Sample CASREP and Automatically Generated Summary

FAILURE OF ONE OF TWO SACS. UNIT HAD LOW OUTPUT AIR PRESSURE. RESULTED IN SLOW GAS TURBINE START. TROUBLESHOOTING REVEALED NORMAL SAC LUBE OIL PRESSURE AND TEMPERATURE. EROSION OF IMPELLOR BLADE TIP EVIDENT. CAUSE OF EROSION OF IMPELLOR BLADE UNDETERMINED. NEW SAC RECEIVED.

Status of Sac:
Part: sac **State: inoperative**

Finding:
Part: air pressure **State: low**

Finding:
Part: lube oil pressure **State: normal**

Finding:
Part: lube oil temperature **State: normal**

Damage:
Part: blade tip **State: eroded**

Finding:
Agent: ship's force **State: has new sac**

SAMPLE CASREP and AUTOMATICALLY GENERATED SUMMARY

Message:

DURING ROUTINE START OF MAIN PROPULSION GAS TURBINE, SAC AIR PRESSURE DECREASED RAPIDLY TO 5.74 PSI. RESULTED IN AN ABORTED ENGINE START. EXACT CAUSE OF FAILURE UNKNOWN. SUSPECT FAULTY IMPELLOR ASSEMBLY.

Summary:

Finding:	
air pressure	lowered
Finding:	
start	aborted
Finding:	
turbine	inoperative
Finding:	
assembly	faulty

RESTRICTION GRAMMAR

- Style of grammar based on
  Linguistic String Grammar, New York University
- Consists of BNF definitions augmented by contextual constraints (called RESTRICTIONS) stated in terms of parse tree
- Restrictions obtain contextual information by moving through globally accessible parse tree
- Produces for semantic analyzer an intermediate syntactic representation:

CONSTITUENT LIST: [subj(X),verb(fail)]
id(sac,X)
sac failed

Regularized parse
(Intermediate Syntactic Representation):

OPS: past perfect progressive
VERB: decrease
SUBJ: pressure
L-MOD: noun: oil

Fragments:

Verb Object -> [elided] Verb Object

replaced engine -> [elided] *replaced engine*

Isolated Noun phrase *X* -> *[There was] X*

failure of sac -> *[There was] failure of sac*

Subj, Complement -> Subj *[be]* Complement

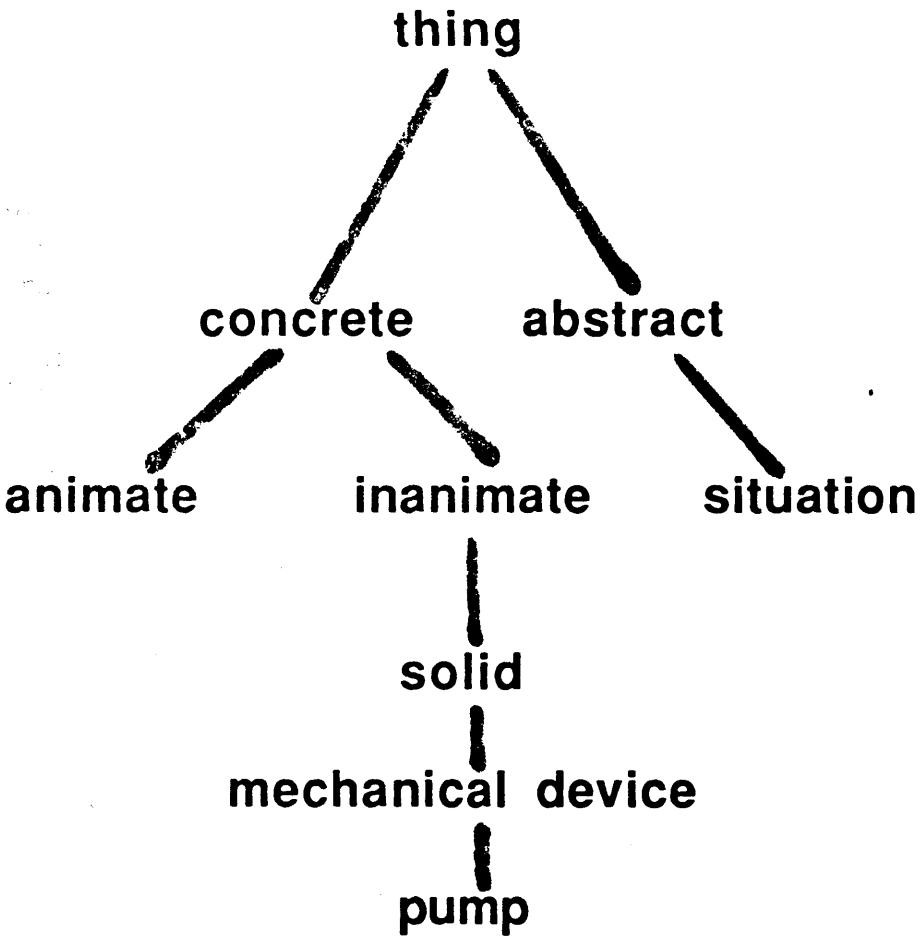
disk bad -> *disk [be] bad*

Complement -> [elided] *[be]* Complement

inoperative -> [elided] *[be] inoperative*

repairing engine -> [elided] *[be] repairing engine*

OBJECT HIERARCHY



CASREPS DOMAIN MODEL

isa hierarchy

```
isa(ships^force,animate).
isa(pump,mechanical_device).

isa1(X,Y) :- isa(X,Y).
isa1(X,Z) :- isa(X,Y),isa1(Y,Z).
```

inherited properties

```
hasprop(solid,mass)

hasprop1(X,Y) :- hasprop(X,Y).
hasprop1(X,Z) :- isa(X,Y),hasprop1(Y,Z).
```

integral parts

```
part(ring^gear,hub).
part(hub,shaft).

connects(speed^increasing^gearbox,fluid^coupling,compressor^shaft).
connects(gear^shaft,speed^increasing^gearbox,fluid^coupling).
```

NOUN PHRASE SEMANTICS

- converts modifiers into *properties*;
- treats *plurals as sets*;
- finds *type of* entity for common nouns, proper names;
- determines definite/indefinite status;
- calls *Clause Semantics* for nominalizations, nounpreds

sac becomes **id(sac, sac1)**

pump becomes **id(pump, pump1)**

replacement becomes **id(event, replace1)**

CASREPS LEXICAL SEMANTICS

SEMANTIC ROLES

agent,actor,instigator,instrument,location,experiencer,
object1,object2,patient,actor1,actor2,vel,dir,value,
symptom,theme,mod,prop,nom,
event,measure,source,goal,ref_pt,direction

VERB RULES

fail <- becomeP(inoperativeP(patient(P)))

clog <- cloggedP(theme(C),instrument(D))

engage <- causeP(agent(C),becomeP(engagedP(patient(P))))

Different uses of *replace:*

The fe replaced the tape unit with the broken screw driver.
The fe replaced the tape unit.
The fe replaced the tape unit with a disk drive.
The disk drive replaced the tape unit.
The tape unit was replaced.

Regularized parse (ISR):

The fe replaced the tape unit with the broken screw driver.

OPS: past
VERB: replace
SUBJ: fe
OBJ: tape^unit (sing)
PP: with
screwdriver (sing)

Lexical Conceptual Clause for REPLACE:

(thematic roles are just arguments to predicates)

replace->

cause(Agent,
use(Instrument,
exchange(Patient1,Patient2)))

MAPPING RULES:

Agent	->	subject / cause(Agent,Y)
Instrument	->	with_pp/ cause(Agent,use(I,Repair-event))
Patient1	->	obj/ cause(Agent,Repair_event)
Patient1	->	sub/ cause(Agent,use(I,exchange(Patient1,Patient2)))
Patient2	->	sub/ cause(Agent,use(I,exchange(Patient1,Patient2)))
Patient2	->	pp(with,Patient2) / cause(Agent,use(I,exchange(Patient1,Patient2)))

SELECTION RESTRICTIONS:

