Dylan (Dynamic Language)

A multi-paradigm language

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Agenda

- History of Dylan
- Concepts of the language
- Multidimensional polymorphism - a silver bullet
- Functional programming with Dylan
- Dylan in a *real* project

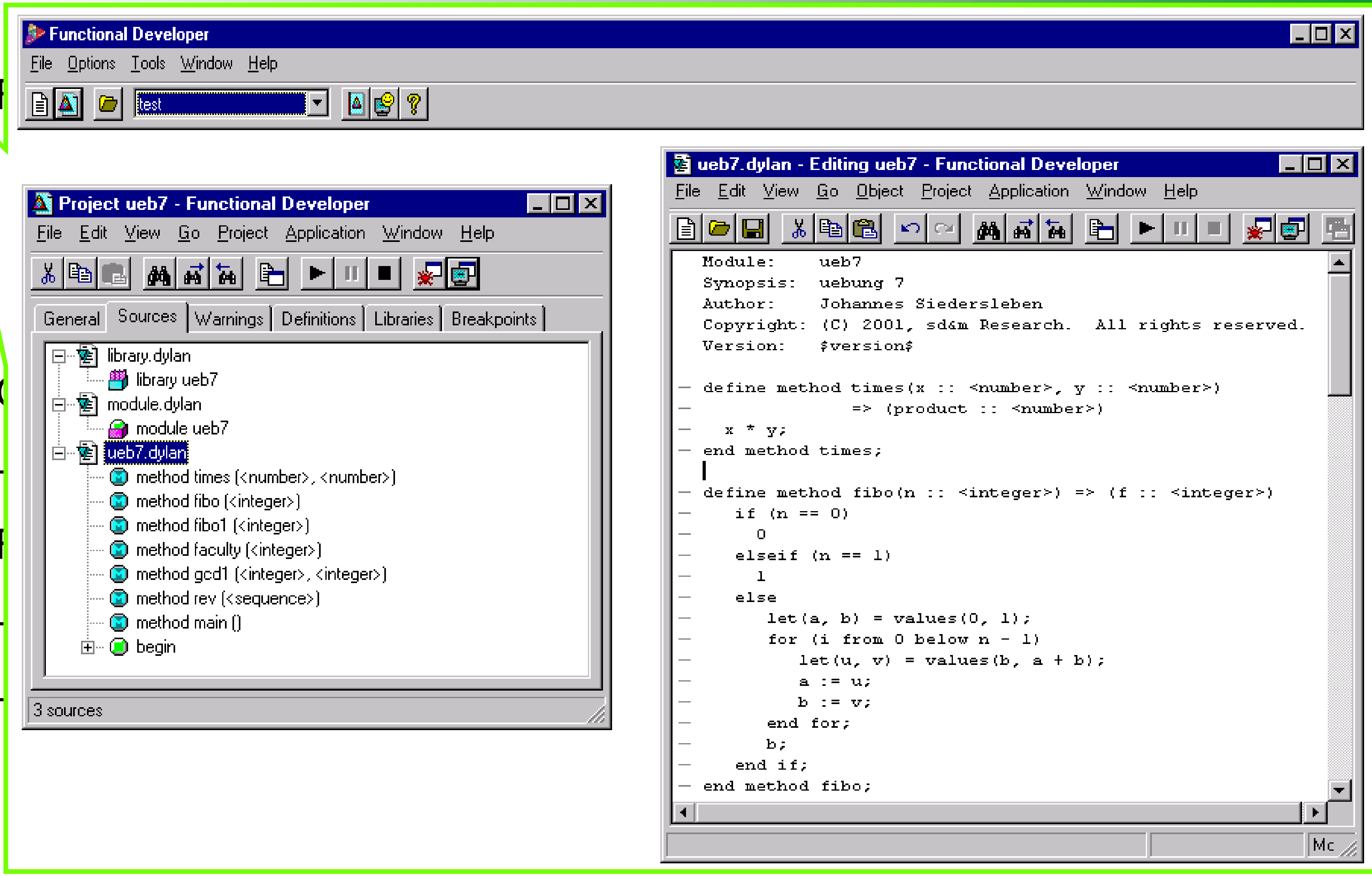
Dylan has been inspired by functional programming languages

- The language was inspired by Scheme and CommonLisp
  - Dylan is a superset of Scheme
  - Extensions:
    - CommonLisp Object System
    - CommonLisp Condition System
    - A production-rule based macro processor
- But: Language syntax is more like Pascal or Modula
- Dylan is a best of breed language; it combines object-oriented, functional and algorithmic programming paradigms

Dylan has been developed by several partners

- Three major partners has been involved in the development of the language
  - Carnegie-Mellon University (Project Gwydion)
  - Digital Corporation
  - Apple Computers, Inc.
  - Harlequin
- Dylan is a general purpose language, but it was targeted for small devices in the beginning (similar to Java)
  - Apple Newton
- The first language draft appeared 1993

