

Figure 6.1: The RETRIEVER

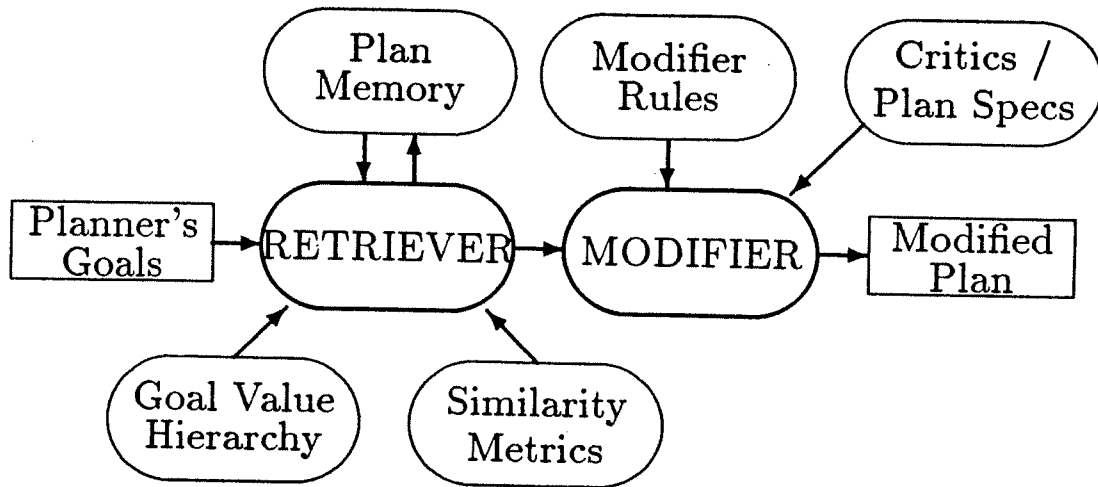


Figure 6.2: The MODIFIER

