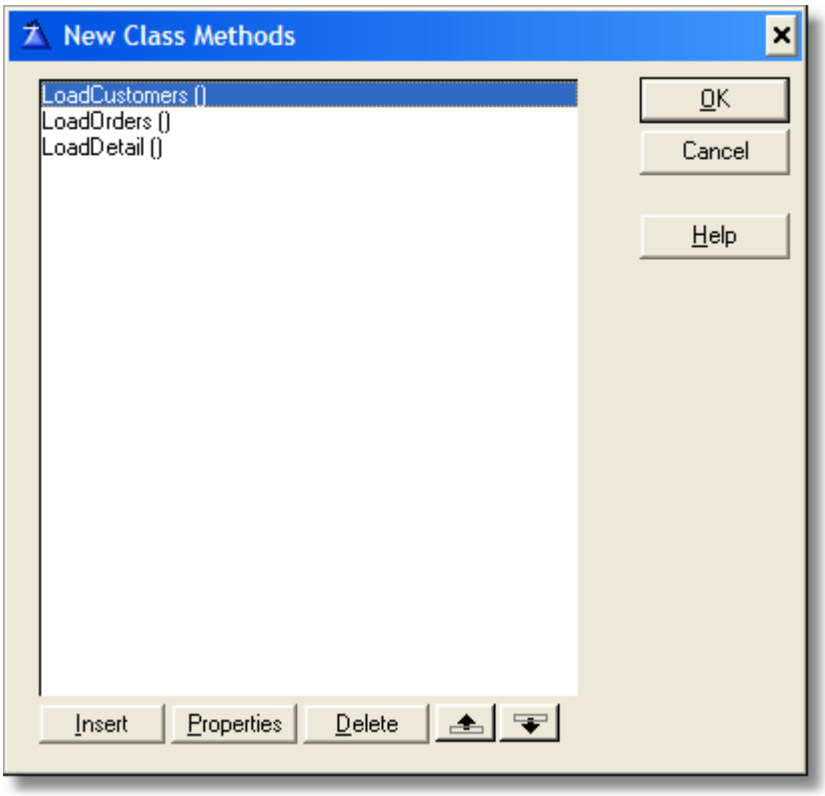
How to Add New Methods

One of the interesting things you can do with template code is add new methods to a local class. The class definition is missing a few methods and this is deliberate. The design of the tree requires that methods load whatever files are listed in the table schematic. This function is ideal for template use as there are internal symbols that retrieve whatever is placed there.

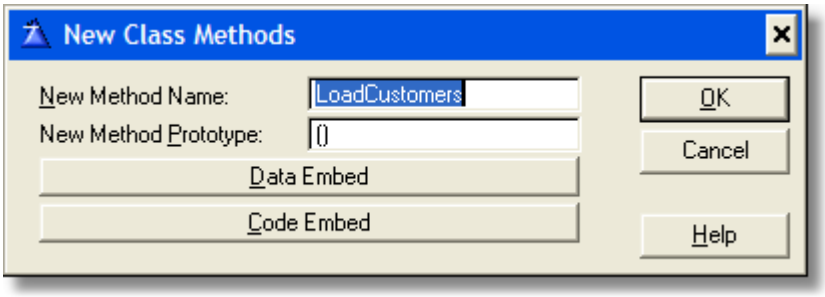
This means that a method must not only be defined, but code written for each of these methods. This is done via the Class dialog. For the local instance of the *RelationTree*, the dialog appears as follows:



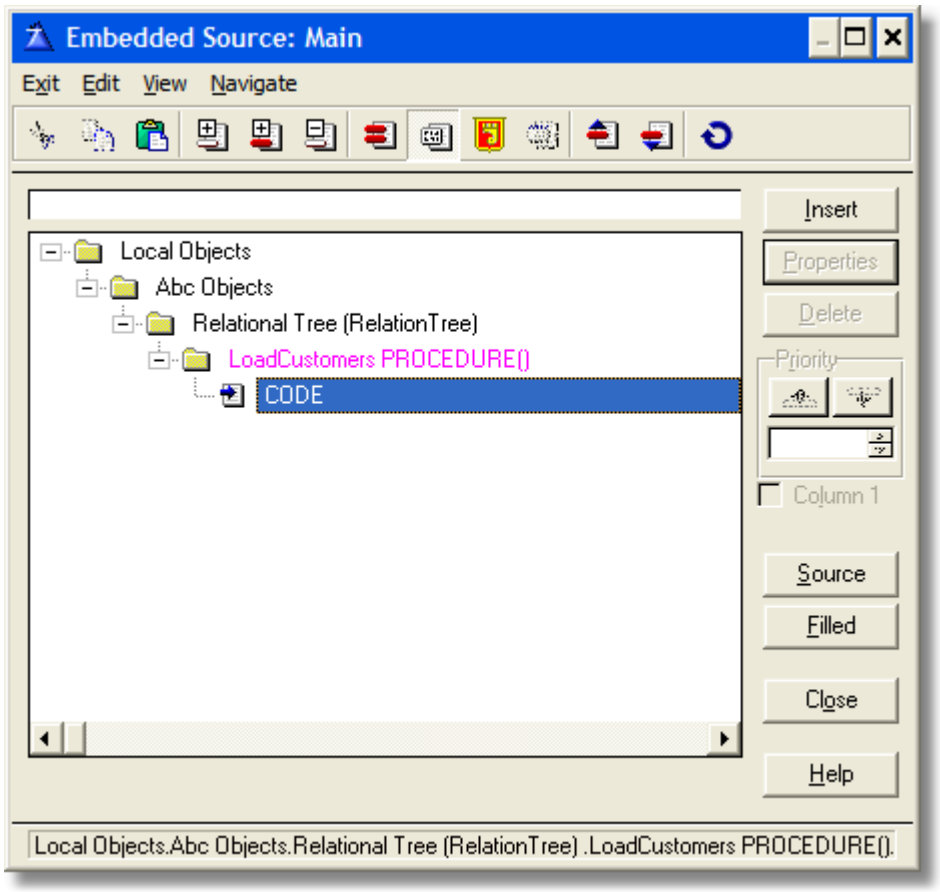
The **DERIVE?** check is set, which enables the *New Class Methods* and *New Class Properties* buttons. **Press** *New Class Methods* and the following dialog appears:



This dialog contains a list of all new methods and their prototypes. If you **press** PROPERTIES the following dialog displays:



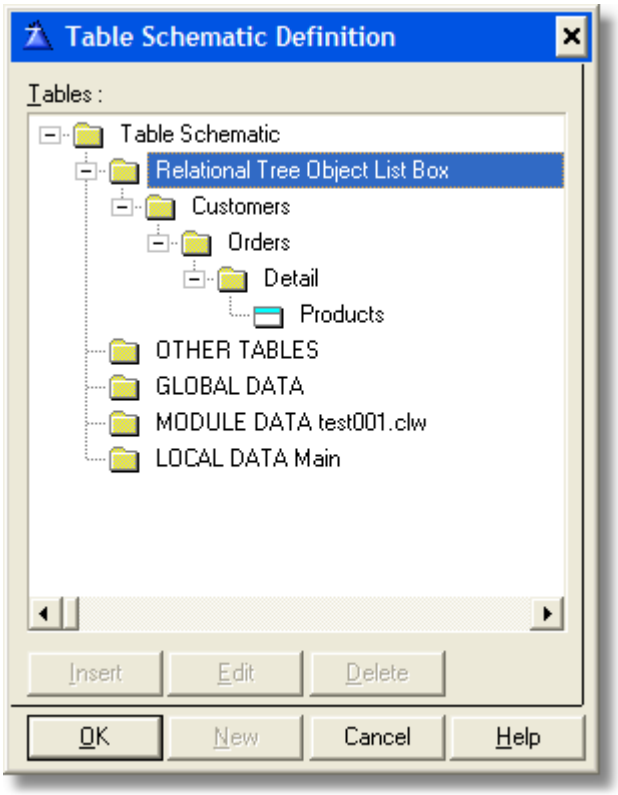
The buttons allow you to declare local variables for this method and/or the code for the method. Both of these buttons take you to the proper embed points.



The point of showing you these dialogs is that without templates generating these points, you are required to fill in these manually. This requires a slight alteration of the template code shown previously to generate the class definition.

```
#AT(%LocalDataClasses),WHERE(%ControlTemplate='RelationalTree(CBook)')
  #FIX(%File,%Primary)
  #CALL(%AddMethods,'Load' & %File,'()')
  #FOR(%Secondary),WHERE(%SecondaryTo = %File
        AND %SecondaryType = 'MANY:1')
    #FIX(%File,%Secondary)
    #CALL(%AddMethods,'Load' & %File,'()')
  #ENDFOR
  #CALL(%SetClassItem(ABC), 'RTree' & %ActiveTemplateInstance)
  #INSERT(%GenerateClass(ABC), 'RTree' & %ActiveTemplateInstance,
          'Local instance and definition'),NOINDENT
#ENDAT
```

The %Primary is the file listed first in the table schematic. For example, a developer may want to add these files to it:



Thus, the value of %Primary would be *Customers*. The next file is related to it. Thus #FIX sets or assigns the value of %Primary to %File. Next a call to %AddMethods, which is a local #GROUP (more on that shortly). That simply generates the proper method declaration.

The #FOR loop is filtered by the WHERE clause and ensures that only related files are considered. It also makes the same call to %AddMethods, but only for related files.

The #GROUP code is listed below:

```
#GROUP(%AddMethods,%pMethodName,%pMethodPrototype),AUTO
#DECLARE(%MethodsPresent)
#DECLARE(%LastNewMethodsInstance)
#SET(%MethodsPresent,0)
#SET(%LastNewMethodsInstance,0)
#FOR(%NewMethods)
  #SET(%LastNewMethodsInstance,%NewMethods)
  #IF(UPPER(CLIP(%NewMethodName))=UPPER(CLIP(%pMethodName)) AND
       UPPER(CLIP(%NewMethodPrototype))=UPPER(CLIP(%pMethodPrototype)))
     #SET(%MethodsPresent,1)
    #BREAK
  #ENDIF
#ENDFOR
#IF(%MethodsPresent=0)
  #ADD(%NewMethods,%LastNewMethodsInstance+1)
  #SET(%NewMethodName,%pMethodName)
  #SET(%NewMethodPrototype,%pMethodPrototype)
#ENDIF
#SET(%DeriveFromBaseClass,%True)
```

The AUTO attribute opens a new scope for the group. This means that any #DECLARE statements in the #GROUP would not be available to the #PROCEDURE being generated. In other words, this is a way to define local (to the #GROUP) symbols.

The first lines define new, local instance only symbols, followed by code that sets their initial values.

The #FOR loop executes as long as there are values in %NewMethods. The #IF guarantees an accurate comparison by testing upper case letters. If there is a match, then the %MethodsPresent flag is set and since there is no longer a need to loop, a #BREAK is issued. Otherwise, the #FOR loop ends naturally once all values are read. Which means the %MethodsPresent flag is not set.

The next #IF tests to see if the %MethodsPresent is not set. If that is true, then increment the number of %NewMethods and set their names. The last act is to set the **DERIVE?** check box.

What this all means is that the class dialog box adds all the new methods to the class definition and these are visible in the dialogs as the previous illustrations show. It means the developer does not have to do any extra work.

This whole exercise is one way to replace the %InstancePrefix:Load:%TreeLevelFile ROUTINE in the ABC and Clarion template chains.

Clarion 5.5 vs Clarion 6

Due to the pre-emptive threading model added to Clarion 6, the template code for generating class definitions is different between the two versions.

CLASS structures can now have the THREAD attribute. To be accurate, you may add it to the CLASS in 5.5, but it does nothing.

Here is the 5.5 version of the %GenerateClass group:

```
#GROUP(%GenerateClass, %Tag, %ClassComment = '', %AsType = %False)
  #ASSERT(%Tag <> '', '%GenerateClass: object Tag is blank!')
  #CALL(%SetClassItem, %Tag)
  #CALL(%GenerateClassDefinition, %ClassLines,
        %ClassComment, %AsType)
```

Compare with the Clarion 6 version:

```
#GROUP(%GenerateClass, %Tag, %ClassComment = '',
       %AsType = %False, %Attrs = '')
  #ASSERT(%Tag <> '', '%GenerateClass: object Tag is blank!')
  #CALL(%SetClassItem, %Tag)
  #CALL(%GenerateClassDefinition, %ClassLines, %ClassComment,
        %AsType, %Attrs)
```

There is an extra parameter, %Attrs. Its use is for adding the THREAD attribute as part of a CLASS declaration as shown below:

```
#INSERT(%GenerateClass, 'ErrorManager', 'Global error manager',
        %False, 'THREAD')
```

Keep in mind that THREAD is not appropriate for any CLASS declared with the TYPE attribute.

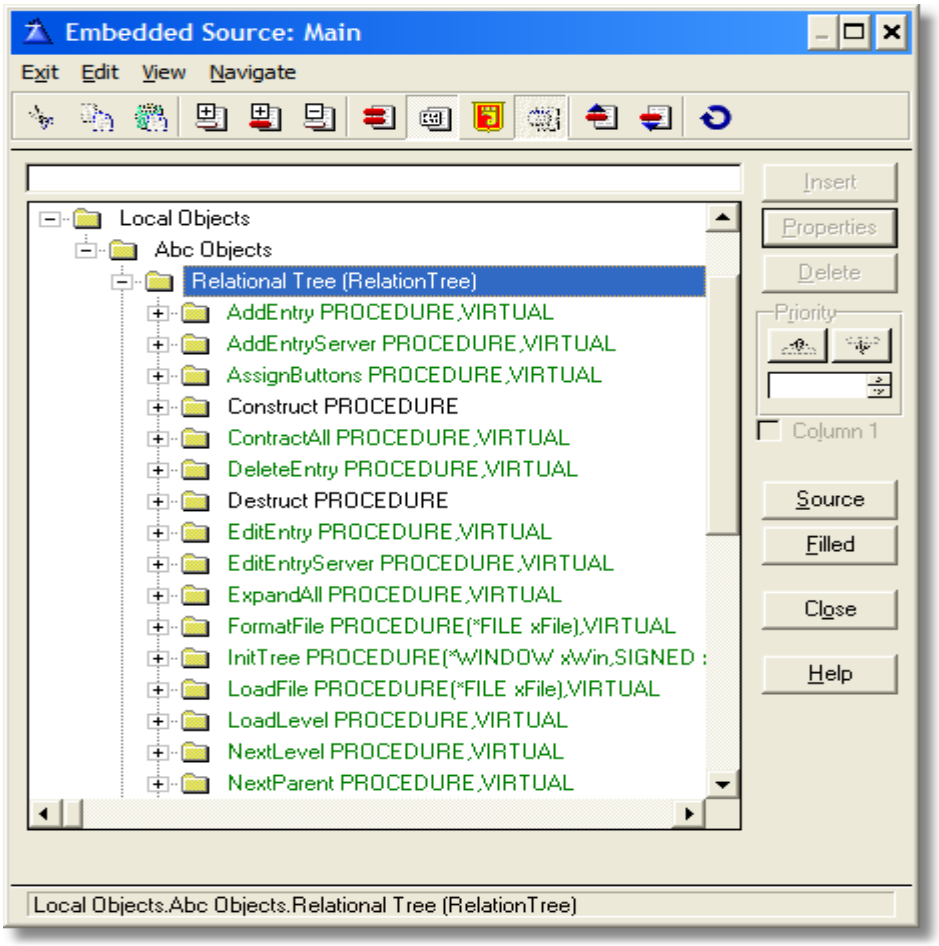
If you would like to add the THREAD attribute after the 5.5 declarations (where appropriate), you have to edit the shipping templates or make your own group.

Generating the embed tree

In order to properly place embed points for public and virtual methods in your class definition, you need some template code to ensure this happens. I've wrapped the line for readability, but the #CALL statement is really on one line:

```
#AT(%ProcedureRoutines),WHERE(%ControlTemplate='RelationalTree(CBook)')
  #CALL(%GenerateVirtuals(ABC),
        'RTree' & %ActiveTemplateInstance,
        'Local Objects|Abc Objects|Relation Tree',
        '%EmbedVirtuals(CBook)')
#ENDAT
```

Notice the same WHERE clause. You want the embed tree to appear for the proper instance. The %GenerateVirtuals from ABC is the key to this. Thus, you get an embed tree that looks similar to this one:



Notice how it appears next to any other local objects. This sets up added embed code to any method for the Relation Tree.

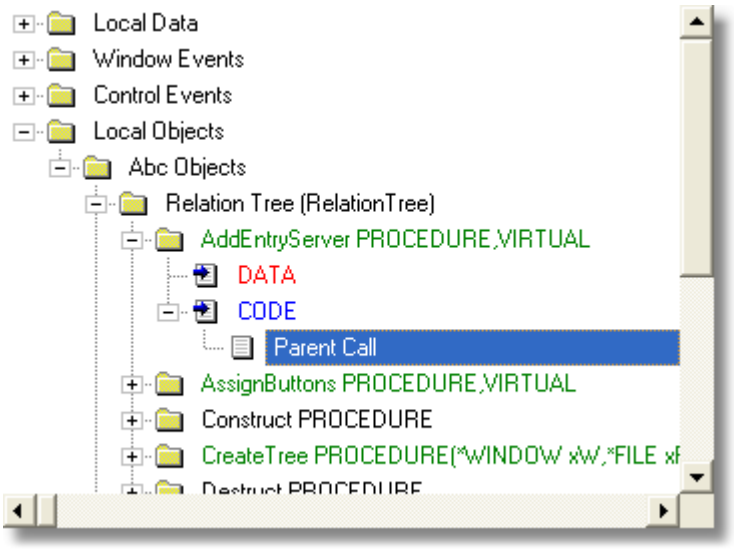
How to Call the Parent

All the methods generated by the templates contain a call to their PARENT method. This code should *always* be generated at a PRIORITY of 5000; this ensures that there is plenty of 'embed space' around the parent call for other code. Where the method is defined to return a value, a method local variable (of the correct type, or reference) called *ReturnValue* is automatically created and a RETURN *ReturnValue* statement is automatically generated at the end of the procedure.