Current resources for Dylan



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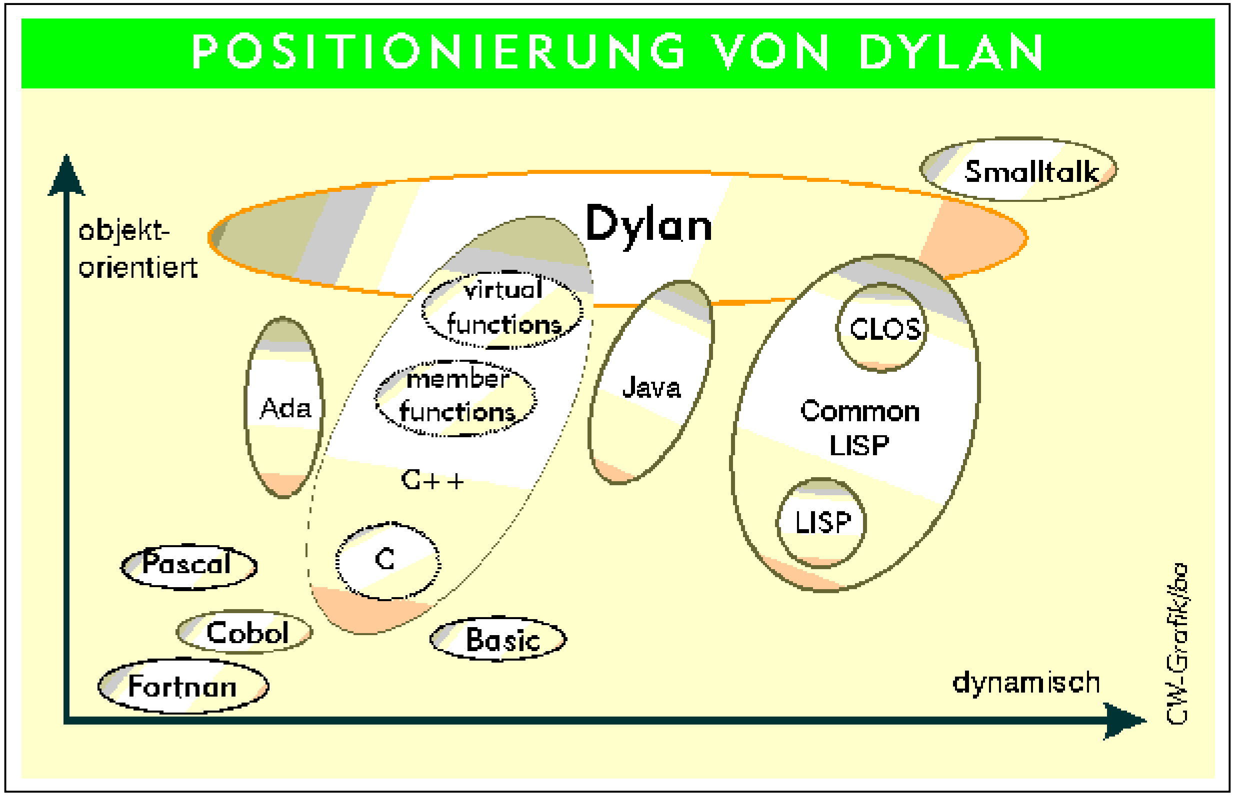
Dylan combines extrem object-oriented concepts with static and dynamic programming style



Every little thing in Dylan is an object

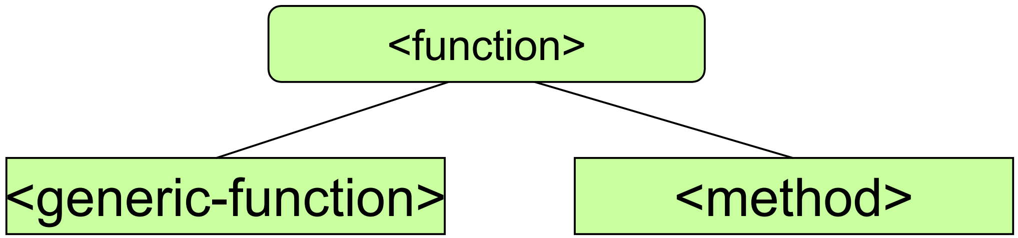
- All objects are first class, even:
  - Numbers and characters
  - Classes
  - Functions
- Every object can be used as a function argument
- All objects are typed and type-safe
- Variables can be strongly typed
- All objects devive from class `<object>`