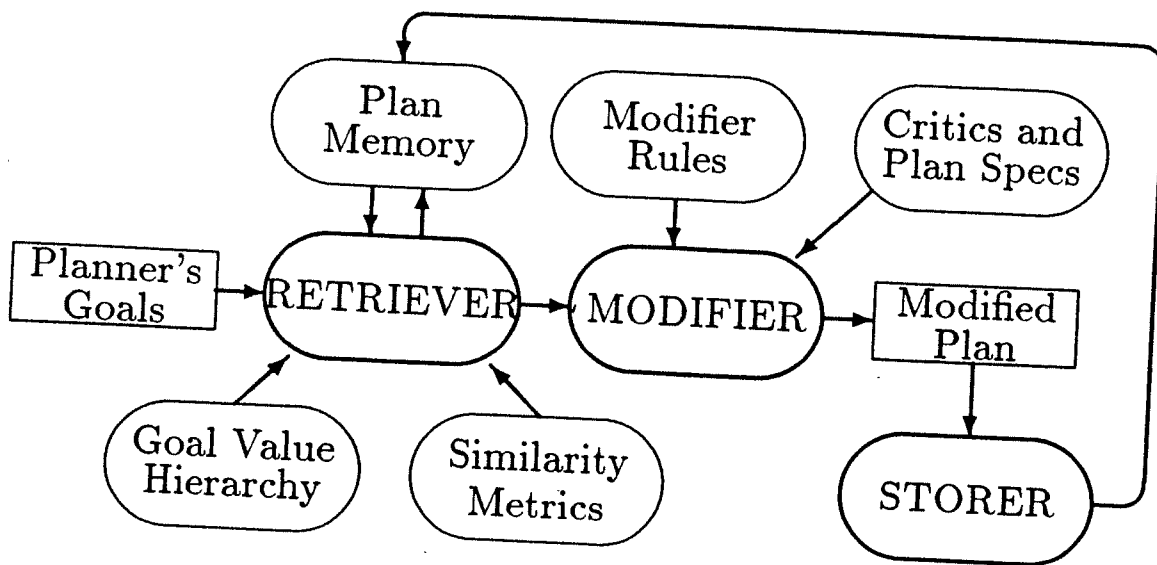


Figure 6.3: The STORER

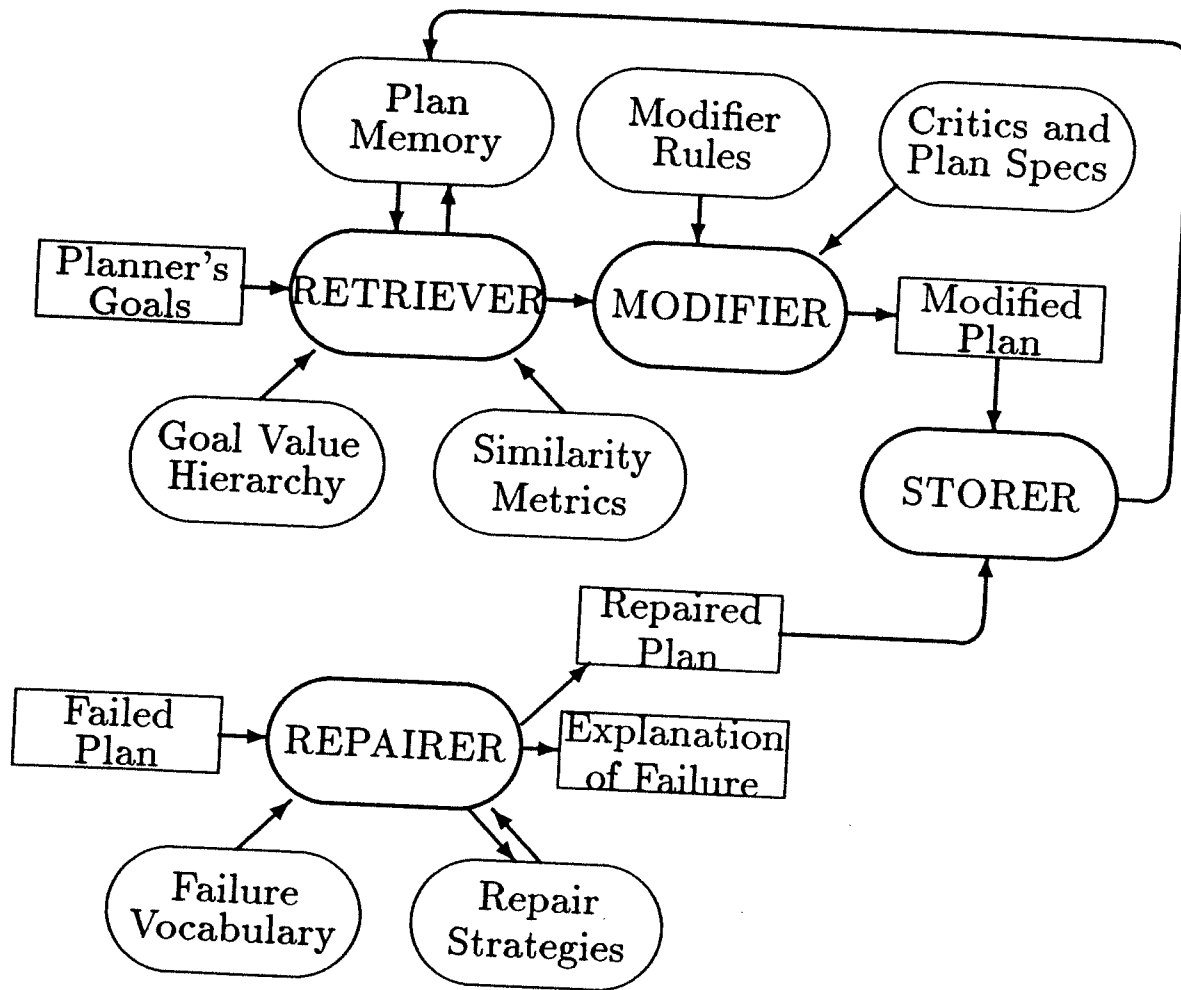