To trigger the generation of this code, a call to %GenerateParentCall should be made inside *every* method of *every* object – this is easily done by adding the following code inside an #AT for every object inside the current template. With any class, there should always be a provision to call the parent class. This is quite easy with template code. Inspect the following code (wrapped for readability):

```
#AT(%TreeClassMethodCodeSection,%ActiveTemplateInstance),
      PRIORITY(5000),
      DESCRIPTION('Parent Call'),WHERE(%ParentCallValid())
  #CALL(%GenerateParentCall(ABC))
#ENDAT
```

This produces the following embed point in the tree (in all embeds, just one is illustrated):



What this gives you is the ability to add your own code before the parent method is called or after it is called, depending on how you want the overriden behavior to work.

Adding Embed Points

This is the code that actually enumerates the embeds for each method and property in your class (provided it is not private). This code is essentially the same for global and local objects and is duplicated for each object. Where an object is dependent upon some other symbol, this must be reflected in the #EMBED statements.

The following code generates all the embeds for the *Tree* object (wrapped for readability):

```
#IF(%BaseClassToUse())
  #CALL(%FixClassName(ABC),%BaseClassToUse())
  #FOR(%pClassMethod)
    #FOR(%pClassMethodPrototype),WHERE(%MethodEmbedPointValid())
      #CALL(%SetupMethodCheck(ABC))
      #EMBED(%TreeMethodDataSection,
             'Relation Tree Method Data Section '),
             %ActiveTemplateInstance,
              ,%pClassMethod,%pClassMethodPrototype,LABEL,DATA,
           PREPARE(,%FixClassName(%FixBaseClassToUse('RelationTree'))),
             TREE(%GetEmbedTreeDesc('TREE','DATA '))
       #?CODE
       #EMBED(%TreeMethodCodeSection,
              'Relation Tree Method Executable Code Section'),
              %ActiveTemplateInstance,
              %pClassMethod,%pClassMethodPrototype,
            PREPARE(,%FixClassName(%FixBaseClassToUse('RelationTree'))),
              TREE(%GetEmbedTreeDesc('TREE','CODE'))
       #CALL(%CheckAddMethodPrototype(ABC),%ClassLines)
    #ENDFOR
  #ENDFOR
  #CALL(%GenerateNewLocalMethods(ABC),'TREE',%True)
#ENDIF
```

You must consistently use the object tag as it is passed to %SetClassItem and to %FixBaseClassToUse on both #EMBEDs. The %GetEmbedTreeDesc call takes parameters to describe how to structure the embed tree for this embed point. Valid values for the first parameter are currently hard coded into the #GROUP – this may change in the future!

The WHERE clause on the inner #FOR loop enforces that the method in question is valid for embedding. For example, is not private. I've color coded these calls like template commands rather than symbols. These are really #GROUP structures, thus they can be built like functions, i.e. they return values. This is a small subtlety of the template language, but it means that one can build some very powerful functions.

If %True is passed as a parameter, it further enforces that *only* virtual methods of the class in question are made available – this is used by the file and relation managers, for example. The last, but one line calls %GenerateNewLocalMethods, which is responsible for generating embed points for any new methods that the user has added to the object.

The first parameter describes how to structure the embed point in the embed tree and is the same as the first parameter to %GetEmbedTreeDesc. The second parameter is %True when this is a global object, or omitted otherwise.

Note that these are procedure local objects and that there are additional #EMBED dependencies; namely %ActiveTemplateInstance (a procedure can have multiple browses) .

These #EMBED dependencies must generally align with the dependencies of the #WITH statement for this object. Procedure local objects usually have an implied dependency upon %ActiveTemplateInstance.

For procedure local objects this code should appear inside a #AT that points to the %LocalProcedures embed point. For global objects, it should appear inside an #AT that points to the %ProgramProcedures embed point.

The Relation Tree template wrapper does not use global data, thus is not needed. However, if your templates need to generate a declaration in the global data area, the following code generates the object declaration (using the *Web Guar*d template):

```
#AT(%GlobalData),WHERE(%GuardEnabled)
  #INSERT(%GenerateClass(ABC),'Guard','Application Security Guard')
#ENDAT
```

The second parameter is the tag of the object to generate; the third parameter simply gets generated as a comment on the class declaration line. Optionally, you may pass %True as a third parameter that will force the object to be generated as a TYPE (i.e., TYPE is appended to the declaration). Global objects should be generated at the %GlobalData embed point, local objects should be generated at the %LocalDataClasses embed point.

The following *WebBuilder* example generates a number of procedure local objects: note that the objects based upon %Control are generated as class types.

```
#AT(%LocalDataClasses),WHERE(%ProcedureHasWebWindow())
  #INSERT(%GenerateClass(ABC),'WebWindowManager')
  #IF(%IsFrame())
    #INSERT(%GenerateClass(ABC),'WebFrameManager')
  #ENDIF
  #IF(%HasQBE())
    #INSERT(%GenerateClass(ABC),'QBEWebWindowManager')
  #ENDIF
  #FOR(%Control),WHERE(%Control <> '')
    #CALL(%SetClassItem(ABC),%Control)
    #IF(ITEMS(%ClassLines))
      #INSERT(%GenerateClass(ABC),
              %Control,'Web Control Manager for ' & %Control,%True)
    #ENDIF
  #ENDFOR
#ENDAT
```

Scoping Issues

As you have seen, %ClassItem is a symbol defined whenever objects are generated by the templates. All template code is executed in the context of its own local %ClassItem. This means that from any given template section (#EXTENSION, #CONTROL, etc.) you can only 'see' your own %ClassItem.

Since you cannot see the %ClassItem of anything else, you cannot #FIX it using a tag that you did not create locally – this is why global objects have their names fixed. You would never be able to fix %ClassItem of the Application (or global extension) to the correct tag, and therefore you would always get generation errors reporting; '*%SetClassItem: Instance not found!*'

The most usual reason to attempt to #FIX an external %ClassItem is to get at the object name. Declaring a local variable inside the parent component and copying the object name into it can achieve this. For example:

```
#DECLARE(%ManagerName)
#FIX(%ClassItem,'Default')
#SET(%ManagerName,%ThisObjectName)
```

Providing that this is done early enough, usually in #ATSTART, and that the child template has the REQ attribute (requiring the parent template), the child can 'see' the declared variables of its parent – hence they have the object name.

The Remaining Control Template Code

Now that the wrapper portion is done, time to turn your attention to the rest of the control template. Since the class is for a relation tree, this is a control on a window, thus the name of the template.

What follows next is the actual Clarion code placed on the window structure. It does this by the CONTROLS statement.

```
#! Add target language code for a generic list box with tree, color
and icon attributes
  CONTROLS
    LIST,AT(,,150,100),USE(?RTree),FORMAT('800L*IT@s200@'),FROM(QTree),#REQ
  END
#! end controls
```

The #REQ attribute in this section means that if you delete the control from the window, then all template code goes with it. If you've added embedded code in this control's embed points, they are not deleted, but moved to an orphaned section of the embed tree. You see this section only when orphaned embeds exist.

The Control Interface Dialogs

The next section simply copies all of the #TABs, #BUTTONs, etc from the ABC version. No need to code something that already exists. Besides, the point of the class and the template is to mimic or duplicate the existing behavior exactly. The benefits of converting to a class and a template wrapper over the existing template should be obvious -- you may extend the behavior far easier and the templates are not driving everything -- that is the class' job.

For this template, I've added it as the first tab in the dialog section:

```
#TAB('&Setup Relation Tree')
  #!Add the developer dialogs
  #INSERT(%RelationTreeProperties)
#ENDTAB
```

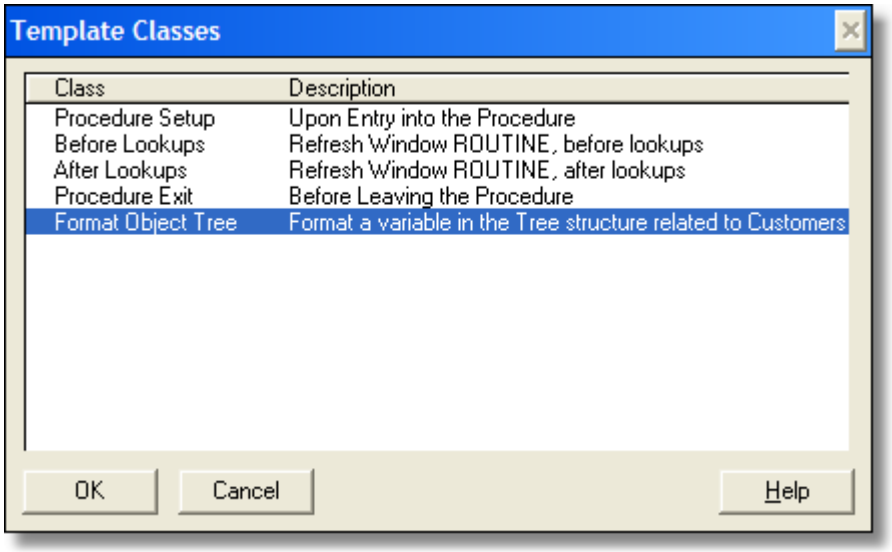
The group, %RelationTreeProperties is with the rest of the #GROUP definitions in the file *CBGroups.tpw*. You can tell this belongs to this template as it is not using the family attribute that you've seen so far. This code is "stolen" from ABRELTREE.TPW with a minor modification. Each icon entry also has a lookup button. Both ABC and Clarion template chains are strictly entry controls, making the template difficult to use.

Formula Editor

Not many programmers use this tool anymore, but there is template support for it. This is done with the #CLASS statement. Thus the following line (wrapped for readability):

```
#CLASS('Format Object Tree','Format a variable in the ' &
        %ActiveTemplateInstanceDescription)
```

The text is changed slightly so one may differentiate between the ABC tree if you place both relation trees on a window. It is theoretically possible to have both trees on the same window (but the control for both must be placed on the window first).



The Design of the Control Template

When considering the design of what a template might do, it is best to get some paper and itemize the major functions. What does the template produce if the developer adds nothing from the default control? What if the list supports colors?

While the dialog (what colors, icons, etc.) exposed to the developer really does not change, the ABRELTREE dialog template code could easily be copied and pasted to a

#GROUP. It is rather lengthy, so I tend to put such dialogs in #GROUPs. I like my template code segmented into functions, thus any maintenance I do is easier. If you run a test on a dummy application (which is smart during the coding and testing phase), you can see that the dialogs are exactly the same. Which is a good thing as anyone used to coding relational tree lists won't have anything new to learn.

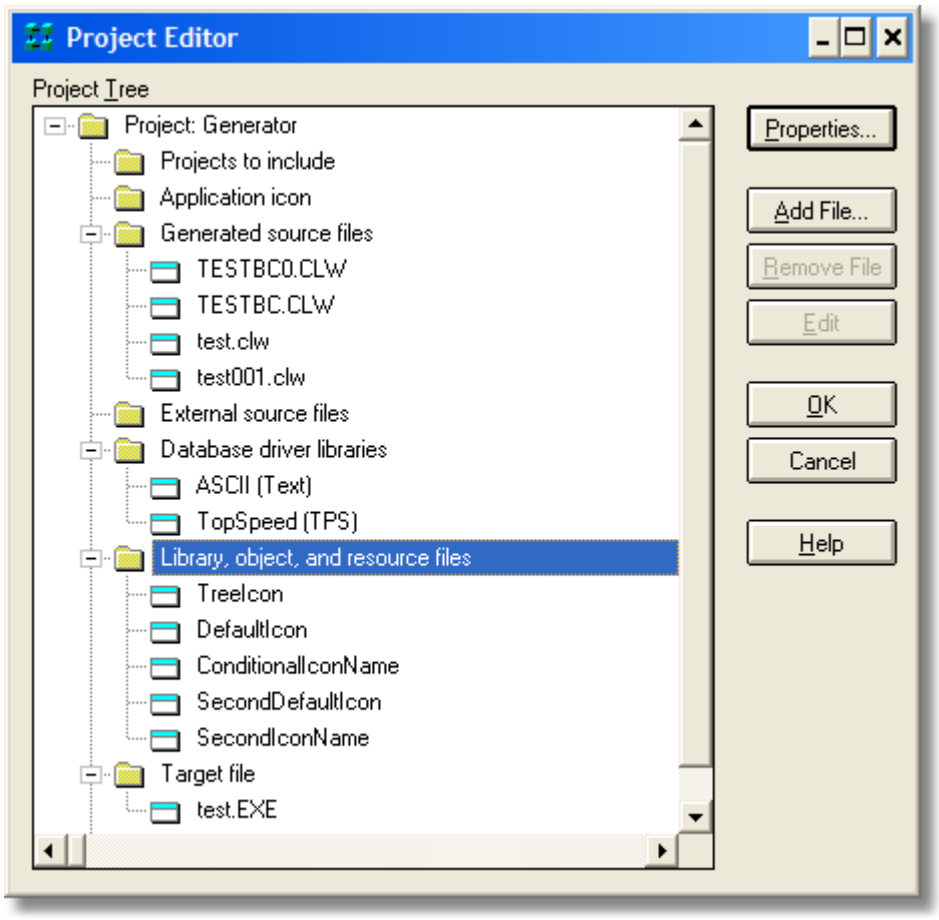
What about icons?

One of the best uses from a template is to do the dull, boring bits of code or tasks for your application. Adding icons to a project tree falls in this category. It is also easy to forget to do. Thus, you have this bit of template code to handle this task for you:

```
#AT(%CustomGlobalDeclarations)
  #INSERT(%FileControlSetFlags(ABC))
  #FOR(%Control),WHERE(%ControlInstance = %ActiveTemplateInstance)
    #IF(%ControlHasIcon)
      #IF(%TreeTitleIcon)
        #INSERT(%StandardAddIconToProject(ABC),%TreeTitleIcon)
      #ENDIF
      #IF(%PrimaryDefaultIcon)
        #INSERT(%StandardAddIconToProject(ABC),%PrimaryDefaultIcon)
      #ENDIF
      #FOR(%PrimaryConditionalIcons)
       #INSERT(%StandardAddIconToProject(ABC),%PrimaryConditionalIcon)
      #ENDFOR
      #FOR(%Secondary),WHERE(%SecondaryType = 'MANY:1')
        #IF(%SecondaryDefaultIcon)
         #INSERT(%StandardAddIconToProject(ABC),%SecondaryDefaultIcon)
         #ENDIF
        #FOR(%SecondaryConditionalIcons)
         #INSERT(%StandardAddIconToProject(ABC),%SecondaryConditionalIcon)
         #ENDFOR
      #ENDFOR
    #ENDIF
  #ENDFOR
#ENDAT
```

The key points from the above code is that each control instance matches the template instance (you could have more than one control on a window). Then add the icons to the project, the %CustomGlobalDeclarations point. But only if they have an icon. Notice also the testing for file types, either primary or a secondary file that has a many-to-one relationship. This keeps the icons constant for a given level of the tree. Lastly, if there are any conditional icon usage. The last thing you should note is that each group called has the ABC parameter as you are calling an ABC group.

I like loading my dialogs with dummy test data, so I can see if the code generated correctly (if at all!). Thus, my project tree for my test application appears as follows:



These “icons” were simply entered into the dialogs so I have some known values to test against. I’ve entered similar data for conditions and colors, again for testing to ensure the correct code generates at the correct time and in the correct locations.

Local Data Embed

There are some local data declarations needed. In this case there is not too much to keep track of. If there is navigation from the toolbar and the local QUEUE instance the relation tree gets its data. You can take care of all of this with one embed as follows:

```
#AT(%DataSection),PRIORITY(3500)
  #IF(%AcceptToolBarControl)
%[20]DerivedInstance    CLASS(%ToolbarRelTreeType)
TakeEvent            PROCEDURE(<*LONG VCR>,WindowManager WM),VIRTUAL
%[20]NULL END
%NULL
 #ENDIF
%[20]TreeQueue      QRelTree
%NULL
#ENDAT
```

The #IF tests to see if toolbar navigation is in use; if so, generate the Clarion code to declare and instantiate a derived class with an overridden method.

The second Clarion line (after the #ENDIF), declares the local instance of the TYPE QUEUE. The [20] means that no matter how short the %TreeQueue generated value is, generate its name and ensure that the next generated code has no more than 20 spaces after it (including the characters for the %TreeQueue value). This is simply a good way to keep labels aligned and counts only for neatness. The %NULL is an internal symbol. In this instance it is used to align closing END statements and add empty lines to the generated source. Declarations bunched up together are hard to read.