A strong subset of the CommonLisp Object System is used in Dylan

- Strong support of multiple inheritance
- Slots are functions (so called slot methods, they can be specialized)
- Classes define no methods in addition to the slot methods
- Scope of names is not defined by classes
  - Dylan has an explicit name space concept based upon libraries and

```
define open abstract class <presentation> (<object>)
  keyword cached:, type: <boolean>, init-value: #f;

  sealed slot name :: <normalized-descriptor>, init-keyword: name:;
  sealed slot controller-class :: limited(<class>, subclass-of: <presentation-controller>);

  sealed slot state :: <object>, init-value: #f;

  sealed slot available-controllers :: <vector>, init-value: #[];
  sealed slot active-controllers :: <vector>, init-value: #[];

  sealed slot lru-count :: <integer>, init-value: 0;
  sealed slot cached? :: <boolean>, setter: #f, init-value: #f, init-keyword: cached:;
end class <presentation>;
```

The core concept of Dylan is the `<function>`



- A <method> is a callable unit of code identified by a fixed parameter signature
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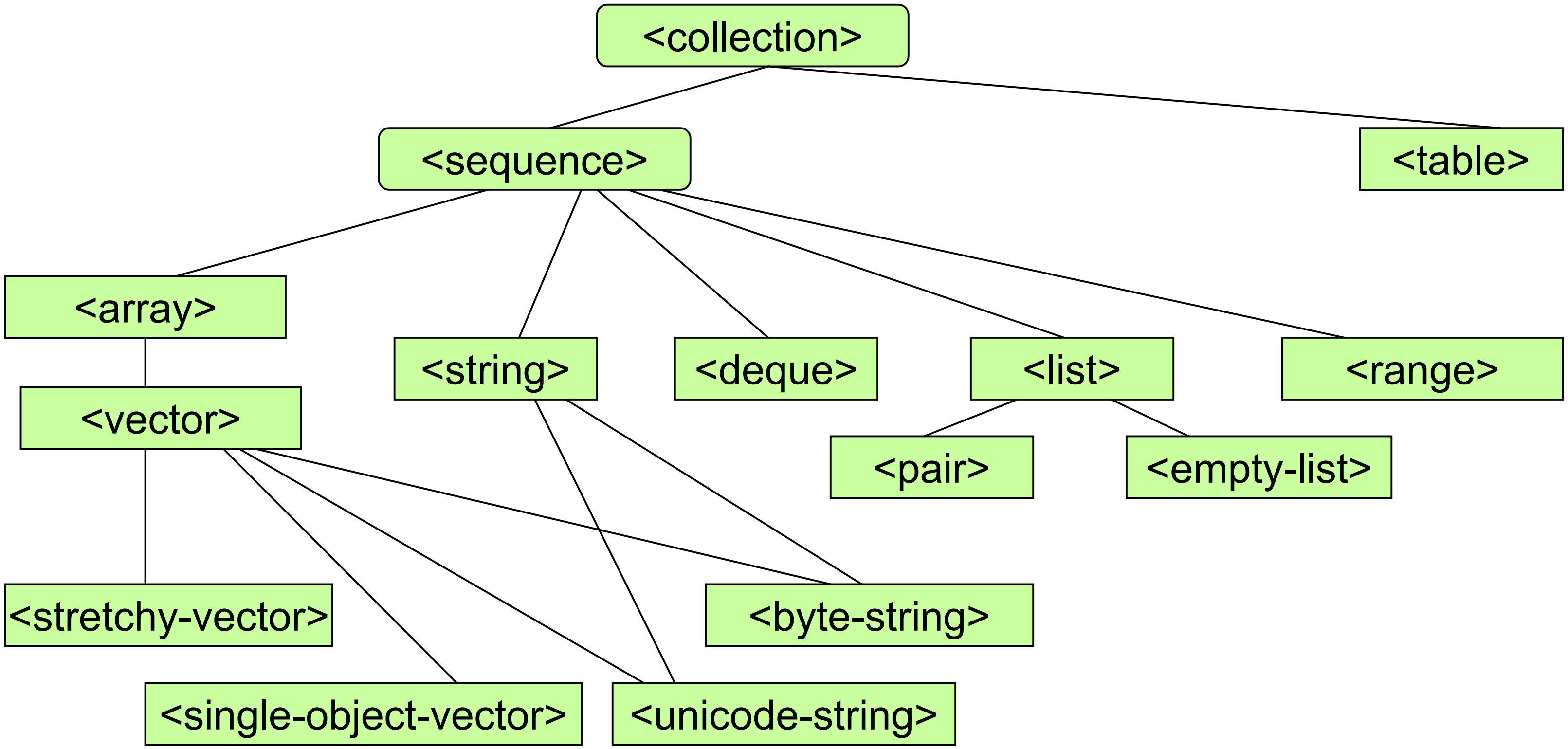
-

```
define open generic (&sequence1 :: <sequence>,
                     &sequence2 :: <sequence>, #key) => result :: <sequence>;

define method intersection (&sequence1 :: <lazy-sequence>, &sequence2 :: <sequence>,
                            #key key: &key :: <function> = identity,
                                 test: &test :: <function> = \==)
      => result :: <lazy-sequence>;
  choose(method (&item)
           member?(&item, &sequence2, key: &key, test: &test)
         end method,
         &sequence1);
end method intersection;
```

A complete collection framework including functional iteration and mapping is supplied



- Supplied iteration and mapping functions:
  - do, map, map-as, map-into, member?, any?, every?, choose, ...