Figure 6.4: The REPAIRER

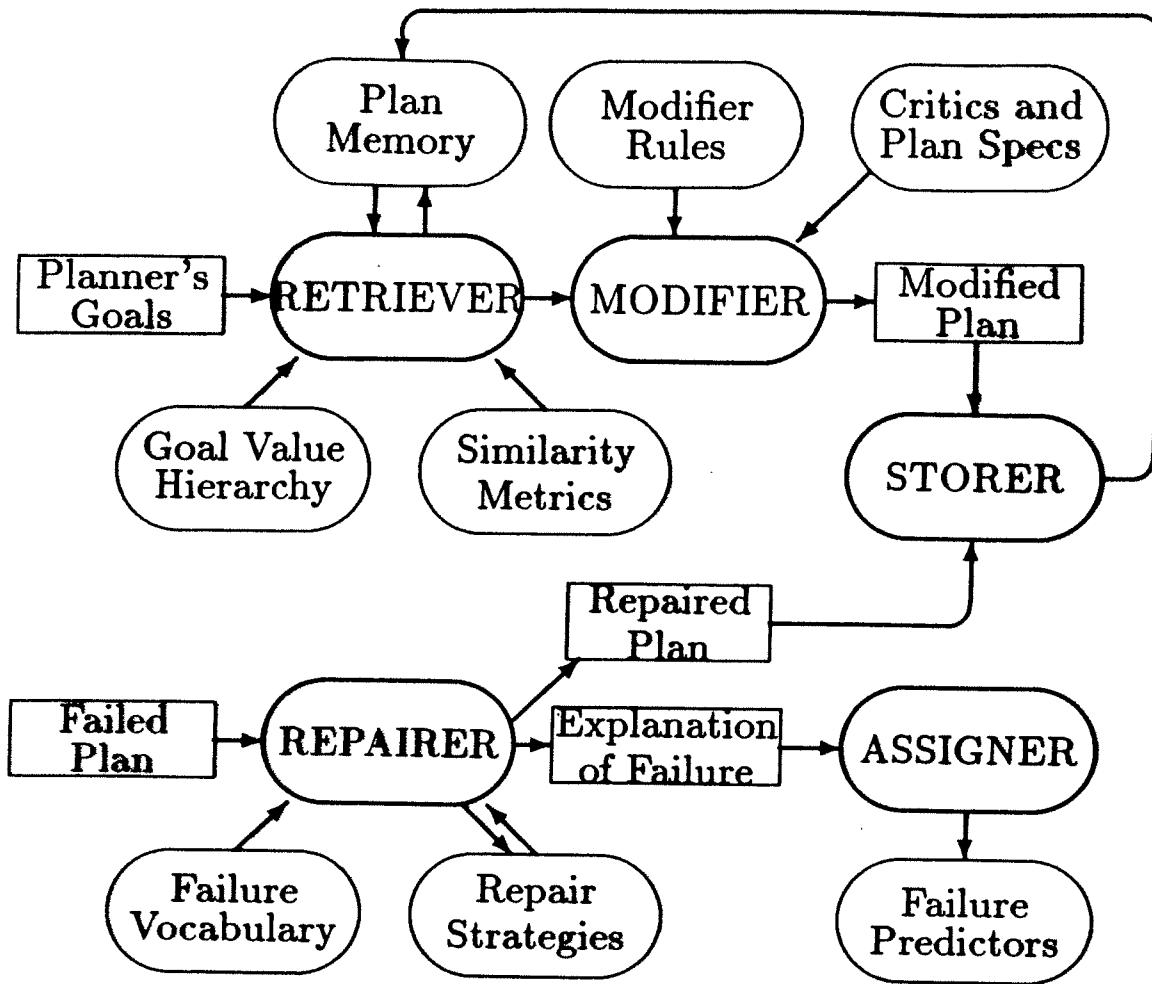


Figure 6.5: The ASSIGNER

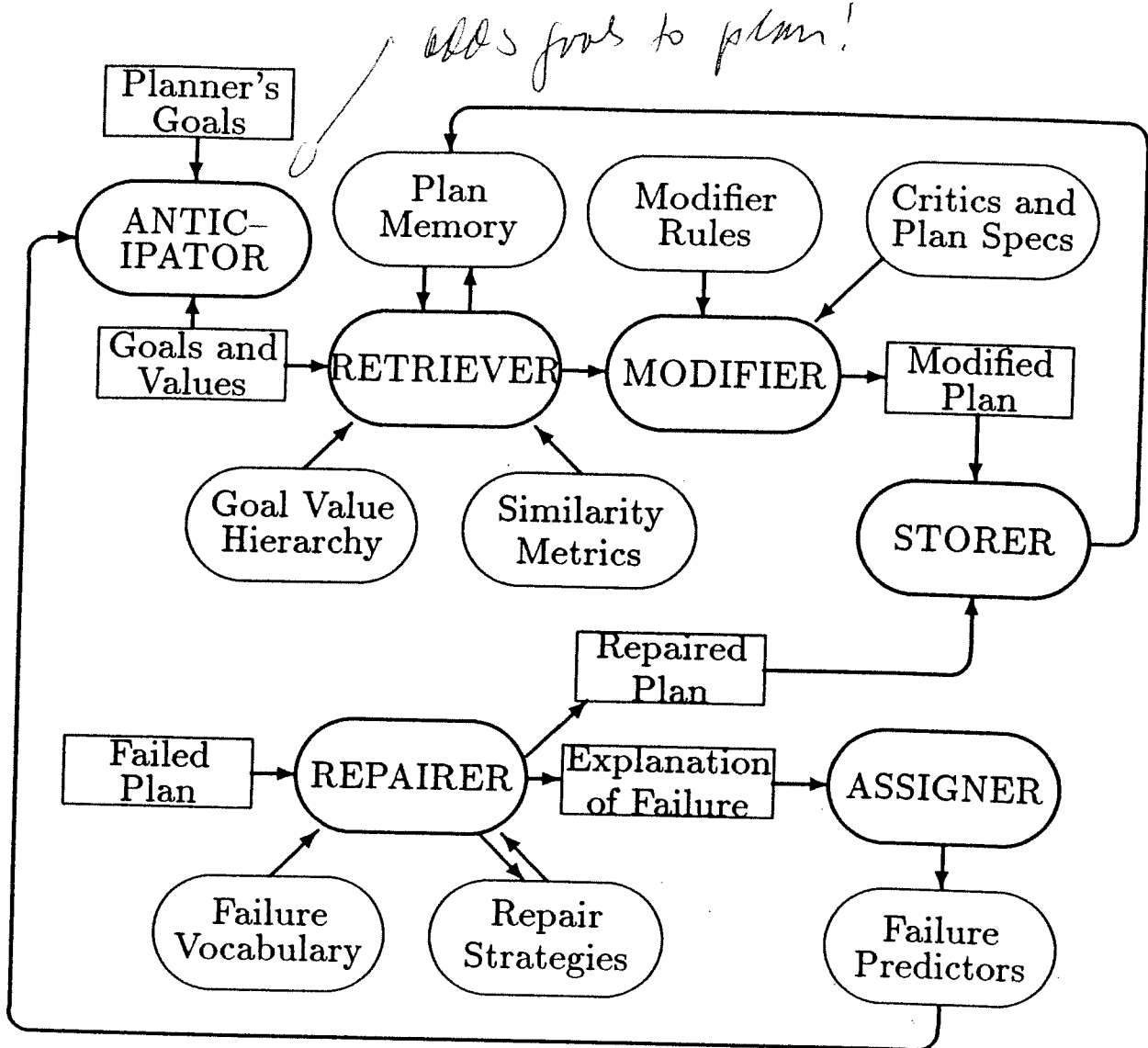


Figure 6.6: The ANTICIPATOR

Searching for plan that satisfies -

Include beef in the dish.