ThisWindow.Init()

This is a locally derived ABC method. This is where all setup actions are performed. Since *ThisWindow.Init()* is executed only once per procedure run, this is an ideal place to add some embeds to set up the relation tree.

First, ensure the toolbar knows about the relation tree (wrapped for easier reading):

```
#AT(%WindowManagerMethodCodeSection,'Init','(),BYTE'),
      PRIORITY(8500),
      WHERE(%AcceptToolBarControl AND %IsFirstInstance)
Toolbar.AddTarget(%InstancePrefix, %TreeControl)
%InstancePrefix.AssignButtons
#ENDAT
```

Notice the WHERE statement. If there is a toolbar and this is the first instance of one, then call the toolbar's *AddTarget* method so the toolbar "knows" about the relation tree control. Then call the *AssignButtons* method, which is one of the methods of the *Relation Tree* class. The %InstancePrefix is the label of the local derived class. The default is *RTree1*.

The tree control should be set in contract mode as this is the expected state and it makes the window ready for use faster. Thus, you need this template code:

```
#AT(%WindowManagerMethodCodeSection,'Init','(),BYTE'),PRIORITY(7500)
#!Start tree list in contracted mode
%InstancePrefix.ContractAll()
#ENDAT
```

The next bit of template code takes care of what to do with icons, if any:

```
#AT(%WindowManagerMethodCodeSection,'Init','(),BYTE'),PRIORITY(8500)
#FIX(%Control,%TreeControl)
#IF(%ControlHasIcon)
  #FOR(%IconList),WHERE(%IconListType <> 'Variable')
    #SET(%ValueConstruct,INSTANCE(%IconList))
    #IF(%IconListType = 'Built-In')
%TreeControl{PROP:IconList,%ValueConstruct} = %IconList
    #ELSIF(%IconListType = 'File')
%TreeControl{PROP:IconList,%ValueConstruct} = '~%IconList'
    #ENDIF
  #ENDFOR
#ENDIF
%TreeControl{PROP:Selected} = True
#ENDAT
```

#FIX is similar to #SET. The #FIX statement fixes the current value of the multi-valued symbol (1st parameter) to the value contained in the 2nd parameter. This is done so that one instance of the symbol may be referenced outside a #FOR loop structure, or so you can reference the symbols dependent upon the multi-valued symbol.

The #FOR statement generates the icon list for the tree control only if the icons are not contained in a variable. In this case, there will be one of two lines generated as icons may be stored internally or referenced externally.

The last bit generates code to ensure the relation list control is selected, or has focus.

The next embed in the *Init* method sets up the alerted keys for the keyboard:

```
#AT(%WindowManagerMethodCodeSection,'Init','(),BYTE'),PRIORITY(8750)
  #IF(%ExpandKeyCode)
%TreeControl{PROP:Alrt,255} = %ExpandKeyCode
  #ELSE
%TreeControl{PROP:Alrt,255} = CtrlRight
  #ENDIF
  #IF(%ContractKeyCode)
%TreeControl{PROP:Alrt,254} = %ContractKeyCode
  #ELSE
%TreeControl{PROP:Alrt,254} = CtrlLeft
  #ENDIF
  #IF(%UpdatesPresent)
%TreeControl{PROP:Alrt,253} = MouseLeft2
  #ENDIF
#ENDAT
```

All that code does is allow the developer assigned alert keys to be used or use the default values. The last bit of code detects if the relation tree is updatable. If it is, then alert the left button double click as the method to go to edit mode.

The generated code looks similar to this (depending on procedure type, name and other controls you may place on a window):

```
ThisWindow.Init PROCEDURE
ReturnValue          BYTE,AUTO

  CODE
  GlobalErrors.SetProcedureName('Main')
  SELF.Request = GlobalRequest
  ReturnValue = PARENT.Init()
  IF ReturnValue THEN RETURN ReturnValue.
  SELF.FirstField = ?RTree
  SELF.VCRRequest &= VCRRequest
  SELF.Errors &= GlobalErrors
  SELF.AddItem(Toolbar)
  CLEAR(GlobalRequest)
  CLEAR(GlobalResponse)
  RTree1.ContractAll
  OPEN(Window)
  SELF.Opened=True
  Toolbar.AddTarget(RTree1, ?RTree)
  RTree1.AssignButtons
  ?RTree{PROP:Selected} = True
  ?RTree{PROP:Alrt,255} = CtrlRight
  ?RTree{PROP:Alrt,254} = CtrlLeft
  SELF.SetAlerts()
  RETURN ReturnValue
```

I've added the emphasis on the lines that this template generated.

ThisWindow.Kill()

There may be times you don't need code placed in the *Kill* method. In this design there is. Since some reference assignments were made, it makes sense to use the *Kill* method to clean up after them. Or you may want a local destructor, it really is your choice. The code for this is simple:

```
#AT(%WindowManagerMethodCodeSection,'Kill','(),BYTE'),PRIORITY(8200)
%InstancePrefix.QRT &= NULL
%InstancePrefix.LDQ &= NULL
#ENDAT
```

This generates code, fairly late in the method to de-reference the two local QUEUE structures.

Window Event Handling

EVENT:GainFocus

If you need to trap for window events, then ensure your template produces the code for it. The design of the tree list ensures that if the user switches to another window and then comes back, the code must ensure the tree list is properly updated. This is to ensure that the other window did not update something.

```
#AT(%WindowEventHandling,'GainFocus')
%InstancePrefix.CurrentChoice = CHOICE(%TreeControl)
GET(%TreeQueue,%InstancePrefix.CurrentChoice)
%InstancePrefix.NewItemLevel = %InstancePrefix.QRT.Level
%InstancePrefix.NewItemPosition = %InstancePrefix.QRT.Position
%InstancePrefix.RefreshTree()
#ENDAT
```

The %InstancePrefix symbol is used instead of SELF as this method is outside of the tree class. When the window gains focus, set the current choice (highlighted item). Using that value, GET that item from the tree queue. Assign the level and position values to the class properties and call the *RefreshTree* method.

Control Event Handling

EVENT:NewSelection

List controls generate events. Thus, you need to have template code that generates proper Clarion code to address this issue. This section of code handles the *NewSelection* event:

```
#AT(%ControlEventHandling,%TreeControl,'NewSelection')
  #IF(%UpdatesPresent OR %GiveExpandContractOption)
IF KEYCODE() = MouseRight
    #IF(%UpdatesPresent AND %GiveExpandContractOption)
  EXECUTE(POPUP('%'InsertPopupText|%'ChangePopupText|%'DeletePopupText|-
|%'ExpandPopupText|%'ContractPopupText'))
    %InstancePrefix.AddEntry
    %InstancePrefix.EditEntry
    %InstancePrefix.RemoveEntry
    %InstancePrefix.ExpandAll
    %InstancePrefix.ContractAll
  END
    #ELSIF(%UpdatesPresent)
  EXECUTE(POPUP('%'InsertPopupText|%'ChangePopupText|%'DeletePopupText'))
    %InstancePrefix.AddEntry
    %InstancePrefix.EditEntry
    %InstancePrefix.RemoveEntry
  END
    #ELSE
  EXECUTE(POPUP('%'ExpandPopupText|%'ContractPopupText'))
    %InstancePrefix.ExpandAll
    %InstancePrefix.ContractAll
  END
    #ENDIF
END
  #ENDIF
#ENDAT
```

This code simply tests if the %UpdatesPresent or %GiveExpandContractOption values are true, and if so, generate the IF KeyCode() structure. Within that structure, if both of those values are true, then execute a POPUP menu that allows, insert, change, delete and expand and contract the current node.

If only %UpdatesPresent, then generate only the insert, change and delete POPUP menu. Otherwise, generate only the expand and contract POPUP menu.

In all cases, an EXECUTE structure generates for each condition and calls a method of the local instance of the relation tree class.

EVENT:Expanded and EVENT:Contracted

If the user expands or contracts the tree, the template must generate code to account for those actions. The following code accomplishes these tasks:

```
#AT(%ControlEventHandling,%TreeControl,'Expanded')
%InstancePrefix.LoadLevel
#ENDAT
#!-------------------------------------------------
#AT(%ControlEventHandling,%TreeControl,'Contracted')
%InstancePrefix.UnloadLevel
#ENDAT
```

EVENT:AlertKey

The next event is the alert key handling. This template code handles this event:

```
#AT(%ControlEventHandling,%TreeControl,'AlertKey')
CASE KEYCODE()
  #IF(%ExpandKeyCode)
OF %ExpandKeyCode
  #ELSE
OF CtrlRight
  #ENDIF
  %TreeControl{PROPLIST:MouseDownRow} = CHOICE(%TreeControl)
  POST(EVENT:Expanded,%TreeControl)
  #IF(%ContractKeyCode)
OF %ContractKeyCode
  #ELSE
OF CtrlLeft
  #ENDIF
  %TreeControl{PROPLIST:MouseDownRow} = CHOICE(%TreeControl)
  POST(EVENT:Contracted,%TreeControl)
  #IF(%UpdatesPresent)
OF MouseLeft2
  %InstancePrefix.EditEntry
  #ENDIF
END
#ENDAT
```

Other Events

The generated code for the last two sections goes in the ABC *ThisWindow.TakeFieldEvent* method. Here is a partial listing of what it may look like:

```
CASE FIELD()
OF ?RTree
  CASE EVENT()
  OF Event:AlertKey
    CASE KEYCODE()
    OF CtrlRight
      ?RTree{PropList:MouseDownRow} = CHOICE(?RTree)
      POST(Event:Expanded,?RTree)
    OF CtrlLeft
      ?RTree{PropList:MouseDownRow} = CHOICE(?RTree)
      POST(Event:Contracted,?RTree)
    END
  END
END
ReturnValue = PARENT.TakeFieldEvent()
CASE FIELD()
OF ?RTree
  CASE EVENT()
  OF EVENT:Expanded
    RTree1.LoadLevel
  OF EVENT:Contracted
    RTree1.UnloadLevel
  END
END
```

The last event handler is the *OtherEvent* embed. This is an ABC embed where you may process other events not handled normally, such as user-defined events or any event in which you may embed a POST message. Think of it as a catch-all embed for events not otherwise handled by the templates.

```
#AT(%ControlOtherEventHandling,%TreeControl)
  #SET(%ValueConstruct,%True)
  #FOR(%ControlEvent),WHERE(%ControlEvent = 'AlertKey')
    #SET(%ValueConstruct,%False)
  #ENDFOR
  #IF(%ValueConstruct)
CASE EVENT()
OF EVENT:AlertKey
  CASE KEYCODE()
    #IF(%ExpandKeyCode)
  OF %ExpandKeyCode
    #ELSE
  OF CtrlRight
    #ENDIF
    %TreeControl{PROPLIST:MouseDownRow} = CHOICE(%TreeControl)
    POST(EVENT:Expanded,%TreeControl)
    #IF(%ContractKeyCode)
  OF %ContractKeyCode
    #ELSE
  OF CtrlLeft
    #ENDIF
    %TreeControl{PROPLIST:MouseDownRow} = CHOICE(%TreeControl)
    POST(EVENT:Contracted,%TreeControl)
    #IF(%UpdatesPresent)
  OF MouseLeft2
    %InstancePrefix.EditEntry
    #ENDIF
  END
END
  #ENDIF
#ENDAT
```

The above code should be obvious as it is merely a different twist on what you've read before.

The Generation of Method Code

The next task is to generate the methods. There are several ways to do this depending on the overall task of what is needed. First, let's get the toolbar out of the way:

```
#AT(%LocalProcedures),WHERE(%AcceptToolbarControl)
%DerivedInstance.TakeEvent PROCEDURE(<*LONG VCR>,WindowManager WM)
  CODE
  CASE ACCEPTED()
  OF Toolbar:Bottom TO Toolbar:Up
    SELF.Control{PROPLIST:MouseDownRow} = CHOICE(SELF.Control)
    EXECUTE(ACCEPTED()-Toolbar:Bottom+1)
      %InstancePrefix.NextParent
      %InstancePrefix.PreviousParent
      %InstancePrefix.NextLevel
      %InstancePrefix.PreviousLevel
      %InstancePrefix.NextRecord
      %InstancePrefix.PreviousRecord
    END
  #EMBED(%ReltreeToolbarDispatch,'RelObjTree Toolbar
Dispatch'),%ActiveTemplateInstance,HIDE
  ELSE
    PARENT.TakeEvent(VCR,%WindowManagerObject)
  END
#ENDAT
```

This template code generates only when there is a need to navigate the tree list by the toolbar navigation method. Notice that depending on the toolbar button pressed, the EXECUTE structure calls one of the derived *RelationTree* methods. The %LocalProcedures symbol means the local objects for this procedure.

The RelationTree Methods

AssignButtons

The method assigns the toolbar buttons to the tree list control. The template code to do this is as follows:

```
#AT(%TreeClassMethodCodeSection,%ActiveTemplateInstance,'AssignButtons','()'),
WHERE(%AcceptToolbarControl)
#EMBED(%AssignToolbarButtons,'Assign Toolbar
Buttons'),%ActiveTemplateInstance,HIDE
Toolbar.SetTarget(%TreeControl)
#ENDAT
```

RefreshTree

The template code below generates applicable code to refresh the tree:

```
#AT(%TreeClassMethodCodeSection,%ActiveTemplateInstance,'RefreshTree','()')
FREE(%TreeQueue)
SELF.Load%Primary()
IF SELF.NewItemLevel
  SELF.CurrentChoice = 0
  LOOP
    SELF.CurrentChoice += 1
    GET(%TreeQueue,SELF.CurrentChoice)
    IF ErrorCode() THEN BREAK.
    IF ABS(SELF.QRT.Level) <> ABS(SELF.NewItemLevel) THEN CYCLE.
    IF SELF.QRT.Position <> SELF.NewItemPosition THEN CYCLE.
    SELECT(%TreeControl,SELF.CurrentChoice)
    BREAK
  END
END
#ENDAT
```

In the class, this is stub method. Almost all of this code could be in the class, but the primary file is not known to the class and neither is the tree control or the tree's data queue. You could add some properties to the class to represent these items and use those properties. In this case, the template code for the *RefreshTree* is not needed. However, you will need to change some of the class methods. If you feel a little adventurous, consider this an exercise.

ContractAll / ExpandAll

These two template embeds are rather interesting. This shows a concept about what code goes in a class and what code the templates are responsible for.

```
#AT(%TreeClassMethodCodeSection,%ActiveTemplateInstance,'ContractAll','()')
SELF.Load%Primary()
#ENDAT
#AT(%TreeClassMethodCodeSection,%ActiveTemplateInstance,'ExpandAll','()')
SELF.Load%Primary()
SELF.LoadAll = False
#ENDAT
```

The point here is that this code generates after the parent call. If you inspect the method code in the class, it appears as incomplete. And this template code appears incomplete too. But after generation, the two bodies of code are really "merged".

LoadLevel

This embed produces the code responsible for loading one level of the tree. It gets called after a user presses the + button on a tree.

```
#AT(%TreeClassMethodCodeSection,%ActiveTemplateInstance,'LoadLevel','()')
SELF.CurrentChoice = %TreeControl{PROPLIST:MouseDownRow}
GET(%TreeQueue,SELF.CurrentChoice)
IF ~SELF.QRT.Loaded
  SELF.QRT.Level = ABS(SELF.QRT.Level)
  PUT(%TreeQueue)
  SELF.QRT.Loaded = True
  SELF.LDQ.LoadedLevel = ABS(SELF.QRT.Level)
  SELF.LDQ.LoadedPosition = SELF.QRT.Position
  ADD(SELF.LDQ,SELF.LDQ.LoadedLevel,SELF.LDQ.LoadedPosition)
  EXECUTE(ABS(SELF.QRT.Level))
  #FOR(%TreeLevelFile)
    BEGIN
    #IF(%TreeLevel=1)
      #IF(%PrimaryKey)
      REGET(%PrimaryKey,SELF.QRT.Position)
       #ELSE
      REGET(%Primary,SELF.QRT.Position)
       #ENDIF
    #ELSE
      REGET(%TreeLevelFile,SELF.QRT.Position)
    #ENDIF
      SELF.FormatFile(%TreeLevelFile)
    END
  #ENDFOR
  END
  PUT(%TreeQueue)
  EXECUTE(ABS(SELF.QRT.Level))
  #FOR(%TreeLevelFile),WHERE(INSTANCE(%TreeLevelFile) > 1)
    SELF.Load%TreeLevelFile()
  #ENDFOR
  END
END
#ENDAT
```

The assumption is that the mouse down row is accurate enough to get the current choice. This is retrieved from the data queue structure. If the *Loaded* flag is not set, then an assignment of the current level is passed to the queue structure and written back. The *Loaded* flag is set to true. The loaded queue structure gets its data from the data queue.

Based on the level, an EXECUTE structure is entered. For every file in the tree, the template builds a BEGIN END structure. Inside these structures, there are only two lines of code generated, one to REGET and the other to format that file's data.

Inside the BEGIN structure, the template tests to see if this is the first file in the table schematic. If it is, then another test to see if a key is also in the schematic. If there is, then a REGET statement is generated based on the key. Otherwise, it is file based. The remaining files in the table schematic use the file based REGET form.

After the format call, the changed queue data is written back to the queue. Then a final EXECUTE structure generates to load the current child file.