The condition (exception) handling of Dylan surpasses everything known in the C-world

- Both exceptions and handlers are objects
- Handlers can fix the problem and return to the signalling code block or they can
- Exc bef
- Sev
- Sim
- N

```
defi
  ..
  bl
  ex
  en
```

```
bject>);
```

```
local method run-block-lock ()
        let &run :: <integer> = 0;

        while (#t)
          block (return)
            let handler <kill> = method (&condition :: <kill>,
                                         &next :: <function>)
                                   if (&run > 1000)
                                     return();
                                   end if;

                                   &next();
                                 end method;

            ... // Test code comes here...

            &run := &run + 1;
          end block;
        end while;
      end method;
```

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Dylan combines multiple inheritance with the so called multimethod dispatch

- Classes define no direct methods beside the slot methods
- Dylan uses generic functions for the active part of a program
- Each generic function can be compromised of methods that adhere to the parameter contract of this function
- Parameters of methods are strongly typed and define the type of arguments the method can be applied to
- The number of the so called applicable methods are computed for every concrete argument situation prior to the function invocation
- The applicable methods are sorted according to their specifity using a class precedence list (short: CPL) algorithm
- The most specific method is invoked
- A method can invoke the next most specific method by calling `next-method();`

Even operators are generic functions in Dylan and can be specialized

```
define generic method \+(x :: <object>,
                         y :: <object>) => z :: <object>;

define method \+(r :: <ratio>, i :: <integer>) => (s :: <rat>)
  r + make(<ratio>, numerator: i)
end \+;

define method \+(s :: <string>, t :: <string>) => (r :: <string>)
  concatenate(s, t);
end method \+;
```

After this definition a program can write:

```
let h :: <string> = "Hello";
let w :: <string> = "World";

let hw :: <string> = h + " " + w;
```

Multimethods allows much more cleaner code than using traditional object-oriented techniques

```
class Shape {
  bool intersect(Shape s) {
    /* generic case - slow */
  }
}
class Rect {
  bool intersect(Shape s) {
      if ( s instanceof Rect ) {
        /* simple and fast */
      }
      else {
        super.intersect(s);
      }
}
class Circle {
  bool intersect(Shape s) {
      if ( s instanceof Circle ) {
        /* simple and fast */
      }
      else {
        super.intersect(s);
      }
}
```

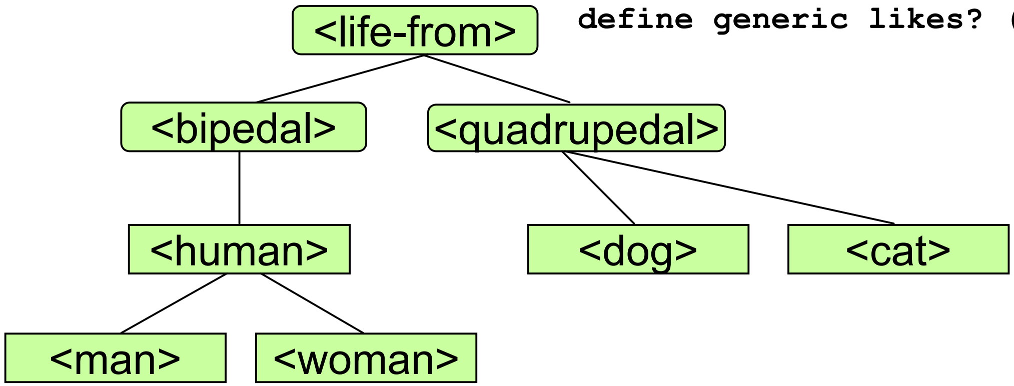
```
define generic intersect (s1 :: <shape>,
                          s2 :: <shape>)
      => <boolean>;

define method intersect (s1 :: <shape>,
                         s2 :: <shape>)
      => <boolean>;
  /* generic case - slow */
end method;

define method intersect (s1 :: <rect>,
                         s2 :: <rect>)
      => <boolean>;
  /* simple and fast */
end method;

define method intersect (s1 :: <circle>,
                         s2 :: <circle>)
      => <boolean>;
  /* simple and fast */
end method;
```

Methods can be added to generic functions at any time

- When a generic function is not sealed, methods can be added by everyone at any point in the program
- Methods can be added syntactically according to the name scope or by using a call to `add-method(...);`
- Every method must comply with the parameter signature of the generic function
- Methods can belong to several generic functions (esoteric feature)
- Methods can be even removed from a generic function by calling `remove-method(...);`
- A complete set of introspection function are available