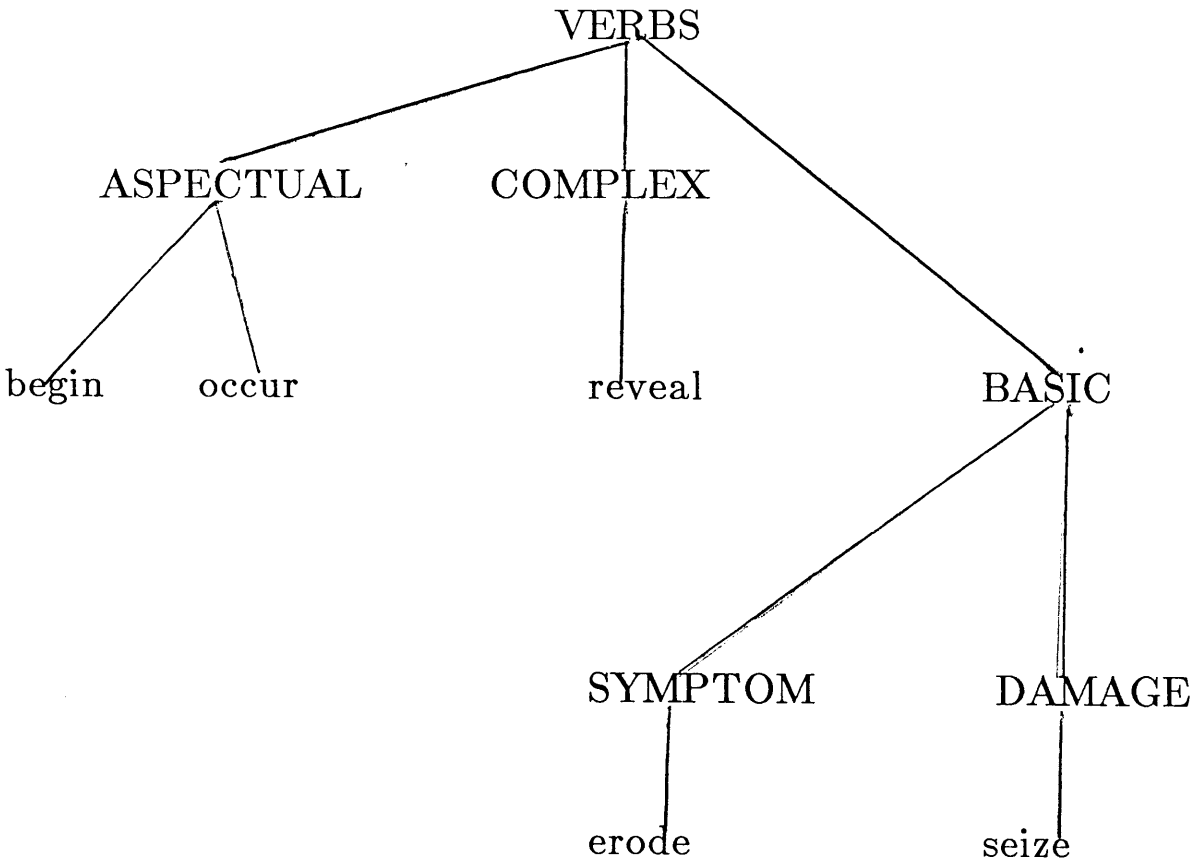
Agent -> class(animate,Agent)/
cause(Agent,X)

Instrument -> class(tool, Instrument)/
cause(Agent,
use(I,Repair-event))

Patient1 -> class(machine_part,Patient1)
AND haspart(Y,Patient1)/
cause(Agent,
use(Instrument,
exchange(Patient1,Patient2)))

Patient2 -> similar(Patient1, Patient2) AND
not(haspart(Y, Patient1)) /
cause(Agent,
use(Instrument,
exchange(Patient1,Patient2)))

VERB TAXONOMY



CLAUSE ANALYSIS ALGORITHM

LOOK UP PREDICATE/ARGUMENT DEFINITION FOR EACH VERB

FOR EACH ARGUMENT (SEMANTIC ROLE)