Include broccoli in the dish.

Make a stir-fry dish.

Found recipe -> REC2 BEEF-WITH-GREEN-BEANS

Recipe exactly satisfies goals ->

Make a stir-fry dish.

Include beef in the dish.

Recipe partially matches ->

Include broccoli in the dish.

in that the recipe satisfies:

Include vegetables in the dish.

Retrieval Phase

Building new name for copy of BEEF-WITH-GREEN-BEANS
Calling recipe BEEF-AND-BROCCOLI

Modifying recipe: BEEF-AND-BROCCOLI
to satisfy: Include broccoli in the dish.

Placing some broccoli in recipe BEEF-AND-BROCCOLI

- Considering ingredient-critic:
 - Before doing step: Stir fry the -Variable-
 - do: Chop the broccoli into pieces the size of chunks.
- ingredient-critic applied.

Modified

A half pound of beef
Two tablespoons of soy sauce
One teaspoon of rice wine
A half tablespoon of corn starch
One teaspoon of sugar
→ A half pound of broccoli
One teaspoon of salt
One chunk of garlic

Chop the garlic into pieces the size of matchheads.
Shred the beef.

Marinate the beef in the garlic, sugar, corn starch,
rice wine and soy sauce.

→ Chop the broccoli into pieces the size of chunks.
Stir fry the spices, rice wine and beef for one minute.
Add the broccoli to the spices, rice wine and beef.
Stir fry the spices, rice wine, broccoli and beef
for three minutes.
Add the salt to the spices, rice wine, broccoli and beef.

CHEF knows more than just the steps of this plan. It also knows what goals should be satisfied when it is run. These goals are derived from its knowledge of stir-frying and its understanding of what items are important in this recipe. In particular, executing this plan should result in the following:

The beef is now tender. The dish now tastes salty.
The dish now tastes savory. The dish now tastes sweet.
The broccoli is now crisp. The dish now tastes like garlic.

Modified Plan

Checking goals of recipe -> BEEF-AND-BROCCOLI

Recipe -> BEEF-AND-BROCCOLI has failed goals.

The goal: The broccoli is now crisp.
is not satisfied.

It is instead the case that: The broccoli is now soggy.

Unfortunately: The broccoli is now a bad texture.
In that: The broccoli is now soggy.

Changing name of recipe BEEF-AND-BROCCOLI
to BAD-BEEF-AND-BROCCOLI

CHEF checks the goals of a plan against the results of a simulation of the plan that is its equivalent of the real world.

Simulator

Explaining the following failures:

It is not the case that: The broccoli is now crisp.
in that: The broccoli is now soggy.

The broccoli is now a bad texture.
in that: The broccoli is now soggy.

In: BAD-BEEF-AND-BROCCOLI

ASKING THE QUESTION: 'What is the failure?'

ANSWER-> The failure is: It is not the case that: The
broccoli is now crisp.

ASKING THE QUESTION: 'What is the preferred state?'

ANSWER-> The preferred state is: The broccoli is now crisp.

ASKING THE QUESTION:

'What was the plan to achieve the preferred state?'

ANSWER-> The plan was: Stir fry the sugar, soy sauce, rice
wine, garlic, corn starch, broccoli and beef for
three minutes.

ASKING THE QUESTION:

'What were the conditions that led to the failure?'

ANSWER-> The condition was: There is thin liquid in the
pan from the beef equaling 4.8 teaspoons.

ASKING THE QUESTION:

'What caused the conditions that led to the failure?'

*Trace of Plan Failure Explanation,
Part I*

ANSWER-> There is thin liquid in the pan from the beef equaling 4.8 teaspoons was caused by: Stir fry the sugar, soy sauce, rice wine, garlic, corn starch, broccoli and beef for three minutes.

ASKING THE QUESTION:

'Do the conditions that caused the failure satisfy any goals?'

ANSWER-> The condition: There is thin liquid in the pan from the beef equaling 4.8 teaspoons is a side effect only and meets no goals.