A complex sample

```
define generic likes? (a :: <life-form>,
                       b :: <life-form>) => likes? :: <boolean>;
```




```
define method likes? (a :: <life-form>, b :: <life-form>) => likes? :: <boolean>
  #f;
end method likes?;

define method likes? (cat :: <cat>, whoCares :: <life-form>) => likes? :: <boolean>
  gives-food?(whoCares);
end method likes?;

define method likes? (dog :: <dog>, human :: <human>) => likes? :: <boolean>
  pet?(human, dog);
end method likes?;

define method likes? (man :: <man>, woman :: <woman>) => likes? :: <boolean>
  looks-good?(woman);
end method likes?;

define method likes? (woman :: <woman>, man :: <man>) => likes? :: <boolean>
  intelligent?(man) & rich?(man);
end method likes?;
```

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Dylan provides a complete set of functional programming constructs

- Functional com
  - Closures
  -
- Func
  - appl
- Iteration
  - do, ma

```
define method addX (n :: <number>, x :: <number>)
  n + x;
end;
```

```
define method add2 (x :: <integer>, y :: <integer>)
er
```

```
# sco
=> 10
# sco
=> 11
# sco
=> 130
# score
=> 470
```

```
#
=>
#
=>
#
=>
```

```
# do(method (a, b) print(a + b); end,
     #(100, 200, 300, 400), #(1, 2, 3));
101
202
303
=> #f
# map(\+, #(1, 2, 3), #(4, 5, 6));
=> #(5, 7, 9)
# reduce(max, 10, #(2, 4, 6, 11));
=> 11
# reduce1(\+, #(1, 2, 3, 4, 5));
=> 15
# choose(even?, #(3, 1, 4, 5, 6, 2));
=> #(4, 6, 2)
# choose-by(even?, range(from: 1),
            #("a", "b", "c", "d", "e", "f", "g", "h"));
=> #("b", "d", "f", "h")
```

Sample from a real application

```
define function build-from-part (&environment :: <sequence>,
                                 &expression :: <select-query-expression>,
                                 #rest &args) => (from-part :: <string>,
                                                  hints :: false-or(<string>));
  let &variables :: <sequence> = remove-duplicates!(as(<vector>, first(&environment).variables));
  let &classes :: <sequence> = choose(rcurry(instance?, <transformed-class>), &variables);
  let &structs :: <sequence> = choose(rcurry(instance?, <transformed-struct>), &variables);
  let &sequences :: <sequence> = choose(rcurry(instance?, <transformed-sequence>), &variables);
  let &first? :: <boolean> = #t;
  let &from-part :: <string> = $empty-string;
  let &hints = #f;

  local method make-table-from-string (&alias :: <string>, &table :: <string>)
          ...
        end method;

  unless (empty?(&classes))
    &classes := choose(complement(compose(empty?, specifity)), &classes);

    unless (empty?(&classes))
      let &class :: <transformed-class> =
            first(sort!(&classes, key: compose(curry(reduce, \+, 0), specifity)));
      let &specifity :: <integer> = reduce(max, 0, &class.specifity);

      ...
    end unless;
  end unless;
```

