16-1

try M_1 finally M_2

$\Rightarrow$ catch M_1 with $(\lambda X.\ \text{seq}(M_2, \text{throw } X))$

$\text{seq}(M_1, M_2) = (\lambda X.\ M_2)\ M_1$
where $X \notin FV(M_2)$

Resume - ISWIM

$M ::= \ldots \mid \text{throw } M \mid \text{catch } M_1 \text{ with } (\lambda X. \lambda R.\ M_2)$

resumer

thrown value

$F ::= \ldots \mid \text{throw } F$

$E[\text{catch } F[\text{throw } V] \text{ with } (\lambda X. \lambda R.\ M_2)]$

$\mapsto E[(M_2\ V)\ (\lambda Z.\ F[Z])]$

no longer forgotten, turned into a function "reified context"

$(+\ 1\ (R\ 3))$

$K ::= \ldots \mid \text{catch}(E, \lambda X.\lambda R.\ M_2, K) \mid \text{throw}(k)$

$V ::= b \mid \text{clo}(\lambda X.\ M, E) \mid \text{kont}(k)$

~~$<$throw~~ $\langle V, E, \text{throw}(k)\rangle$ $\quad \langle E', k', M_2, R\rangle$

$\mapsto \langle ((M_2\ V)\ R), E', k'\rangle \quad := \text{search}(K, \text{ret})$

$\text{search}(\text{fun}(V, k_1), k_2) = \text{search}(k_1, \text{fun}(V, k_2))$

$\text{search}(\text{arg}(E, N, k_1), k_2) = \text{search}(k_1, \text{arg}(E, N, k_2))$

$\text{search}(\text{ret}, k_2) = \langle \emptyset, \text{ret}, (\lambda X.\lambda R.\ X), \text{kont}(k_2)\rangle$

$\text{search}(\text{catch}(E, M, k_1), k_2) = \langle E, k_1, M, \text{kont}(k_2)\rangle$

$\langle V, E, \text{fun}(\text{kont}(k_2), k_1)\rangle \mapsto \langle V, E, k_2\rangle$

$M ::= \ldots \mid \text{abort } M$

....

$\mapsto E[(M_2\ V)\ (\lambda Z.\ \text{abort } E[F[Z]])]$

$E[\text{abort } M] \mapsto M$

First-Class Kontinuations
- Continuations are reified in ~~the~~ language

~~M = X (λX.M)~~

$M = V \mid X \mid (M\ N) \mid (o^n\ M \ldots) \mid \text{callcc}\ M$

$V = b \mid (\lambda X.M) \mid K\ E$

$E = \square \mid (E\ N) \mid (V\ E) \mid (o^n\ V \ldots\ E\ M \ldots) \mid \text{callcc}\ E$

$E[(\lambda X.M)\ V] \mapsto E[M[X \leftarrow V]]$

$E[(o^n\ b \ldots)] \mapsto E[\delta(o^n, b \ldots)]$

$E[\text{callcc}\ V] \mapsto E[V\ (K\ E)]$ copied

$E[(K\ E')\ V] \mapsto E'[V]$

forgotten

$\ulcorner$catch M_1 with $(\lambda X.M_2)\urcorner$

$\Rightarrow$ ~~callcc (λ THROW M ...)~~

callcc $(\lambda K.$

let THROW $= (\lambda X.(K\ M_2))$ in

$M_1)$

$\ulcorner$throw $M\urcorner$

$\Rightarrow$ THROW M

callcc = call with current continuation