UnloadLevel

This embed is almost the same as the *LoadLevel* embed. The purpose of this embed is to remove data from the queue structures when the user presses the - button on the tree.

```
#AT(%TreeClassMethodCodeSection,%ActiveTemplateInstance,'UnloadLevel','()')
  SELF.CurrentChoice = %TreeControl{PROPLIST:MouseDownRow}
  GET(%TreeQueue,SELF.CurrentChoice)
  IF SELF.QRT.Loaded
    SELF.QRT.Level = -ABS(SELF.QRT.Level)
    PUT(%TreeQueue)
    SELF.QRT.Loaded = False
    SELF.LDQ.LoadedLevel = ABS(SELF.QRT.Level)
    SELF.LDQ.LoadedPosition = SELF.QRT.Position
    GET(SELF.LDQ,SELF.LDQ.LoadedLevel,SELF.LDQ.LoadedPosition)
    IF ~ErrorCode()
      DELETE(%LoadedQueue)
    END
    EXECUTE(ABS(SELF.QRT.Level))
  #FOR(%TreeLevelFile)
      BEGIN
    #IF(%TreeLevel=1)
      #IF(%PrimaryKey)
        REGET(%PrimaryKey,SELF.QRT.Position)
      #ELSE
        REGET(%Primary,SELF.QRT.Position)
      #ENDIF
    #ELSE
        REGET(%TreeLevelFile,SELF.QRT.Position)
    #ENDIF
        SELF.FormatFile(%TreeLevelFile)
      END
  #ENDFOR
    END
    PUT(%TreeQueue)
    SELF.CurrentLevel = ABS(SELF.QRT.Level)
    SELF.CurrentChoice += 1
    LOOP
      GET(%TreeQueue,SELF.CurrentChoice)
      IF ErrorCode() THEN BREAK.
      IF ABS(SELF.QRT.Level) <= SELF.CurrentLevel THEN BREAK.
      DELETE(%TreeQueue)
    END
  END
#ENDAT
```

This embed makes the same assumption *LoadLevel* does, in that the mouse down row property is accurate enough to detect which line of the tree to affect. The data queue item is retrieved by that value.

If the *Loaded* flag is true, the *Level* field is set to negative. The *Loaded* flag is then set to false. The data queue's fields are then primed and an attempt to get a record follows. If there is not an error, the current record is deleted.

The EXECUTE structure is then built exactly as *LoadLevel*. Unlike *LoadLevel*, there are two extra lines of code generated after the PUT. The current level is saved and the current choice is incremented by 1. This keeps the highlight bar at the same position.

The final act is to generate a LOOP structure. Its purpose is to remove all data items under the current node.

FormatFile

This embed appears at first glance, to not appear to do much work.

```
#AT(%TreeClassMethodCodeSection,%ActiveTemplateInstance,'FormatFile',
      '(*FILE xFile)')
  #FOR(%TreeLevelFile),WHERE(INSTANCE(%TreeLevelFile) = 1)
EXECUTE(ABS(SELF.QRT.Level))
  BEGIN
    #INSERT(%FormatPrimary)
  END
  #ENDFOR
  #FOR(%TreeLevelFile),WHERE(INSTANCE(%TreeLevelFile) > 1)
  BEGIN
    #INSERT(%FormatSecondary)
  END
  #ENDFOR
END
#ENDAT
```

This template code, to put it simply, generates an EXECUTE structure to determine which file in the schematic needs its data formatted so that it looks nice. It uses two #GROUP structures to accomplish this; %FormatPrimary and %FormatSecondary.

The reason for these two groups is that the template code to do either task is quite complex and slightly different. Therefore, it makes sense for a template programmer to use this technique. It does keep certain tasks segmented so that any maintenance you may need to do is easier.

These groups are responsible for ensuring the correct icons, conditional icons, colors, and conditional colors are properly set. Also, icons could be external file resources or linked into the current project. Feel free to inspect this code in the file *CBGroups.tpw*, located in the template folder.

Dynamic New Methods

This embed's responsibility is to ensure that the new methods have code for them. The new methods are placed in the new methods dialog for you as discussed earlier.

```
#AT(%NewMethodCodeSection,%ActiveTemplateInstance,%ClassItem,%NewMethods)
#IF (~(VAREXISTS(%PrimaryFlag)))
  #DECLARE(%PrimaryFlag,LONG)
#ENDIF
#IF (~(VAREXISTS(%NewInstance)))
  #DECLARE(%NewInstance,LONG)
#ENDIF
```

The above code looks to see if a symbol is declared. If not, it declares it. The reason for this is that this template code is "re-entrant", meaning that it gets executed many times. If this check is not done, you'll get complaints during source generation that a symbol is already declared.

```
#SET(%NewInstance,%NewInstance + 1)
#IF(%PrimaryFlag=0)
  #SET(%PrimaryFlag,%PrimaryFlag + 1)
  #SELECT(%TreeLevelFile,1)
  #IF(%TreeTitle)
SELF.QRT.Display = '%TreeTitle'
SELF.QRT.Loaded = False
SELF.QRT.Position = ''
SELF.QRT.Level = 0
    #INSERT(%IconGroup),NOINDENT
    #CALL(%ColorGroup)
ADD(%TreeQueue)
  #ENDIF
```

This section of template code increments the local symbols. In the Clarion language, simple incrementation is easy:

```
NewInstance += 1
```

However, the templates do not support that type of syntax. The #SET command must be used. It assigns a value to a user-defined symbol.

Next is a check to see if the %PrimaryFlag is zero, which it should be the first time this template code executes. If it is, then another #SET command to increment the current value. On the next pass, the template code after the #ELSE executes (a bit further in this code).

Select the first file in the schematic with the #SELECT statement. The #SELECT statement is really a form of #FIX, in that it fixes a symbol to an instance.

If there is a %TreeTitle (an entry on the tree dialog), then set the display accordingly. Since a tree title is not based on a file, it is not loaded, nor does it have any level values.

The next two lines of template code are different, but they are not different in functionality. #INSERT has an optional attribute, NOINDENT. This means any code in this #GROUP generates in the same column as the line above it. #CALL is the same as the #INSERT with the NOINDENT attribute.

```
Access:%Primary.UseFile()
  #IF(%PrimaryKey)
SET(%PrimaryKey)
  #ELSE
SET(%Primary)
  #ENDIF
LOOP
  #EMBED(%BeforePrimaryNext,
         'Relational Object Tree, Before NEXT on primary file'),
          %ActiveTemplateInstance,
           MAP(%ActiveTemplateInstance,
           %ActiveTemplateinstanceDescription),
          LEGACY
  IF Access:%Primary.Next() <> Level:Benign
    IF Access:%Primary.GetEOF()
      BREAK
    ELSE
      POST(EVENT:CloseWindow)
      RETURN
    END
  END
  #EMBED(%AfterPrimaryNext,
          'Relational Object Tree, After NEXT on primary file'),
          %ActiveTemplateInstance,
          MAP(%ActiveTemplateInstance,
          %ActiveTemplateinstanceDescription),LEGACY
```

The above code uses ABC method calls. If there is a key in the schematic, then the templates generate code to set read access by key. Otherwise, the access is set by record order.

A LOOP structure is then generated. Just inside the LOOP is an embed point. This has the LEGACY attribute on it, meaning that it won't appear in the embed tree until the developer presses the legacy button on the embed tree toolbar.

The next section of code tests an ABC call to see if reading the next record returns anything besides a LEVEL:Benign (no error). If it does, then test for end of file using an ABC method call. If it has reached the end of file, then break out of this loop. Any other error is deemed fatal and a close window event is posted to the current window, in effect closing the procedure.

Next is another legacy embed, which happens after a record is read successfully.

```
#IF(%PrimaryFilter)
  IF ~(%PrimaryFilter) THEN CYCLE.
#ENDIF
  SELF.QRT.Loaded = False
  #IF(%PrimaryKey)
  SELF.QRT.Position = POSITION(%PrimaryKey)
  #ELSE
  SELF.QRT.Position = POSITION(%Primary)
  #ENDIF
  SELF.QRT.Level = %TreeLevel
  #IF(%TreeChildFile)
    #INSERT(%TreeChildGroup),NOINDENT
    #SET(%PrimaryFlag,%True)
  #ELSE
  SELF.FormatFile(%TreeLevelFile)
  ADD(%TreeQueue,POINTER(%TreeQueue) + 1)
  #ENDIF
```

This section of code first tests to see if any filter is applied. If so, then code generates to cycle to the top of the loop if not filtered. The next #IF tests to see if a key is in effect, and if so, generate the correct code to use the key to determine the current position. Otherwise, use the file to determine the current position.

If this is a child file, then insert the code to handle child files. Then assign a true value to the %PrimaryFlag symbol to flag that primary file processing is completed. If this is not a child file, then call the FormatFile method, with the current file passed as a parameter. After returning from this method call, add any queue fields values to the queue structure, in sorted order.

The following template code executes when the %PrimaryFlag is not zero.

```
#ELSE
  #FOR(%TreeLevelFile),WHERE
       (INSTANCE(%TreeLevelFile) = %NewInstance)
    #FIX(%File,%TreeLevelFile)
    #FIX(%Secondary,%TreeLevelFile)
    #FIX(%Relation,%TreeParentFile)
    #FIX(%Key,%FileKey)
    #FOR(%RelationKeyField)
      #IF(%RelationKeyField)
  %RelationKeyFieldLink = %RelationKeyField
      #ELSE
        #FIX(%KeyField,%RelationKeyFieldLink)
        #IF(%KeyFieldSequence = 'ASCENDING')
  CLEAR(%RelationKeyFieldLink)
        #ELSE
  CLEAR(%RelationKeyFieldLink,1)
        #ENDIF
      #ENDIF
    #ENDFOR
```

The #FOR loop is an interesting bit of code. There is a WHERE clause attached to it, which is a template way of filtering. In this case, the filter is if the %TreeLevelFile instance equals the %NewInstance value. Remember, the %NewInstance is incremented every time this template code executes. Next a series of #FIX commands. #FIX is like the Clarion assignment of:

```
File = TreeLevelFile
Secondary = TreeLevelFile
```

and so forth. Next, another #FOR loop for each relating key field. If the current field is part of a relating key, then generate as many lines of code to prime the relating or matching values. Otherwise, if not a relating field, assign the linking field to the key field. This is for those occaisions where a custom relation is defined in the table schematic. The next logic branch determines how to generate the CLEAR statement, the default low value, or the option second parameter to clear to high values in the case of descending field sort order.

```
Access:%File.UseFile()
SET(%FileKey,%FileKey)
LOOP
  #EMBED(%BeforeSecondaryNext,
         'Relational Object Tree, Before NEXT on secondary file'),
        %ActiveTemplateInstance,%Secondary,
        MAP(%ActiveTemplateInstance,
        %ActiveTemplateInstanceDescription),LEGACY
  IF Access:%File.Next()
    IF Access:%File.GetEOF()
      BREAK
    ELSE
      POST(EVENT:CloseWindow)
      RETURN
    END
  END
  #FOR(%RelationKeyField),WHERE(%RelationKeyField)
  IF %RelationKeyFieldLink <> %RelationKeyField THEN BREAK.
  #ENDFOR
  #EMBED(%AfterSecondaryNext,
         'Relational Object Tree, After NEXT on secondary file'),
        %ActiveTemplateInstance,%Secondary,
        MAP(%ActiveTemplateInstance,
        %ActiveTemplateInstanceDescription),LEGACY
```

The above template code is pretty much the same as before, but this time, the code acts on the current secondary file. The following code acts on any child files to the current child file and again, what it does, discussed prior. Just on the primary file.

```
    #IF(%SecondaryFilter)
    IF ~(%SecondaryFilter) THEN CYCLE.
    #ENDIF
    SELF.QRT.Loaded = 0
    SELF.QRT.Position = POSITION(%TreeLevelFile)
    SELF.QRT.Level = %TreeLevel
    #IF(%TreeChildFile)
      #INSERT(%TreeChildGroup),NOINDENT
    #ELSE
    SELF.FormatFile(%TreeLevelFile)
    ADD(%TreeQueue,POINTER(%TreeQueue) + 1)
    #ENDIF
  #ENDFOR
#ENDIF
END
#ENDAT
```

This embed is quite busy! If not for some calls to #GROUPs, this part of the template would be quite difficult to read. For space reasons, the comments are omitted in the book, but open the source files and almost every line of code, template and target language has comments.

You can see that there are many possibilities of which Clarion code generates based on various decisions the template code makes.

AddEntryServer

EditEntryServer

DeleteEntryServer

These three embeds are almost identical, so a discussion of one is enough to cover the others. The only significant differences are the edit modes.

```
#AT(%TreeClassMethodCodeSection,%ActiveTemplateInstance,'AddEntryServer','()')
  #IF(%UpdatesPresent)
    #EMBED(%BeginAddEntryRoutine,
             'Relational Object Tree, Beginning of Add Record'),
             %ActiveTemplateInstance,
             MAP(%ActiveTemplateInstance,
             %ActiveTemplateinstanceDescription),NOINDENT
SELF.CurrentChoice = %TreeControl{PROPLIST:MouseDownRow}
GET(%TreeQueue,SELF.CurrentChoice)
CASE ABS(SELF.QRT.Level)
```

The above template code first checks to see if there was an update procedure entered in the developer dialog. If not, this template code quits and no target code generates. If so, then declare an embed point. %UpdatesPresent is a symbol that is set to %True in the #ATSTART section.

Next, generate target code to detect the current row and get its level. The level value is wrapped in a Clarion CASE statement.

If there is a procedure entered in %PrimaryUpdate by the developer, then generate target code to call the update procedure:

```
   #IF(%PrimaryUpdate)
OF 0
     #EMBED(%BeforePreparingRecordOnAdd,
            'Relational Object Tree, Before Preparing for Add'),
            %ActiveTemplateInstance,%Primary,
            MAP(%ActiveTemplateInstance,
            %ActiveTemplateinstanceDescription),LEGACY
  Access:%Primary.PrimeRecord
  GlobalRequest = InsertRecord
     #EMBED(%BeforeCallingUpdateOnAdd,
      'Relational Object Tree, Before Update on Add'),
            %ActiveTemplateInstance,%Primary,
            MAP(%ActiveTemplateInstance,
            %ActiveTemplateinstanceDescription),LEGACY
  %PrimaryUpdate
  IF GlobalResponse = RequestCompleted
    SELF.NewItemLevel = 1
    SELF.NewItemPosition = POSITION(%File)
    SELF.RefreshTree()
  END
     #EMBED(%AfterCallingUpdateOnAdd,
            'Relational Object Tree, After Update Procedure on Add'),
            %ActiveTemplateInstance,%Primary,
            MAP(%ActiveTemplateInstance,
            %ActiveTemplateinstanceDescription),LEGACY
    #ENDIF
```

The above code handles calling the update procedure for the primary file. After a successful return, set the new item level and position. Then call the *RefeshTree* method.

The template code now must check for any records in child files:

```
  #FOR(%TreeLevelFile),WHERE(INSTANCE(%TreeLevelFile) > 1)
    #SUSPEND
```

At this point a #SUSPEND statement is encountered. All target code from here to its matching #RESUME statement is potentially not generated. The reason is to build, conditionally, any remaining OF structures -- the condition being if there are child files to process. By that is meant any calls to edit procedures for each child file in the schematic.

```
      #SET(%ValueConstruct,INSTANCE(%TreeLevelFile)-1)
#?OF %ValueConstruct
      #IF(INSTANCE(%TreeLevelFile) = ITEMS(%TreeLevelFile))
        #SET(%ValueConstruct,%ValueConstruct + 1)
```

What the above code is doing is simply passing the level number to %ValueConstruct. This makes the OF statement for each child file.

The following section is conditional, and used only at the bottom of the CASE statement as it "groups" the last two files. In other words, it REGETs the parent, then LOOPs through all the matching child records. It then calls the matching %SecondaryUpdate procedure for that child file.

```
#?OROF %ValueConstruct
  #?LOOP WHILE ABS(SELF.QRT.Level) = %ValueConstruct
    #?SELF.CurrentChoice -= 1
    #?GET(%TreeQueue,SELF.CurrentChoice)
  #?UNTIL ERRORCODE()
       #ENDIF
  #?REGET(%TreeParentFile,SELF.QRT.Position)
       #EMBED(%BeforePreparingRecordOnAdd,
            'Relational Object Tree, Preparing Record for Add'),
            %ActiveTemplateInstance,%Primary,
            MAP(%ActiveTemplateInstance,
            %ActiveTemplateinstanceDescription),LEGACY
  #?GET(%TreeLevelFile,0)
       #FIX(%File,%TreeLevelFile)
       #FIX(%Relation,%TreeParentFile)
  #?CLEAR(%File)
       #FOR(%FileKeyField),WHERE(%FileKeyField
            AND %FileKeyFieldLink)
  #?%FileKeyField = %FileKeyFieldLink
       #ENDFOR
  #?Access:%File.PrimeRecord(1)
  #?GlobalRequest = InsertRecord
       #FIX(%File,%Primary)
       #FIX(%Secondary,%TreeLevelFile)
       #EMBED(%BeforeCallingUpdateOnAdd,
            'Relational Object Tree, Before Update on Add'),
            %ActiveTemplateInstance,%Secondary,
            MAP(%ActiveTemplateInstance,
            %ActiveTemplateinstanceDescription),LEGACY
```

As a final act, it does what the previous update calls did, test for successful completion of the update procedure (user did not cancel the edit).

```
 %SecondaryUpdate
  #?IF GlobalResponse = RequestCompleted
       #SET(%ValueConstruct,INSTANCE(%TreeLevelFile))
    #?SELF.NewItemLevel = %ValueConstruct
    #?SELF.NewItemPosition = POSITION(%Secondary)
    #?SELF.RefreshTree()
  #?END
       #EMBED(%AfterCallingUpdateOnAdd,
            'Relational Object Tree, After Update Procedure on Add'),
            %ActiveTemplateInstance,%Secondary,
            MAP(%ActiveTemplateInstance,
            %ActiveTemplateInstanceDescription),LEGACY
      #RESUME
    #ENDFOR
  END
  #ENDIF
#ENDAT
```

The main difference in the other methods (Edit and Delete), is the passing of the edit signal to *GlobalRequest* and issuing of the WATCH statement, plus the different descriptions of the #EMBED statements.