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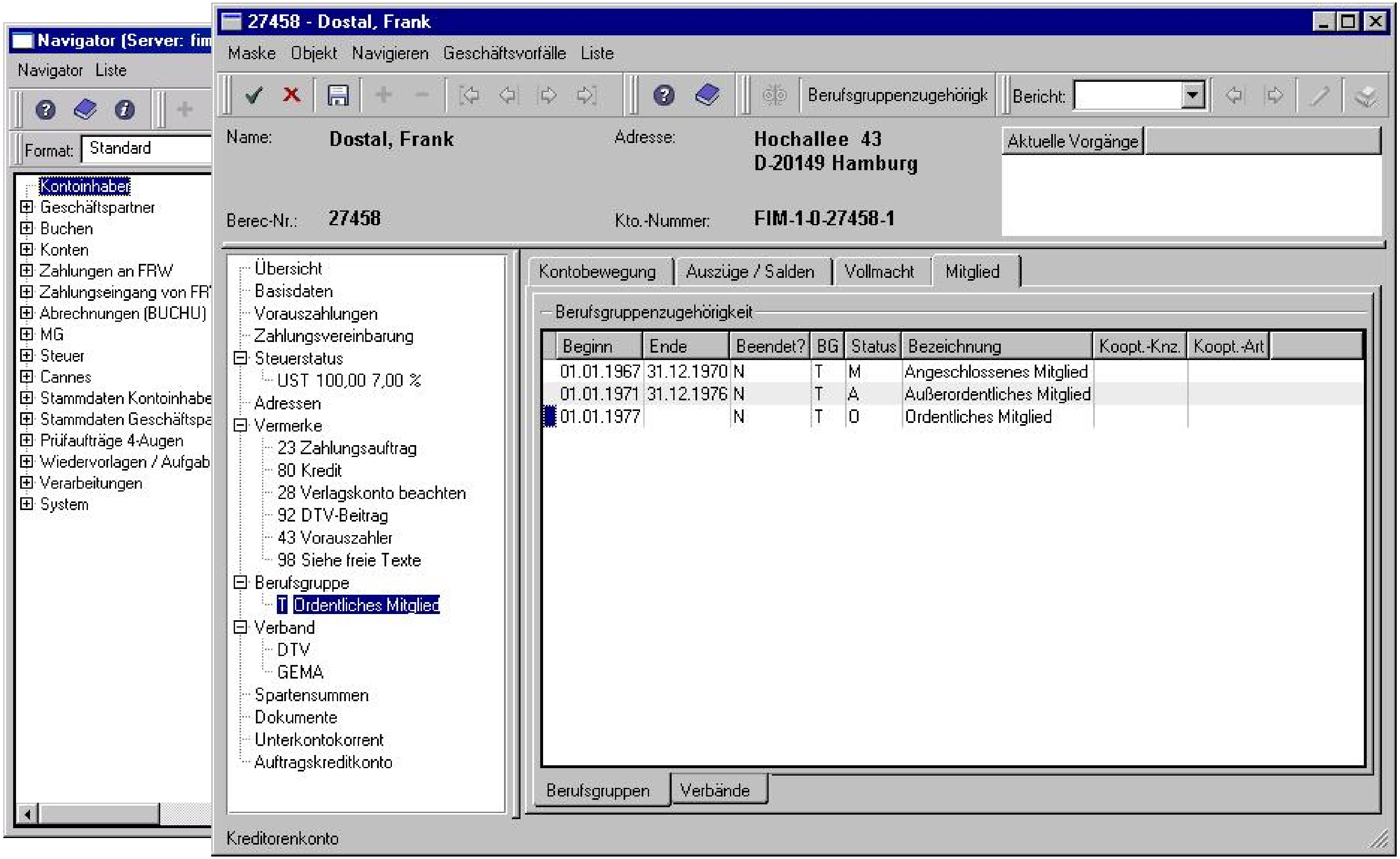
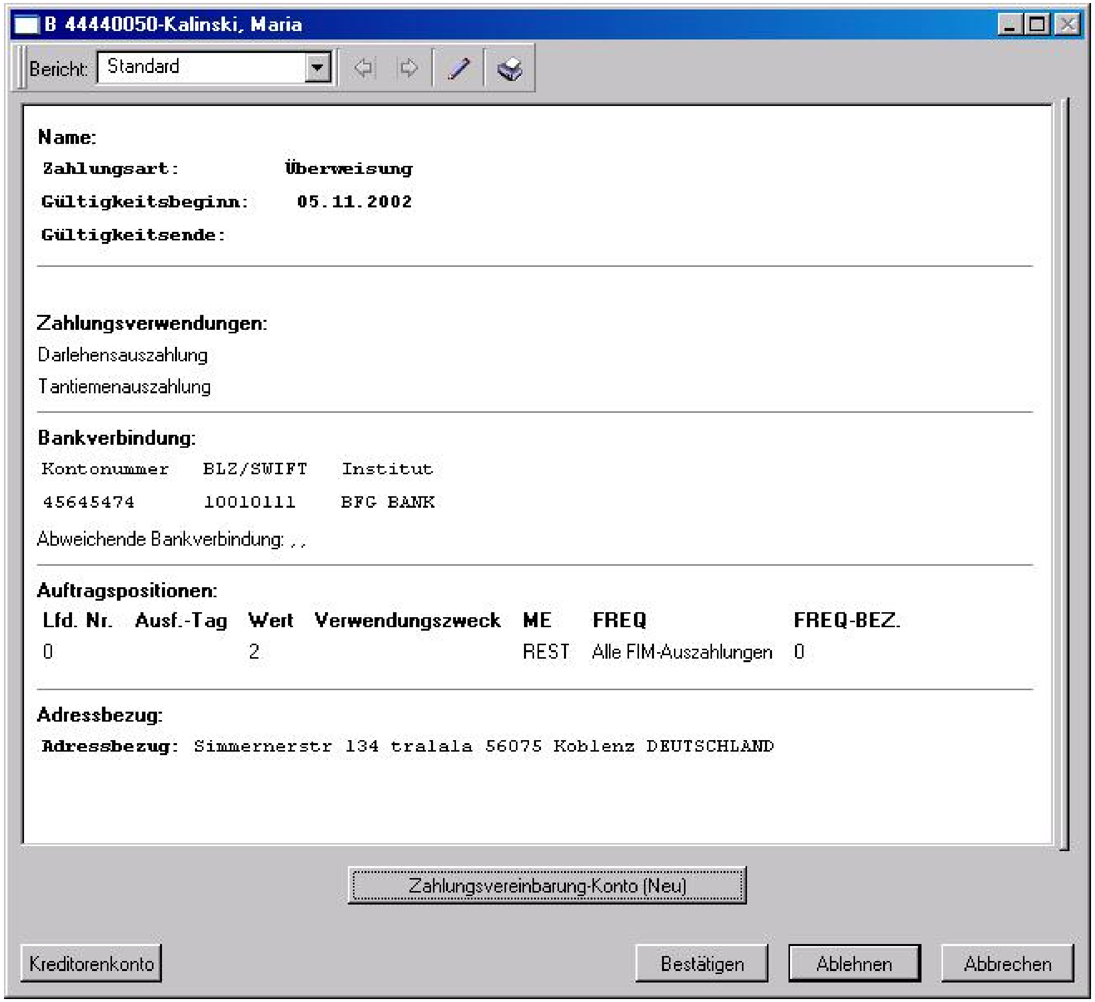
Dylan can be used successfully in very large commercial information systems