ASKING THE QUESTION:

'What goals does the step which caused the condition enabling the failure satisfy?'

ANSWER-> The step: Stir fry the sugar, soy sauce, rice wine, garlic, corn starch, broccoli and beef for three minutes.
enables the satisfaction of the following goals:
The dish now tastes savory.
The beef is now tender.

CHEF explains the failures that it encounters through a causal description of why they have occurred.

*Trace of Plan Failure Explanation
Part II*

Found TOP TOP1 -> SIDE-EFFECT:DISABLED-CONDITION:CONCURRENT
TOP -> SIDE-EFFECT:DISABLED-CONDITION:CONCURRENT has 3
strategies associated with it:
 SPLIT-AND-REFORM
 ALTER-PLAN:SIDE-EFFECT
 ADJUNCT-PLAN

CHEF uses its causal description of a problem to find a TOP
that has strategies which will solve it.

ATOP

Applying TOP -> SIDE-EFFECT:DISABLED-CONDITION:CONCURRENT
to failure it is not the case that: The broccoli is now
crisp.

in recipe BAD-BEEF-AND-BROCCOLI

Asking questions needed for evaluating strategy:
SPLIT-AND-REFORM

ASKING -> Can plan

Stir fry the sugar, soy sauce, rice wine,
garlic, corn starch, broccoli and beef for
three minutes.
be split and rejoined

Found plan: Instead of doing step: Stir fry the sugar,
soy sauce, rice wine, garlic, corn starch, broccoli
and beef for three minutes
do:

S1 = Stir fry the broccoli for three minutes.

S2 = Remove the broccoli from the result of action S1.

S3 = Stir fry the sugar, soy sauce, rice wine, garlic,
corn starch and beef for three minutes.

S4 = Add the result of action S2 to the result of action
S3.

S5 = Stir fry the result of action S4 for a half minute.

Asking questions needed for evaluating strategy:
ALTER-PLAN:SIDE-EFFECT

ASKING -> Is there an alternative to

Stir fry the sugar, soy sauce, rice wine,
garlic, corn starch, broccoli and beef for

Repairing a Plan Part I

three minutes.
that will enable
The dish now tastes savory.
which does not cause
There is thin liquid in the pan from the
beef equaling 4.8 teaspoons.

No alternate plan found

Asking questions needed for evaluating strategy:

ADJUNCT-PLAN

ASKING -> Is there an adjunct plan that will disable
There is thin liquid in the pan from the beef
equaling 4.8 teaspoons.
that can be run with
Stir fry the sugar, soy sauce, rice wine, garlic,
corn starch, broccoli and beef for three minutes.

No adjunct plan found

Deciding between modification plans suggested by
strategies:

Only one modification can be implemented

-> SPLIT-AND-REFORM

Implementing plan -> Instead of doing step: Stir fry the
sugar, soy sauce, rice wine, garlic, corn starch,
broccoli and beef for three minutes.

do: S1 = Stir fry the broccoli for three minutes.
S2 = Remove the broccoli from the result of action S1.
S3 = Stir fry the sugar, soy sauce, rice wine, garlic,
corn starch and beef for three minutes.
S4 = Add the result of action S2 to the result of
action S3.
S5 = Stir fry the result of action S4 for a half
minute.

Suggested by strategy SPLIT-AND-REFORM.

Repairing a Plan

Part II

Building demons to anticipate failure.

Building demon: DEMONO to anticipate interaction between rules:

"Meat sweats when it is stir-fried."

"Stir-frying in too much liquid makes vegetables soggy."

Indexing demon: DEMONO under item: MEAT

by test:

Is the item a MEAT.

Indexing demon: DEMONO under item: VEGETABLE

by test:

Is the item a VEGETABLE.

and Is the TEXTURE of item CRISP.

Goal to be activated = Avoid failure of type
SIDE-EFFECT:DISABLED-CONDITION:CONCURRENT
exemplified by the failure 'The broccoli is now soggy'
in recipe BEEF-AND-BROCCOLI.