Other Control Templates

There are two control templates in addition to the one that places the list control on a window. These two templates are discussed here.

RelObjTreeUpdateButtons

This template places 3 buttons on the window. This template also appears only if the *RelationalTree* control template exists on the window.

```
#CONTROL(RelObjTreeUpdateButtons,
            'Update buttons for a Relational Object Tree'),
            DESCRIPTION('Update buttons for Relational Tree for '
            & %Primary),REQ(RelationalTree)
  CONTROLS
       BUTTON('&Insert'),AT(,,45,14),USE(?Insert)
       BUTTON('&Change'),AT(50,0,45,14),USE(?Change)
       BUTTON('&Delete'),AT(50,0,45,14),USE(?Delete)
  END
```

The above code declares a control template and the controls to place on the window. Notice the REQ attribute on the #CONTROL statement. This means that whatever template is named there, it must be on the window (or report), before this template appears on any list.

The CONTROLS statement declares that what follows are the controls to place on the window. This is usually pure Clarion code. Notice the first control is missing the first two parameters of the AT statement. This means that once the developer picks this control template, when the mouse moves over the window, the cursor changes to a cross-hair shape. When the left button is pressed, the controls are placed at the spot where the cross-hair is, one after the other.

If you author a control template with many controls, one useful tip is to require multiple mouse clicks to place all of the controls where you want. To do this, simply have the 4th or 5th control (for example), omit the first two parameters of its AT statement.

```
#ATSTART
  #DECLARE(%HelpControl)
  #FOR(%Control)
    #IF(UPPER(EXTRACT(%ControlStatement,'STD',1))='STD:HELP')
      #SET(%HelpControl,%Control)
      #BREAK
    #ENDIF
  #ENDFOR
```

The previous section of code starts an #ATSTART section. Remember, an #ATSTART statement specifies template code to execute before the #CONTROL generates it code. That actually applies to other template types, but the current context is control templates.

The next section following is simply code to determine if there is a control on the window that calls STD:Help, a Clarion equate that calls Windows standard Help. If it finds one, it breaks out of the loop. If it does not find one, the loop expires once all controls on the window are inspected.

```
  #DECLARE(%AddControl)
  #DECLARE(%EditControl)
  #DECLARE(%RemoveControl)
  #FOR(%Control),WHERE(%ControlInstance = %ActiveTemplateInstance)
    #CASE(%ControlOriginal)
    #OF('?Insert')
    #OROF('?Add')
      #SET(%AddControl,%Control)
     #SET(%ValueConstruct,EXTRACT(%ControlStatement,'BUTTON',1))
      #IF(%ValueConstruct)
        #SET(%ValueConstruct,SUB(%ValueConstruct,2,
             LEN(%ValueConstruct)-2))
      #ELSE
        #SET(%ValueConstruct,SUB(%ControlOriginal,2,
             LEN(%ControlOriginal)-1))
      #ENDIF
       #SET(%InsertPopupText,%ValueConstruct)
```

The above template code declares symbols for each of the three controls for the three possible edit methods.

The #FOR loop looks through all controls where the control instance matches the template instance. This technique ensures that these controls get unique names in the case where there could be more than one tree list control on the window.

The #CASE structure looks for the use variables each button might have -- in this instance, possible synonyms for each of the edit actions. Once it finds one with either use variable labels, it assigns that control to the %AddControl (or one of the others -- see below).

The %ControlStatement contains the control's declaration statement (and all attributes). EXTRACT is looking for the control type, in this case a button. Since the first attribute is a BUTTON, the 1 is the 3rd parameter. In plain English, "Please give me the button text attribute."

If it finds button attributes (%ValueConstruct has a value if it does), then make %ValueConstruct contain only the actual attributes. If %ValueConstruct is empty, then use a slightly different method to assign the attributes to it.

The final line of this section of code is to assign the value of the contruct to the %InsertPopupText. Thus, whatever the text is, the pop-up menu has the same text. The rest of the #ATSTART section does the same thing for the *Edit* and *Delete* controls, and is omitted here.

Control Event Handling

The buttons need event processing, or what they should do when pressed by the user. The following template code handles this:

```
#AT(%ControlEventHandling,%AddControl,'Accepted')
%TreeControl{PropList:MouseDownRow} = CHOICE(%TreeControl)
%InstancePrefix.AddEntry()
#ENDAT
```

When pressing the button control that does adding or inserting, an EVENT:Accepted generates. The CHOICE statement returns the row of whatever is highlighted. This is passed to the list control, then a call to *AddEntry* method that belongs to the current object name of the *RelationTree*.

The change and delete button controls do the same thing, except for the name of the control and the method call. These method calls are in the parent class, which set the edit mode and then call *UpdateLoop* method. Before I get to that method, I must take a small detour for toolbar navigation.

Toolbar Issues

This template code accounts for toolbar editing. The template code executes whether or not a toolbar is present or not. If it is not present, then the toolbar code is bypassed.

```
#AT(%ReltreeToolbarDispatch,%ActiveTemplateParentInstance),WHERE(%AcceptToolbarControl)
OF Toolbar:Insert TO Toolbar:Delete
  SELF.Control{PROPLIST:MouseDownRow} = CHOICE(SELF.Control)
  EXECUTE(ACCEPTED()-Toolbar:Insert+1)
    %InstancePrefix.AddEntry()
    %InstancePrefix.EditEntry()
    %InstancePrefix.DeleteEntry()
  END
#ENDAT
```

If you notice the #AT location, this is actually a hidden (from the developer) embed. Embeds with the HIDE attribute are for template use only. They provide a place to embed code. You could think of this as the same functionality as #GROUPs, but without actually defining one.

Below is the template code where the above code gets embedded (I think you can spot where):

```
#AT(%LocalProcedures),WHERE(%AcceptToolbarControl)
%DerivedInstance.TakeEvent   PROCEDURE(<*LONG VCR>,WindowManager WM)
  CODE
  CASE ACCEPTED()
  OF Toolbar:Bottom TO Toolbar:Up
    SELF.Control{PROPLIST:MouseDownRow} = CHOICE(SELF.Control)
    EXECUTE(ACCEPTED() - Toolbar:Bottom + 1)
      %InstancePrefix.NextParent()
      %InstancePrefix.PreviousParent()
      %InstancePrefix.NextLevel()
      %InstancePrefix.PreviousLevel()
      %InstancePrefix.NextRecord()
      %InstancePrefix.PreviousRecord()
    END
  #EMBED(%ReltreeToolbarDispatch,
          'Relational Object Tree Toolbar Dispatch'),
         %ActiveTemplateInstance,HIDE
  ELSE
    PARENT.TakeEvent(VCR,%WindowManager)
  END
#ENDAT
```

Notice the #AT location. %LocalProcedures is a symbol that contains the class declaration for toolbar management. The template code for this is as follows:

```
#AT(%DataSection),PRIORITY(3500)
  #IF(%AcceptToolBarControl)
%[20]DerivedInstance CLASS(%ToolbarRelTreeType)
TakeEvent            PROCEDURE(<*LONG VCR>,WindowManager WM),DERIVED
%[20]NULL END
%NULL
  #ENDIF
%[20]TreeQueue QRelTree
%[20]LoadedQueue LoadedQ
%NULL
#ENDAT
```

This is the code that declares the local instance of the %ToolbarRelType, an ABC class. %AcceptToolBarControl is a check box on the dialog for the relation tree. If the developer checks this box, the condition is true and the code generates.

TakeEvent is an overridden virtual method. It is this method that %LocalProcedures refers to. The [20] means to generate the label normally and then add spaces, up to 20 characters (includes both label and spaces). This is a way to ensure the code aligns in the proper column. %NULL is an internal symbol and a great way to generate leading white space. This makes the closing END statement align with the PROCEDURE statement.

Therefore, if you declare a method in a class (overridden or not), you *must* follow up by writing the code for the method. That is where the #AT(%LocalProcedures) comes in.

%DerivedInstance contains the label of the local object. %InstancePrefix is the symbol for the local tree class. Since the methods listed there are not part of this class, you cannot use SELF, but the label of the local instance for the tree class. This also illustrates how a class can call an unrelated method in another class.

Special Conditions

There is a special condition that should be taken into account. What if the developer adds the HIDE or DISABLE attribute to any of the edit buttons? That should be taken into account as that is possible. Therefore the following template code addresses this:

```
#AT(%BeginAddEntryRoutine)
  #IF(%Control=%TreeControl)
    #IF(%AddControl)
IF %AddControl{PROP:Disable}
  RETURN
      #IF (~%AcceptToolbarControl)
ELSIF %AddControl{PROP:Visible} = False
  RETURN
      #ENDIF
END
    #ENDIF
  #ENDIF
#ENDAT
```

I am showing only the add routine as the change and delete are nearly identical. If you go back to the template code for *AddEntryServer*, you will find an #EMBED labeled %BeginAddEntryRoutine. This template inserts the code at that spot.

So if the current control is the current tree control, and if there is an %AddControl present, then generate code to test to see if the control is currently disabled. If it is, the generated code quits there with the RETURN statement.

Next, the template code checks to see if the toolbar control is not present, and if so, generates code to test if the control button is hidden and again, RETURN right away as there is nothing else to do.

Assignment of Edit Buttons

The last thing for this control template is to ensure the class knows which button controls are used for editing.

```
#AT(%AssignToolbarButtons,%ActiveTemplateParentInstance),WHERE(%AcceptToolBarControl)
  #IF (%RemoveControl)
%DerivedInstance.DeleteButton = %RemoveControl
  #ENDIF
  #IF (%AddControl)
%DerivedInstance.InsertButton = %AddControl
  #ENDIF
  #IF (%EditControl)
%DerivedInstance.ChangeButton = %EditControl
  #ENDIF
  #IF (%HelpControl)
%DerivedInstance.HelpButton = %HelpControl
  #ENDIF
#ENDAT
```

Again, this code generates into an #EMBED point, the *AssignButtons* method. But only when the %AcceptToolBarControl check box is set. The template checks each control to see if it exists, and if so, generates Clarion code to assign the control buttons to the property for each.

RelObjTreeExpandContractButtons

This control template adds the function to expand the entire tree and collapse the entire tree. It is not very big.

```
#CONTROL(RelObjTreeExpandContractButtons,
         'Expand/Contract buttons for a Relational Object Tree'),
         DESCRIPTION('Expand/Contract buttons for a Relational
                      Object Tree for ' &
                      %Primary),REQ(RelationalTree)
  CONTROLS
       BUTTON('&Expand All'),AT(,,45,14),USE(?Expand)
       BUTTON('Co&ntract All'),AT(50,0,45,14),USE(?Contract)
  END
```

The above declares the template and its controls. It uses the same concepts discussed earlier to populate these controls on a window.

```
#ATSTART
  #DECLARE(%ExpandControl)
  #DECLARE(%ContractControl)
  #FOR(%Control),WHERE(%ControlInstance = %ActiveTemplateInstance)
    #CASE(%ControlOriginal)
    #OF('?Expand')
      #SET(%ExpandControl,%Control)
      #SET(%ValueConstruct,EXTRACT(%ControlStatement,'BUTTON',1))
      #SET(%ExpandPopupText,SUB(%ValueConstruct,2,
             LEN(%ValueConstruct)-2))
    #OF('?Contract')
      #SET(%ContractControl,%Control)
      #SET(%ValueConstruct,EXTRACT(%ControlStatement,'BUTTON',1))
      #SET(%ContractPopupText,SUB(%ValueConstruct,2,
             LEN(%ValueConstruct)-2))
    #ENDCASE
  #ENDFOR
#ENDAT
```

The above code is a "pre-process" as with earlier discussions about #ATSTART. First, two symbols are declared. Then a loop, restricted to the current instance of this control. %ControlOriginal is the original field equate label of the control as listed in the control template from which it came. The developer can change the field equate at any time and as many times as they want. However, the %ControlOriginal never changes, thus this is the reason why this symbol is tested.

In the case where the symbol is "Expand", then the %ExpandControl gets the %Control's field equate, even if this field equate was changed by the developer. It next extracts the button's text and places it in %ValueConstruct. The pop-up text is also extracted and placed in its symbol, %ExpandPopupText. The same process is done for the Contract button. The template is now ready to proceed as all of its prep work is completed.

```
#AT(%ControlEventHandling,%ExpandControl,'Accepted')
%TreeControl{PropList:MouseDownRow} = CHOICE(%TreeControl)
%InstancePrefix.ExpandAll()
#ENDAT
```

The above code does the event processing when the *Expand* control is accepted. If that event happens, then call the method to expand the entire tree.

```
#AT(%ControlEventHandling,%ContractControl,'Accepted')
%TreeControl{PropList:MouseDownRow} = CHOICE(%TreeControl)
%InstancePrefix.ContractAll()
#ENDAT
```

This code does the event processing when the *Contract* control is accepted. If that event happens, then call the method to collapse the entire tree.

Chapter 7 – Template User Guide

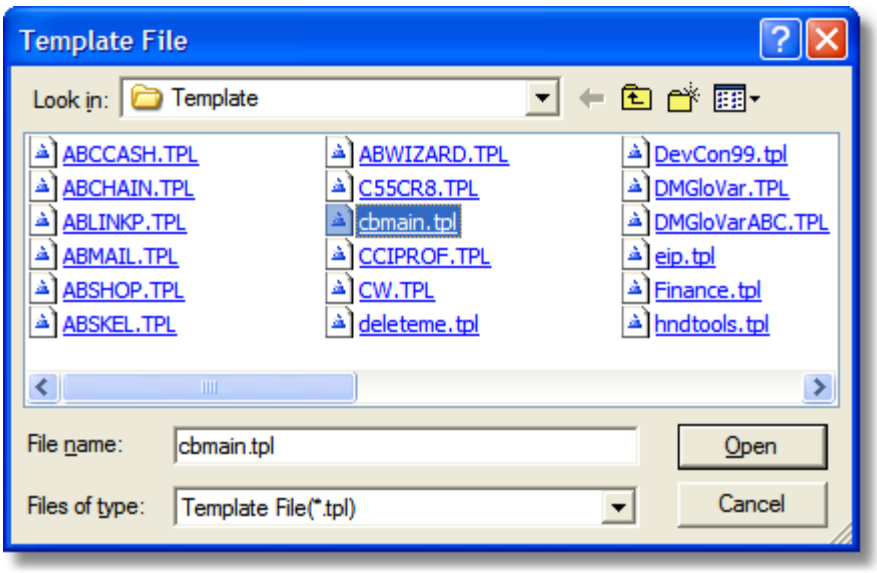
Introduction

Now that the template is done, time to put it to use. This chapter covers each prompt and also serves as a tutorial on how to use it. In this case, it is to fill in the prompts so the resulting tree list looks and behaves just like the one found in the *Invoice* example.

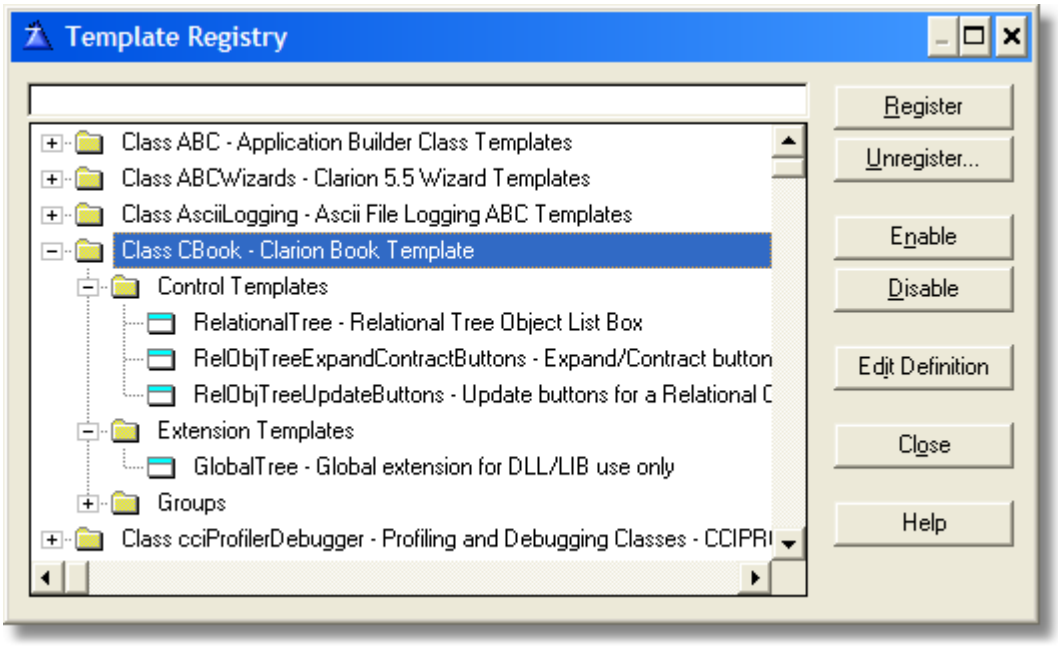
Registration

You cannot use the template until you register the template. Open the registry and **press** REGISTER. If the registry button is disabled, you are in multi-user mode. You must uncheck this box under the *Application Setup* dialog.