- Project FIM for GEMA
  - Central application of the company
  - About 50 person-years development effort
  - About 4 million lines of code written completely in Dylan
    - 1.5 million lines of code for technical framework
    - 2.5 million lines of code for the application
  - About 400 dialogs and 45 batches
  - About 800 persistent classes (tables) in the underlying database
  - Some tables have about 30 million entries
- The project has been started before Java matured and has gone into production before the first J2EE application server was commercially available

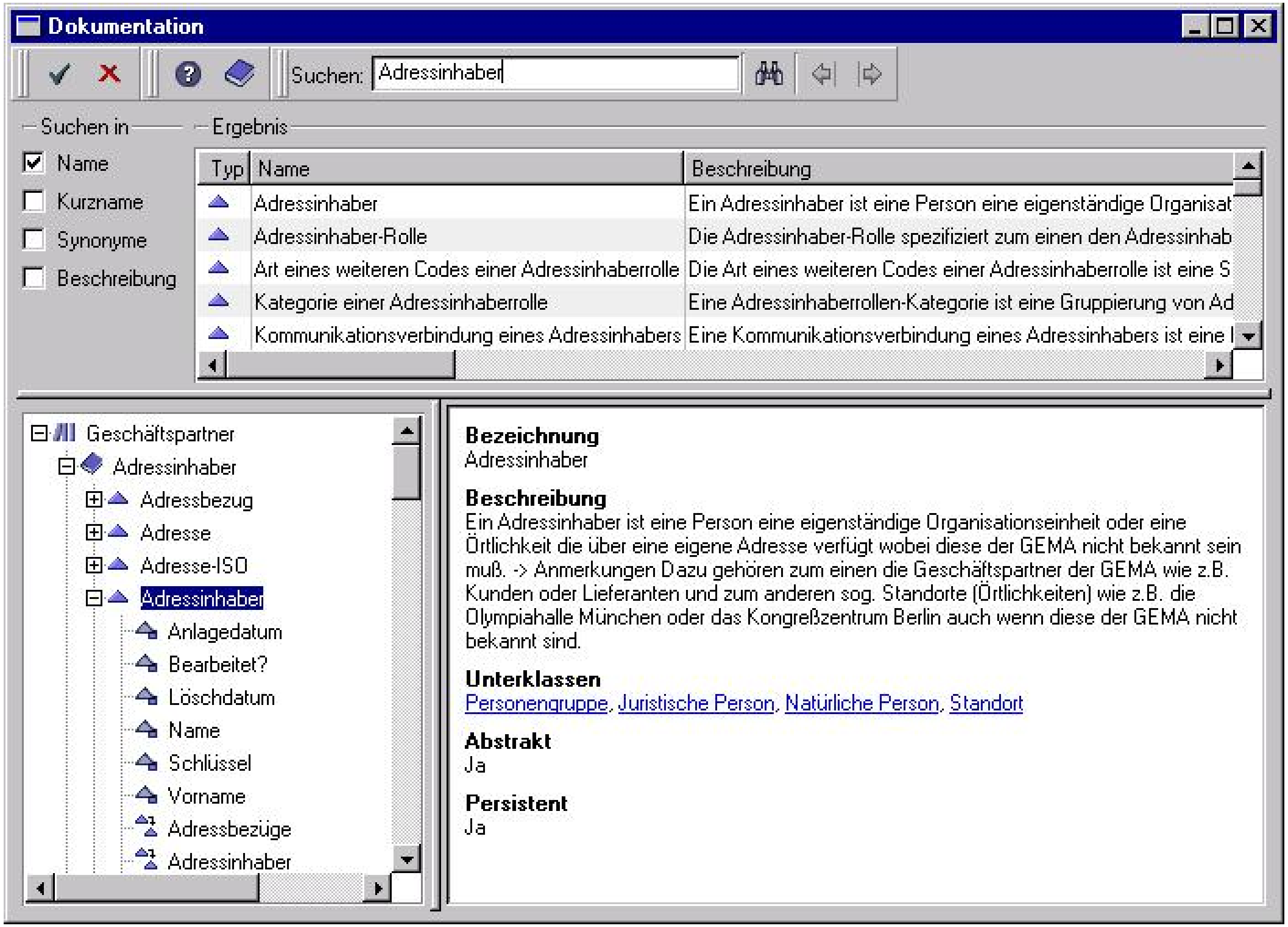
Some screenshots of FIM (1/4)