Building demon: DEMON1 to anticipate interaction between rules:

"Liquids make things wet."

"Stir-frying in too much liquid makes vegetables soggy."

Indexing demon: DEMON1 under item: SPICE

by test:

Is the TEXTURE of item LIQUID.

Indexing demon: DEMON1 under item: VEGETABLE

by test:

Is the item a VEGETABLE.

and Is the TEXTURE of item CRISP.

Goal to be activated = Avoid failure of type
SIDE-EFFECT:DISABLED-CONDITION:CONCURRENT
exemplified by the failure 'The broccoli is now soggy' in
recipe BEEF-AND-BROCCOLI.

CHEF uses its explanation of why a failure has occurred to build links that will allow it to predict the failure later, in similar circumstances.

Anticipator

Searching for plan that satisfies -

Include chicken in the dish.

Include snow pea in the dish.

Make a stir-fry dish.

Avoid failure of type

SIDE-EFFECT:DISABLED-CONDITION:CONCURRENT

exemplified by the failure 'The broccoli is now soggy'
in recipe BEEF-AND-BROCCOLI.

Found recipe -> REC9 BEEF-AND-BROCCOLI

Recipe exactly satisfies goals ->

Avoid failure of type

SIDE-EFFECT:DISABLED-CONDITION:CONCURRENT

exemplified by the failure 'The broccoli is now soggy'
in recipe BEEF-AND-BROCCOLI.

Make a stir-fry dish.

Recipe partially matches ->

Include chicken in the dish.

in that the recipe satisfies: Include meat in the
dish.

Recipe partially matches ->

Include snow pea in the dish.

in that the snow pea can be substituted for the
broccoli

Building new name for copy of BEEF-AND-BROCCOLI based on its
goals.

Calling recipe CHICKEN-STIR-FRIED

Modifying recipe: CHICKEN-STIR-FRIED

to satisfy: Include chicken in the dish.

Placing some chicken in recipe CHICKEN-STIR-FRIED

Modifying recipe: CHICKEN-STIR-FRIED

to satisfy: Include snow pea in the dish.

Searching for plan that satisfies -

Include chicken in the dish.

Include snow pea in the dish.

Make a stir-fry dish.

Collecting and activating tests.

Fired: Is the dish STYLE-STIR-FRY.

Fired: Is the item a MEAT.

Fired: Is the item a VEGETABLE.

Is the TEXTURE of item CRISP.

Chicken + Snow Pea + Stir frying = Failure

"Meat sweats when it is stir-fried."

"Stir-frying in too much liquid makes vegetables soggy."

Reminded of BEEF-AND-BROCCOLI.

Fired demon: DEMONO

Based on features found in items: snow pea, chicken and
stir fry

Adding goal: Avoid failure of type

SIDE-EFFECT:DISABLED-CONDITION:CONCURRENT exemplified by

the failure 'The broccoli is now soggy' in recipe

BEEF-AND-BROCCOLI.

CHEF uses its understanding of past failures to anticipate problems that will arise in new situations.

Created recipe CHICKEN-STIR-FRIED

CHICKEN-STIR-FRIED

A half pound of chicken
Two tablespoons of soy sauce
One teaspoon of rice wine
A half tablespoon of corn starch
One teaspoon of sugar
A half pound of snow pea
One teaspoon of salt
One chunk of garlic

Bone the chicken.
Chop the garlic into pieces the size of matchheads.
Shred the chicken.
Marinate the chicken in the garlic, sugar, corn starch, rice wine and soy sauce.
Chop the snow pea into pieces the size of chunks.
Stir fry the snow pea for three minutes.
Remove the snow pea from the pan.
Stir fry the spices, rice wine and chicken for three minutes.
Add the snow pea to the spices, rice wine and chicken.
Stir fry the spices, snow pea, rice wine and chicken for a half minute.
Add the salt to the spices, snow pea, rice wine and chicken.

CHEF uses its anticipation of a problem to find a plan that avoids it.