Find the *cbmain.tpl* file as shown below:



When the template is registered, it will appear similar to the following figure (this will differ depending on which templates you've registered):

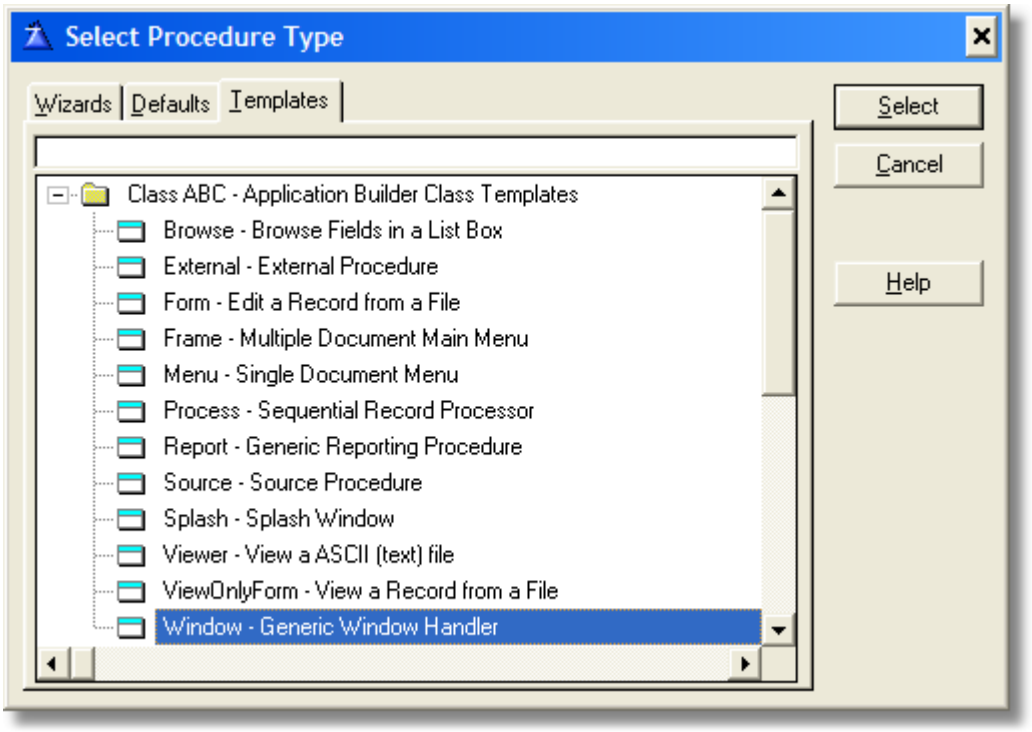


Press OK to close the template registry. The template is now ready for use.

Adding the control template

You may add the relation tree control template to any procedure with a window. The best use is with either a *Browse* or *Window* procedure. For simplicity's sake, I'll use a plain window with no buttons.

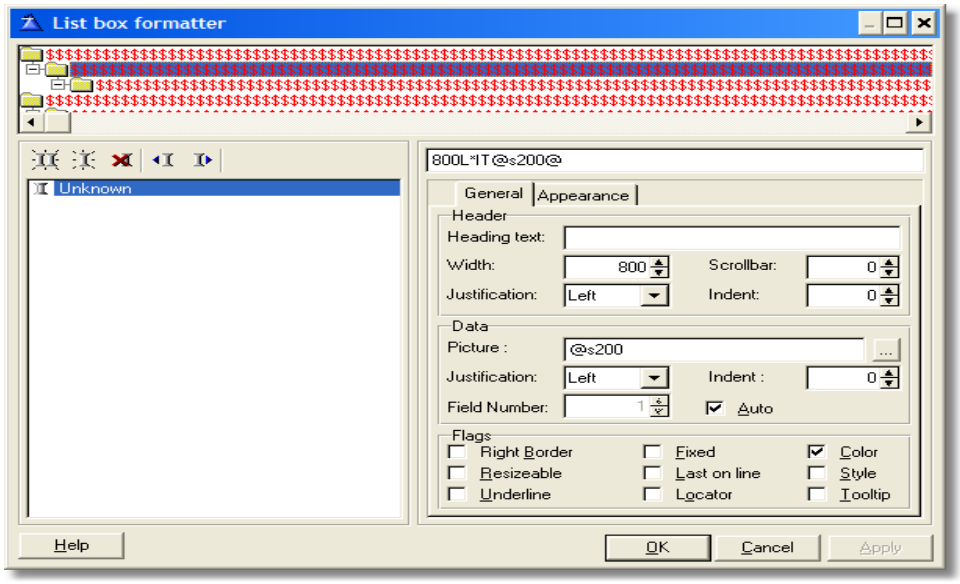
Press INS anywhere in an existing application (even if you just created a new one). Give this new procedure any name you wish. **Choose** *Window* for the procedure type.



Press SELECT to accept this choice. You are now presented with a procedure dialog. **Press** WINDOW. You are now presented with a few choices. Normally, it would be an *MDI Child Window,* as a procedure like this is called from a *Frame* procedure. It does not really matter as long as it is a *Window* type procedure.

Resize the window to fill the 800x600 outline so you have some room to work. From either the CONTROL TEMPLATE button on the *Tools* toolbar or from the populate control template from the main menu, **choose** RELATIONAL ➢ TREE OBJECT LIST BOX. Once done the dialog closes and when your mouse cursor is over the window, it changes to a cross hair.

Once you determine where you want to drop the control, **press** the left mouse button. The list box formatter appears.

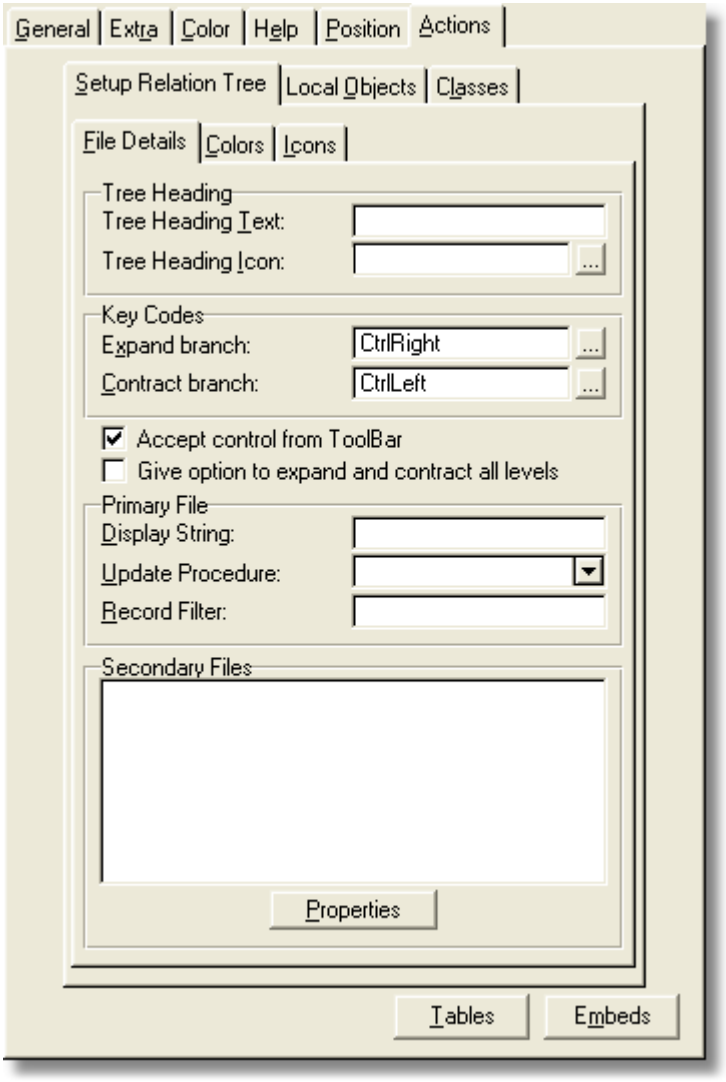


Press OK, making no changes, as you do not use this tool. Resize the control so it fills a little more than half the window vertically with equal margins on both sides horizontally. At the moment, you have an empty list box.

Right-click on the list box and **choose** ACTIONS.

Setup Relation Tree

File Details tab



This is where you'll do most of your work. These are the prompts for the control template.

Tree Heading Text

Enter the optional text for the root node of the tree.

Example: **Enter** *CUSTOMERS" ORDERS*

Tree Heading Icon

Enter an icon file name or press the ellipsis button to lookup an icon file. Note that all icons mentioned here are in the *%root%\examples\invoice* folder.

Example: **Enter** *File.ico*

Expand Branch

Enter the keystroke that is used to expand the current node of the tree. You may optional press the ellipsis button to open the key stroke dialog. The default is CTRL-RIGHT.

Example: Leave as-is.

Contract Branch

Enter the keystroke that is used to contract or collapse the current node of the tree. You may optionallly press the ellipsis button to open the key stroke dialog. The default is CTRL-LEFT.

Example: Leave as-is.

Accept control from Toolbar

If you use toolbars, check this box to add navigation and editing functions from the VCR toolbar. The default is to not use toolbar navigation.

Example: **Check** this box.

Give option to expand or contract all levels

This enables the user to expand or collapse the entire tree. Since the tree is file loaded, a large amount of data may cause long delays. For smaller amounts of data, this is usually fine. The default is to allow this action.

Example: Leave the box checked.

Display String

Enter an expression for the primary file. This uses any valid Clarion expressions to construct how this file's data appears on the list box.

Example: **Enter** *CLIP(CUS:FirstName) & ' ' & CLIP(CUS:LastName) &' '& FORMAT(CUS:CustNumber,@P(#######)P)*

Note: In Clarion 6 and later, **press F10** to show the zoom box. It can display more text than what is allowed, thus making it easier to enter long strings or expressions.

Update Procedure

Enter or choose from the drop list the name of the edit procedure. This procedure is usually a form procedure.

Example: **Enter** *UpdateCustomers*.

Record Filter

If the primary file in the tree should be filtered in some way, enter the filter expression here. Any valid Clarion expression that could be used as a filter is valid.

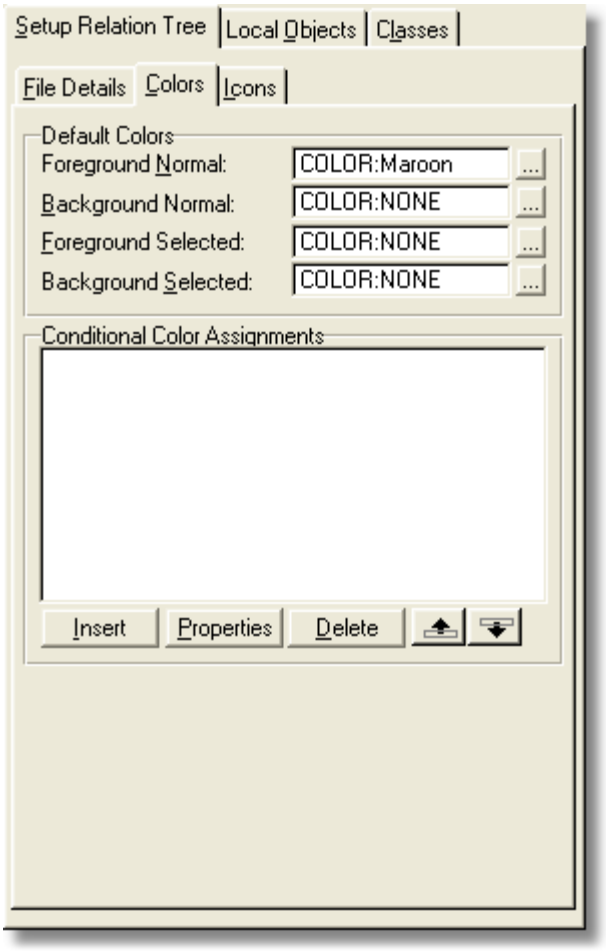
Example: Leave this blank as there is no filter in this example.

Secondary files

All files listed as related to the primary file are listed here. Since there is nothing yet in the table schematic, there is nothing to do. You'll come back to this later.

Colors tab

This is where you will enter any colors for this level of the tree. It looks like this:



The default colors are as follows:

Foreground Normal

Enter a color equate or a hex value for the normal foreground color. You can also press the ellipsis button to open the color dialog box and pick the color you wish.

Example: **Enter** *COLOR:Maroon*

Background Normal

Enter a color equate or a hex value for the normal background color. You can also press the ellipsis button to open the color dialog box and pick the color you wish.

Example: Leave this blank to default to no color (black).

Foreground Selected

Enter a color equate or a hex value for the foreground selected (highlight bar is on the current row) color. You can also press the ellipsis button to open the color dialog box and pick the color you wish.

Example: Leave this blank to default to no color.

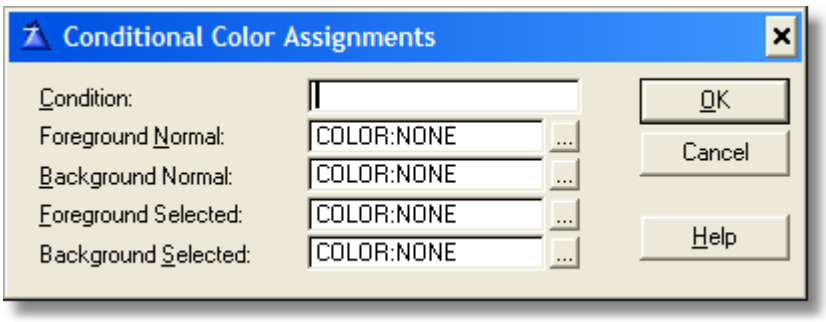
Background Selected

Enter a color equate or a hex value for the background selected (highlight bar is on the current row) color. You can also press the ellipsis button to open the color dialog box and pick the color you wish.

Example: Leave this blank to default to no color.

Conditional Color Assignments

This is a list of all conditions that could apply to this node of the tree. You may **press** INSERT to add a new condition, PROPERTIES to edit a condition, or DELETE to remove a condition. The UP or DOWN buttons change the order of the conditions if you have more than one condition. Using any of the edit buttons shows this dialog:



Condition

Enter a valid Clarion expression for the condition. The condition must be true for the colors to take effect. An example expression would be *CUS:InArrears*. Any value in this field would be true.

Example: Leave blank as there are no conditions for this file.

Foreground Normal

Enter a color equate or a hex value for the normal foreground color. You can also press the ellipsis button to open the color dialog box and pick the color you wish.

Example: Leave this blank to default to no color (black).

Background Normal

Enter a color equate or a hex value for the normal background color. You can also press the ellipsis button to open the color dialog box and pick the color you wish.

Example: Leave this blank to default to no color (black).

Foreground Selected

Enter a color equate or a hex value for the foreground selected (highlight bar is on the current row) color. You can also press the ellipsis button to open the color dialog box and pick the color you wish.

Example: Leave this blank to default to no color.

Background Selected

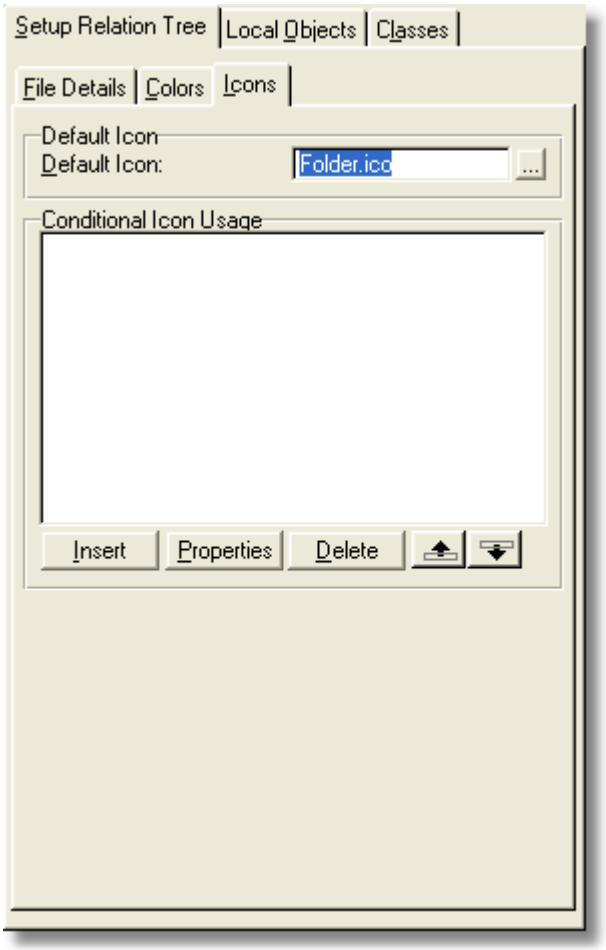
Enter a color equate or a hex value for the background selected (highlight bar is on the current row) color. You can also press the ellipsis button to open the color dialog box and pick the color you wish.