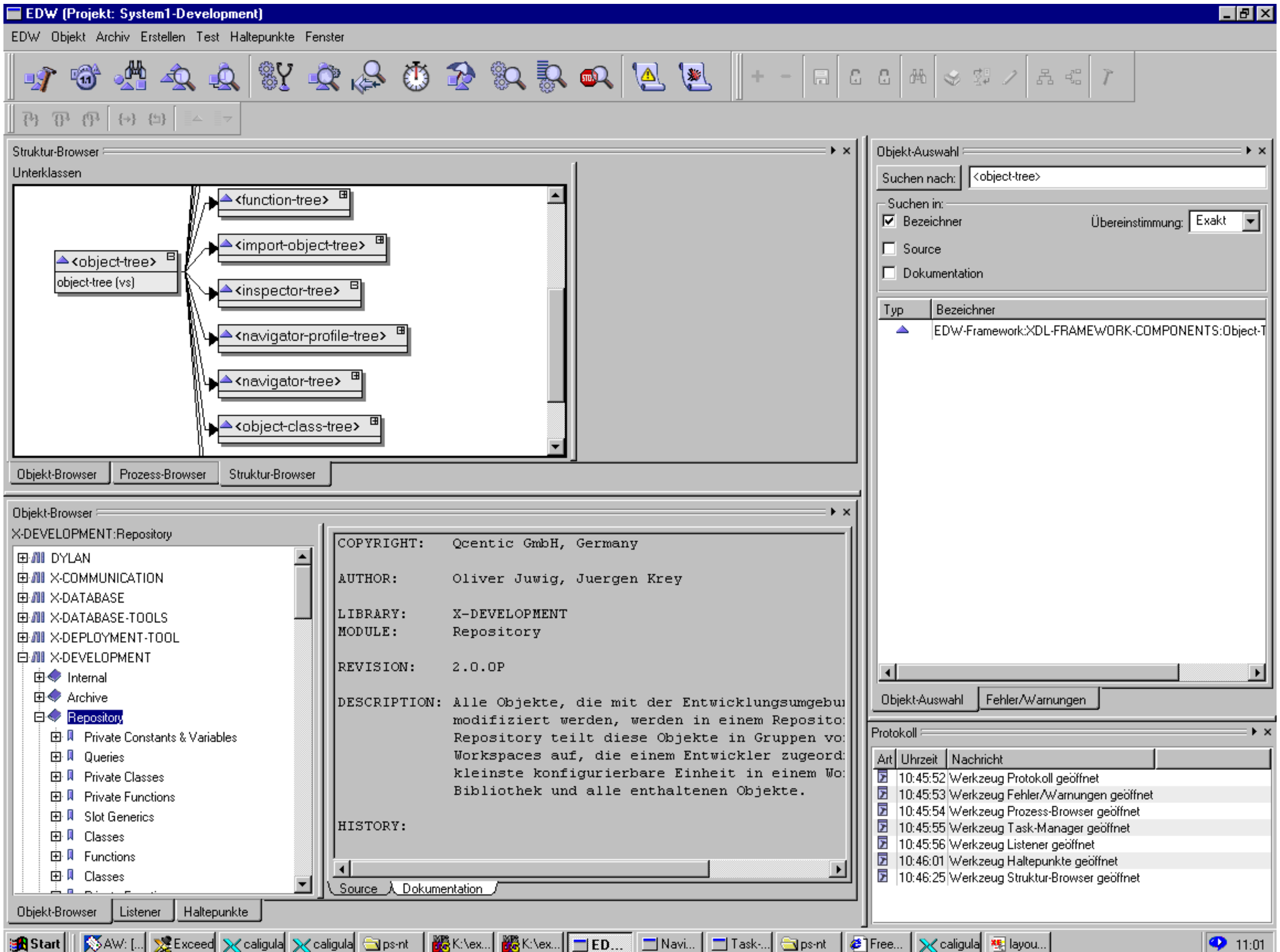
Some screenshots of FIM (2/4)



Some screenshots of FIM (3/4)



Some screenshots of FIM (4/4)



Discussion

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