(1) IF THERE ARE SYNTACTIC CONSTITUENTS —
PROPOSE SYNTACTIC CONSTITUENT
&CALL NP ANALYSIS
&TEST SELECTIONAL RESTRICTIONS

(2) OR IF ROLE IS OBLIGATORY AND THERE IS NO FILLER —
FAIL

(3) OR IF NO FILLER AND ESSENTIAL ROLE —
CALL REFERENCE RESOLUTION
TO HYPOTHESIZE A FILLER
&TEST SELECTIONAL RESTRICTIONS

(4) OR IF NO FILLER AND NON-ESSENTIAL AND NOT OBLIGATORY —
LEAVE UNFILLED

INTERPRETING *FAIL*
sac failed

ISR

OPS: past
VERB: fail
SUBJ: sac

LEXICAL SEMANTICS

fail <- becomeP(inoperative(P(patient(_)))

patient(P) <- subj(P)

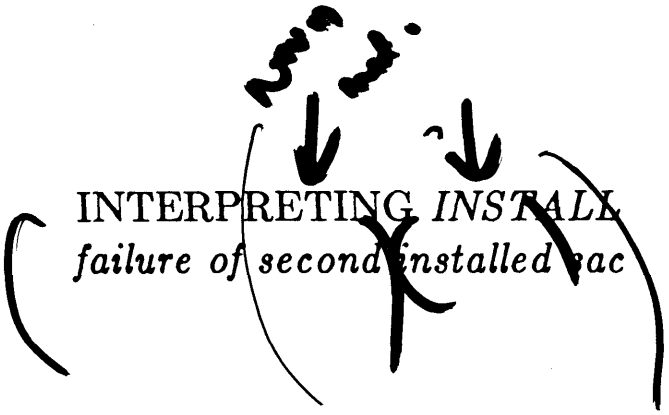
INTERACTION WITH PRAGMATICS

Noun phrase semantics is called for *sac*,

Reference resolution returns **sac1**

FINAL SEMANTIC REPRESENTATION

becomeP(inoperative(patient(sac1)))



INTERPRETING *INSTALL*
failure of second installed sac

ISR

OPS: past
VERB: install
SUBJ: failure of second
OBJ: sac

LEXICAL SEMANTICS

install <- cause(agent(_),
becomeP(installedP(theme(_)))

agent(P) <- subj(P)
theme(T) <- obj(T)

INTERACTION WITH PRAGMATICS

Noun phrase semantics is called for *failure of second,*

DON'T WANT TO LOOK FOR A REFERENT FOR *second*

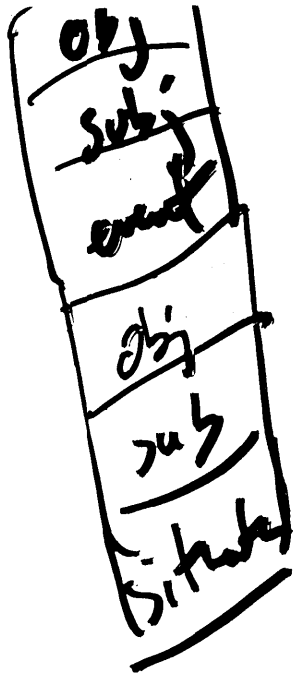
DON'T WANT TO LOOK FOR A REFERENT FOR *failure*

Noun phrase semantics returns pointer **failure_1**

Testing semantic class: **animate** of *failure_1*

FAILED

ALGORITHM



After each sentence:

- Update set of discourse entities — Current Context
- Update ordered subset of discourse entities — Potential Foci

When input noun phrase is:

	Example
Full noun phrase: (definite or unmarked)	
Search Current Context for exact match	*'diesel ... diesel'*
Fail? Search for inexact match	*'SAC ... unit'*
Fail? Search Potential Foci for associate, create discourse entity & relation	*'diesel ... SAC'*
Fail? Create discourse entity	*'diesel'*
Full noun phrase: (indefinite)	
Create discourse entity	*'a diesel'*
pronoun or elided:	
Search Potential Foci for first semantically coherent potential focus	*'unit has low output pressure. Results ...'*
Fail? Use domain knowledge to infer default referent	*'[eserop author] believe ...'*

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REFERENCE RESOLUTION EXAMPLE

While diesel[1] was operating with SAC[2] disengaged the SAC lo alarm sounded. Believe[3] the coupling from diesel[4] to SAC lube oil pump to be sheared.