Example: Leave this blank to default to no color.

When you are finished, **press** OK to close this dialog and save any changes or CANCEL to abort any edits and close this dialog. You may add another condition, or edit an existing condition, or delete a condition at this point if you wish.

Icons

This dialog allows you specify any icons for the tree list.



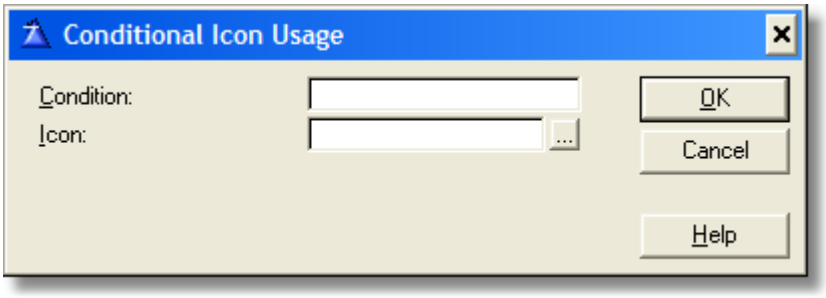
Default icon

Enter an icon name or press the ellipsis to look up an icon file.

Example: **Enter** *folder.ico*

Conditional Icon Use

This is a list of all conditions that could apply to this node of the tree. You may **press** INSERT to add a new condition, PROPERTIES to edit a condition, or DELETE to remove a condition. The UP or DOWN buttons change the order of the conditions if you have more than one condition. Using any of the edit buttons shows this dialog:



Condition

Enter a valid Clarion expression for the condition. The condition must be true for the colors to take effect. An example expression would be *CUS:InArrears*. Any value in this field would be true.

Example: Leave blank as there are no conditions for this file.

Icon

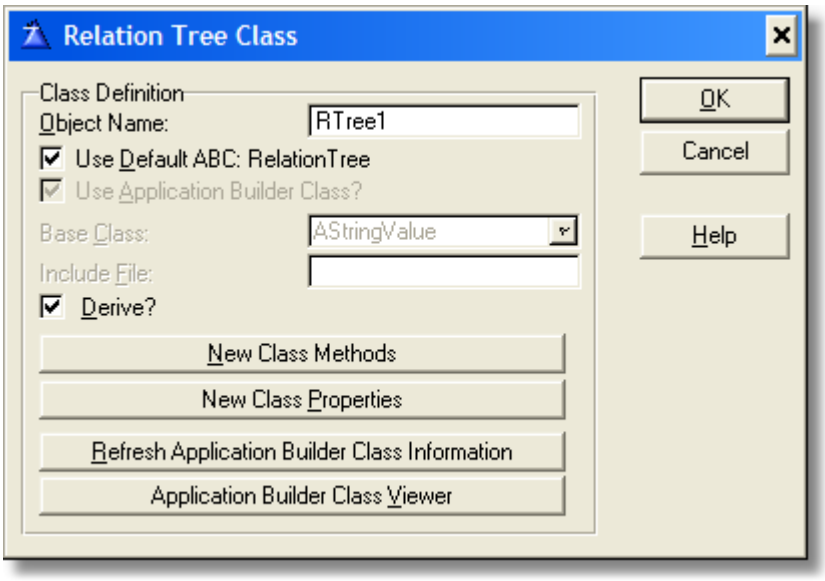
Enter an icon name or press the ellipsis to look up an icon file.

Example: Leave blank as there are no conditional icons for this level in the tree.

When you are finished, **press** OK to close this dialog and save any changes or CANCEL to abort any edits and close this dialog. You may add another condition, or edit an existing condition, or delete a condition at this point if you wish.

Local Objects

This tab shows the details for the local object. **Press RELATION TREE CLASS** and this dialog appears:



Object Name

This is the default name for the local instance of this class. You may enter another name for this object if you wish, or leave it as is.

Example: Leave the default name.

Use default ABC: RelationTree

Leave this setting checked if this is the correct parent class. If not, clear the check box to allow you to choose a different parent class.

Example: Leave checked.

Use Application Builder Class?

This prompt enables only if the Use Default is cleared. The default is checked, meaning you want to pick another ABC class as the parent.

Example: Not applicable.

Base class

This drop list shows all the ABC classes to choose from. Pick a new class from this list. This is a drop list only if the previous check box is set. If it is cleared, then this control is an entry where you enter the name of the parent class.

Example: Not applicable.

Include File

This entry control is enabled only if the use ABC check box is cleared. Enter the name of the include file where the class definition can be found.

Example: Not applicable.

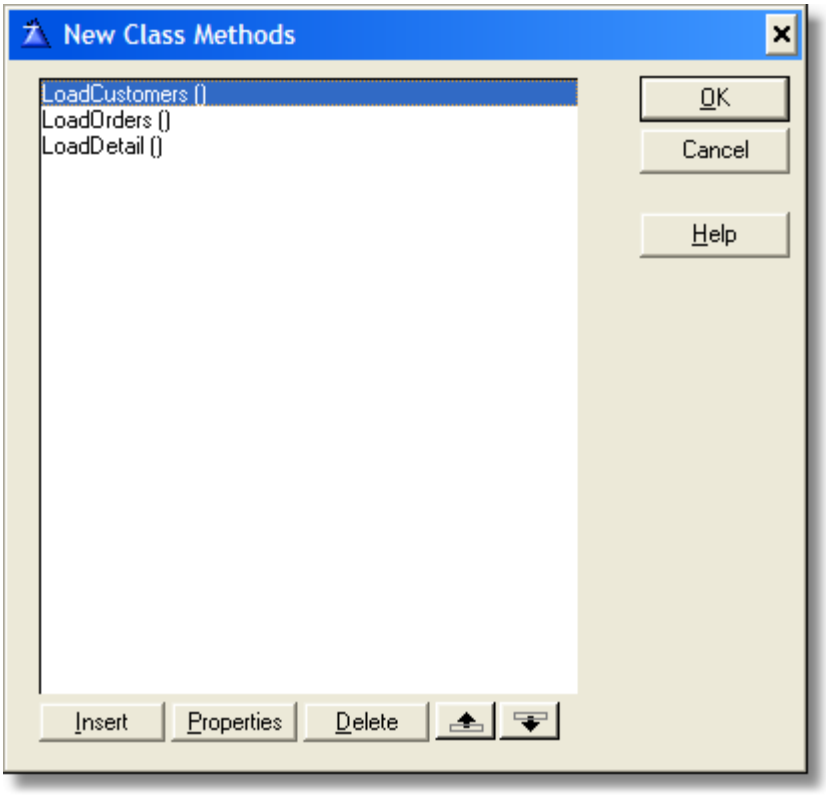
Derive?

This check box is enabled automatically when one or more files are placed in the schematic. The files in the schematic must be related to the primary file. Setting this check enables the following two buttons.

Example: Leave this setting as you find it. It is checked if you've added a file, unchecked if not (you will later).

New Class Methods

Pressing this button shows the following dialog:

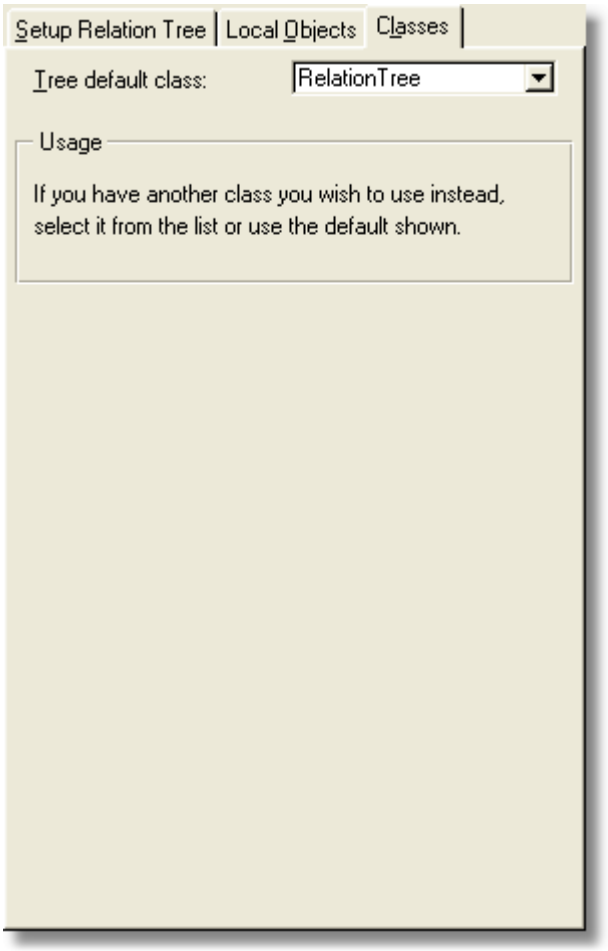


You may or may not have any methods listed here. The template automatically adds these methods based on the files in the table schematic. Since the template automatically keeps this list, you should not add any new methods of your own or change the names or parameters.

Press CANCEL and confirm you wish to cancel (if prompted). The rest of the buttons are covered in the Clarion documentation. **Press** CANCEL again and confirm you wish to cancel (if prompted).

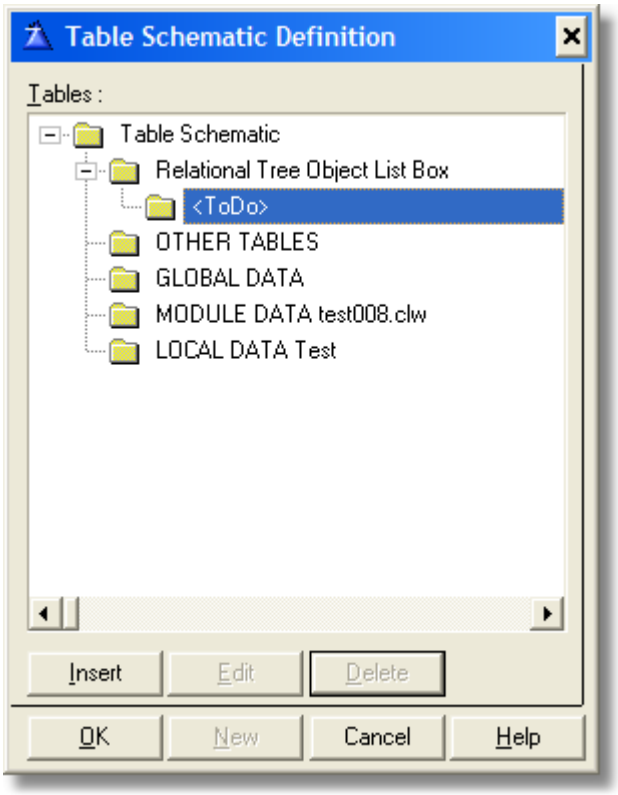
Classes

This tab shows the name of the parent class. You may change it to another ABC compliant class that handles trees if you wish.

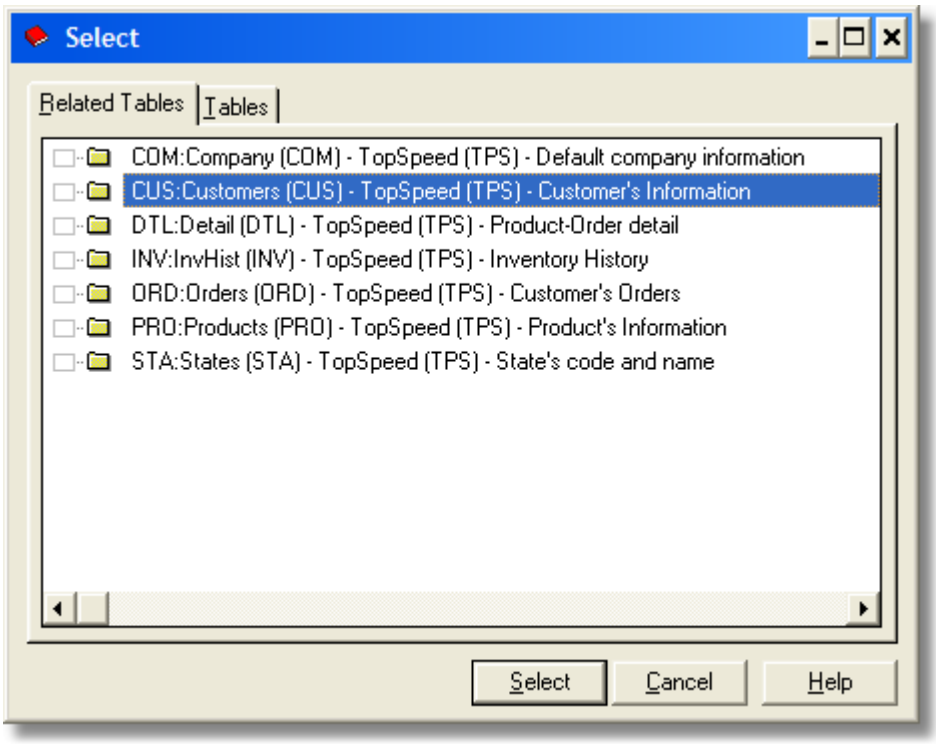


Adding files to the Table Schematic

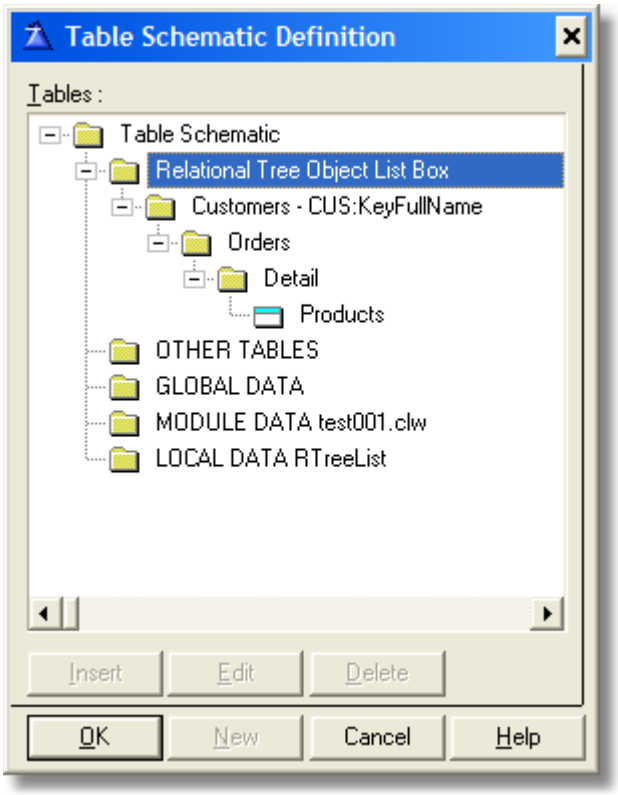
If you are at the procedure properties dialog, **press** the TABLE button. If you are at the application tree, **right-click** and **choose** TABLES.



Press INSERT and the following dialog displays:



Highlight *Customers* and **press** SELECT. The *Customer* file is now in the tree. **Press** EDIT and **choose** *KeyFullName*. **Press** SELECT. With the *Customer* file selected, **press** INSERT and **select** *Orders*. **Press** SELECT. Repeat for *Detail* and *Products*. The table schematic should appears as follows:

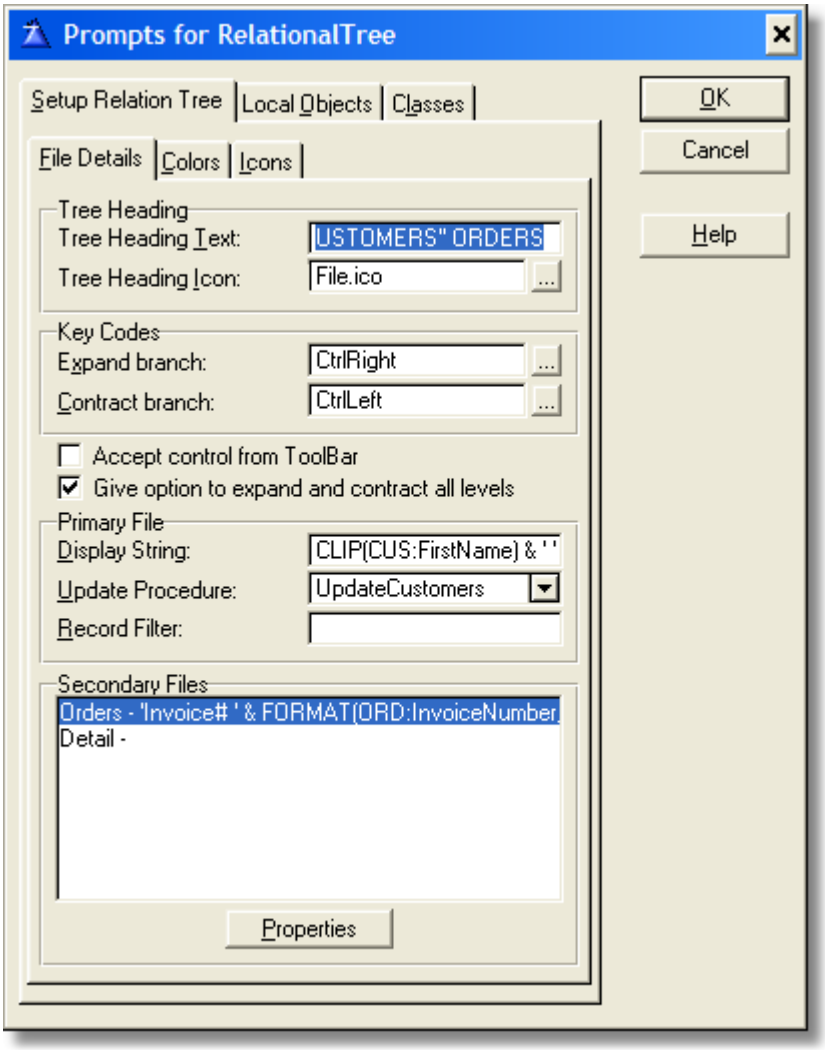


Press OK to close the table schematic dialog. This adds all the files needed for the tree list. **Press** OK to close the procedure dialog (if still open).

Finishing the Tree List

You do not have to always go back to the window formatter to work on the tree dialog. You do need to fill in how other files appear in the tree list. **Right-click** on the procedure and **choose** *extensions*. Or you may use the right side pane of the application view (Clarion 5.5 and later). Expand the extension node of the tree. For either method, **select** *Tree Structure Related to Customers*, if not already selected.

The dialog has changed to reflect the files added to the table schematic.



You now see the secondary files listed. Except you won't find *Products* in this list. Only files that have a 1:MANY relationship to a child file are listed. The same rule applies the the *New Methods* dialog. Each dialog for the secondary files is the same as the primary file. To open those dialogs, **highlight** a file and **press** PROPERTIES. Fill in the prompts as follows:

Open the secondary dialog for the *Orders* file and fill in these prompts as described below.

Display String

Enter: *'Invoice# ' & FORMAT(ORD:InvoiceNumber,@P######P) &', Order# ' & FORMAT(ORD:OrderNumber,@P#######P) & ', (' & LEFT(FORMAT(ORD:OrderDate,@D1)) & ')'*

Update Procedure

Enter or **select** from the drop down *UpdateOrders*.

Select the COLOR tab.

Foreground Normal

Enter *COLOR:Navy*

Select the ICON tab.

Default Icon

Enter or **select** *invoice.ico*.

Press OK to close and save your changes. Open the secondary dialog for *Detail*.

Display String

Leave this blank as the string required is too big to fit in the maximun entry control size of 255 characters. You'll use an embed instead.

Update Procedure

Enter or **select** from the drop down *UpdateDetail*.

Select the COLOR tab.

Foreground Normal

Enter *COLOR:Green*

You need to enter a conditional color assignment. **Press** INSERT.

Condition

Enter *DTL:BackOrdered = TRUE*

Foreground Normal

Enter *COLOR:Red*

Press OK to save these edits. **Select** the ICON tab.

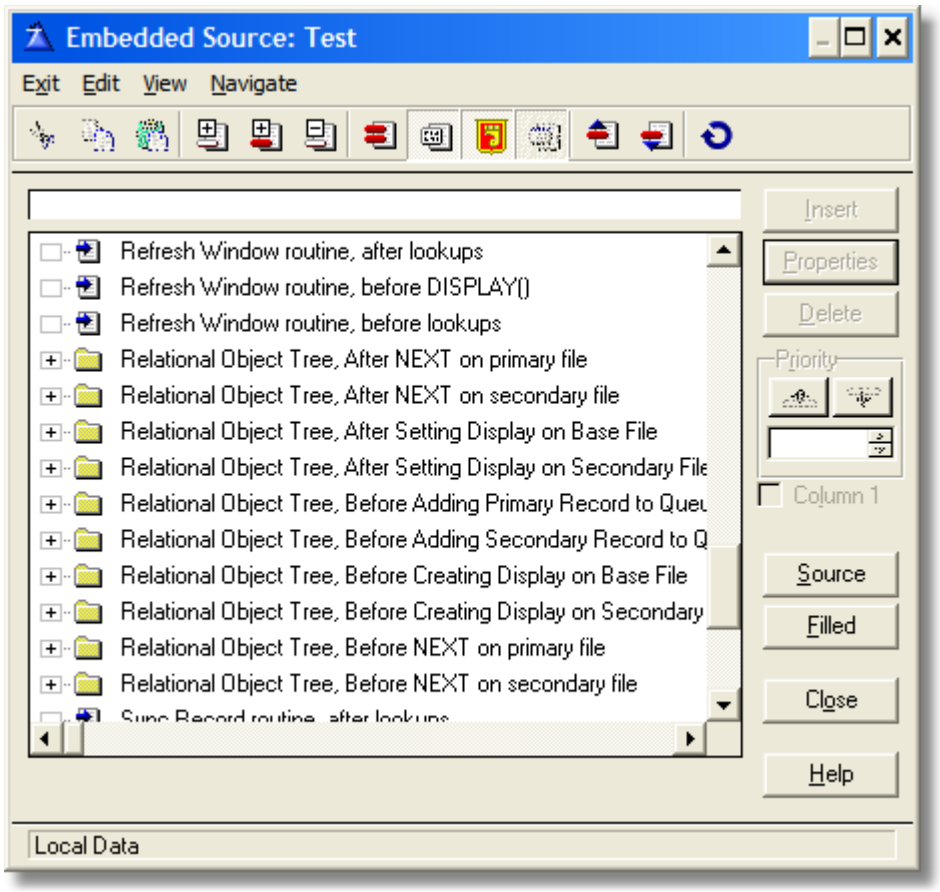
Default Icon

Enter or **select** *star.ico*.

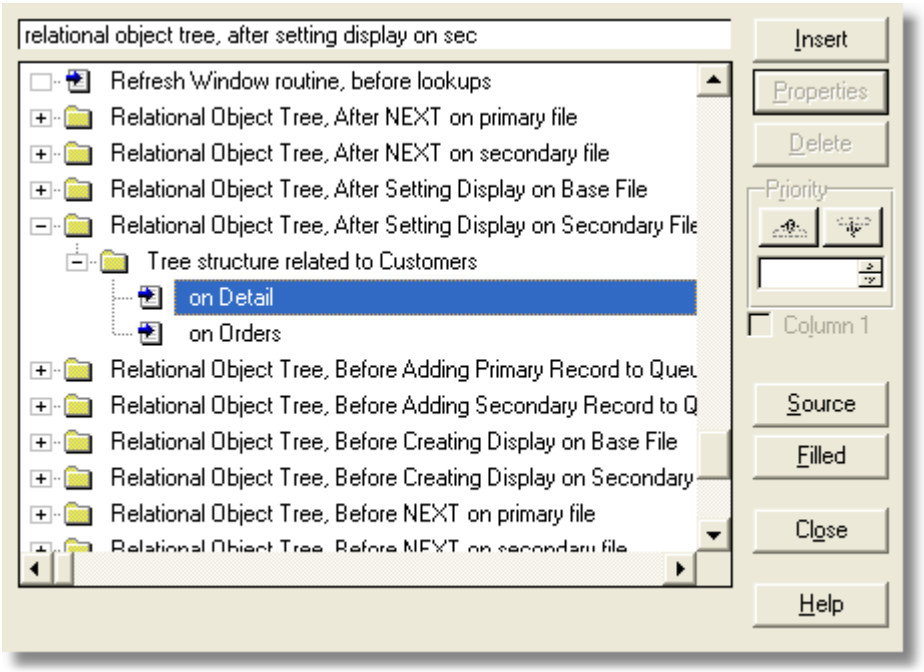
Press OK to close this dialog and save your changes. **Press** OK to close any other remaining dialogs until you are back to the application tree.

The Embeds

Open the embed tree by your favorite method. There are many embeds with the LEGACY attribute in the templates. This means that they are visible only when the legacy button is pressed on the embed tree toolbar.

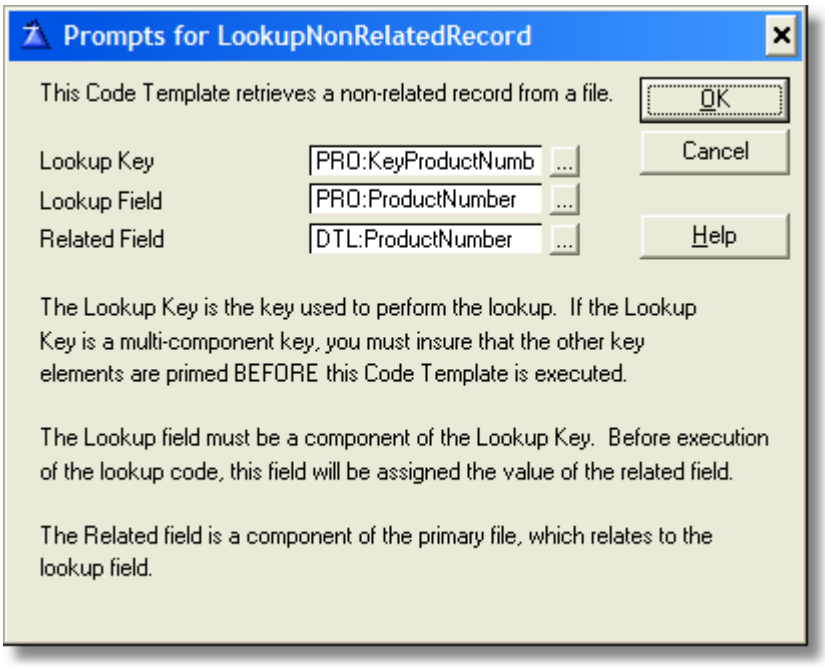


Using the locator, find *Relational Object Tree, After Setting Display on Secondary File*. Expand this tree.



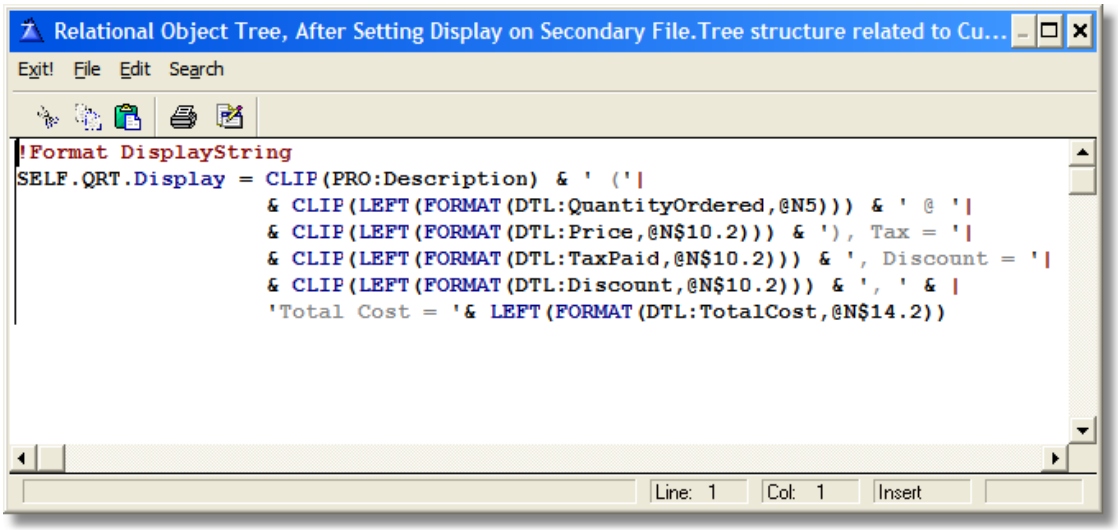
Find the *Detail* file. You need to insert two embeds:

Press INSERT and **choose** *Lookup non-related record*. Fill in the prompts as shown in the next figure.



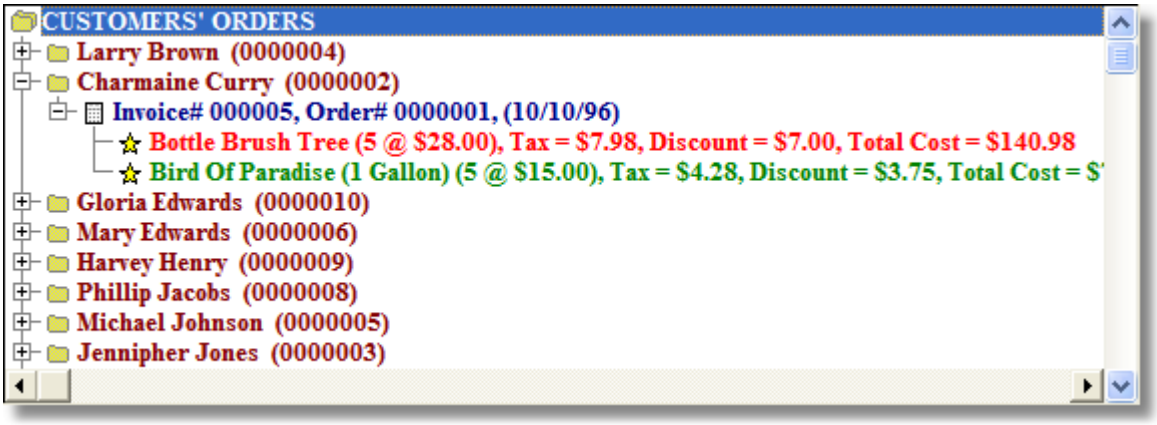
Press OK to close the dialog when done. This does a lookup into the *Product* file.

You need to add another embed. **Press** INSERT and **choose** *Source*. Enter the source as shown in the next figure:



Select EXIT when done and save your edits.

Save all of your work and test. You should have something like the following figure when the test app runs:



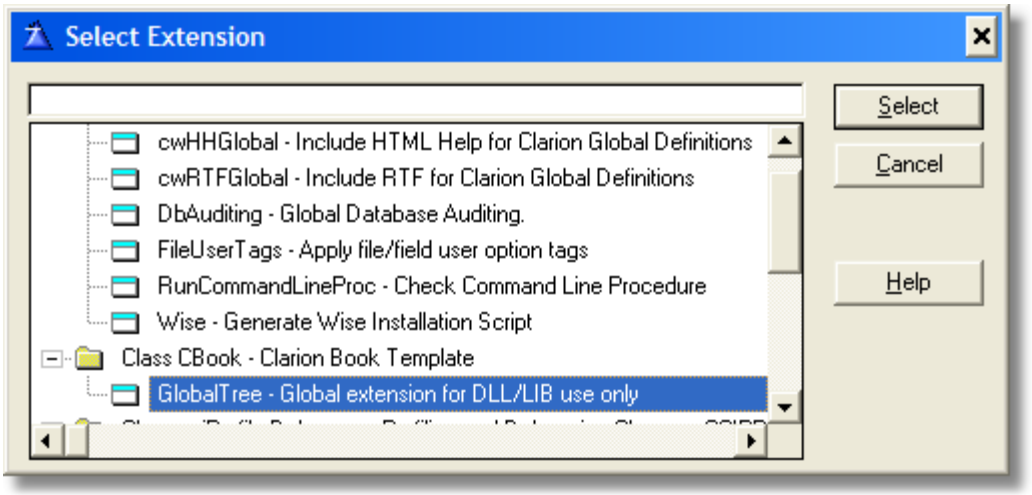
Dynamic Link Library Issues

Since this template is a pure control template, this does not, by itself, work in a DLL setting. This is because this class is local and used only when a specific control is placed on a window.

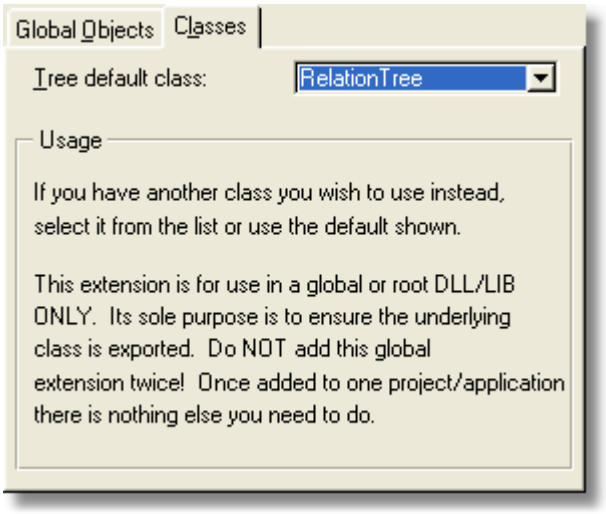
If you tried to link in an ABC DLL that contains all the ABC class definitions, you will get a link error for each method call. This is because there is nothing to set up the exports for this class.

This is why a global extension exists. This extension belongs where the ABC classes are defined to your application such as a root or global DLL. It is used only once as that is all you need.

Open the Global properties dialog and **press** EXTENSIONS. **Choose** the only global extension in the *Class CBook* node:



Press SELECT to choose the extension. This adds the extension template to the DLL application. Look at the following figure:



This template ensures that the *RelationTree* class and its methods are available for export, meaning they are available for later applications to call once this DLL is inserted into the application.

You'll need to ensure that your DLL projects are correctly set up. If you follow the instructions for doing this for an ABC application, that is all you need. This template is designed to follow ABC's lead, thus nothing extra is required by the developer.