Situation	Result
1. First mention of diesel	Create discourse entity, diesel1
2. First mention of SAC	Create discourse entity, SAC1; recognize that SAC1 and diesel1 are part of the same system, (SSDG).
3. ~~Find subject of 'believe'~~	~~Recognize reference to person author1~~
4. Second mention of diesel	Recognize reference to diesel1.

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PROBLEMS THAT REQUIRE INTERACTION BETWEEN SYNTAX, SEMANTICS, & PRAGMATICS

- ruling out syntactically correct but semantically anomalous parses

- recovering implicit information,
  i.e. from elided subjects, & essential roles
  resulted in slow gas turbine start

- semantic control of fillers to subordinate verbs
  syntactic: *jane hoped to go*
  semantic: *jane continued the search*

CASREPS -- Recovering Implicit Information

Fragments are parsed as regular syntactic structures

replaced sac.
tensed verb + object

Placeholders complete sentence in ISR

(subject) replaced sac

Placeholders assigned semantic roles

(agent) replaced sac

Implicit semantic roles added

(agent) replaced sac (with object2)

Semantic roles receive correct referents

(ship's force) replaced sac (with new sac)

RECOVERING IMPLICIT INFORMATION

Example:	Semantic Processing	Result
'Request replacement of SAC.'	Create a subject and treat as pronoun	[ship's force] *request replacement of SAC.*
'Exact cause of failure unknown.'	Replace missing verb with *'be'*	*Exact cause of failure* [be] *unknown*
'Loss of lube oil pressure.'	Insert verb *'occur'* or *'exist'*	*Loss of lube oil pressure* [occur].
'Beyond shipboard repair'	Create pronoun subject (as for tvo) and insert *'be'*	[SAC] [be] *beyond shipboard repair.*
'Diesel was operating.'	First try definite, then try indefinite (see reference resolution)	[a] *diesel was operating.*

Examples

1. **An inspection of lube oil filter** revealed contamination
2. **Loss of lube oil pressure** occurred during **operation**
3. SAC received **high usage**
4. **Investigation** revealed adequate lube oil
5. Request **replacement of SAC**
6. **Erosion of impellor blade tip** evident
7. Unit has low output air pressure, resulting in **slow gas turbine starts**

Nominalizations vs. Clauses

Similarities:

- Lexical Decomposition
- Semantic Roles
- Selectional Restrictions on Role Fillers

Differences:

- Syntactic Expression of Role Fillers Differs —
  e.g., Subject vs. Noun Modifier
- Role Fillers for Nominalizations are Syntactically Optional
- Tense is Absent in Nominalizations
- Dealing with Previous Mention of Situation

NOMINALIZATION ANALYSIS ALGORITHM

LOOK UP PREDICATE/ARGUMENT DEFINITION FOR
RELATED VERB

FOR EACH ARGUMENT

(1) IF THERE ARE SYNTACTIC CONSTITUENTS —
PROPOSE SYNTACTIC CONSTITUENT
&CALL NP ANALYSIS
&TEST SELECTIONAL RESTRICTIONS

(2a) CALL REFERENCE RESOLUTION FOR NOMINALIZATION

FOR EACH SEMANTIC ROLE:

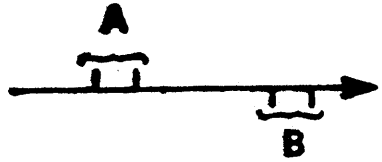
(3) IF ESSENTIAL ROLE AND NO FILLER —
CALL REFERENCE RESOLUTION TO
SUGGEST A FILLER
&TEST SELECTIONAL RESTRICTIONS

(4) ELSE LEAVE UNFILLED

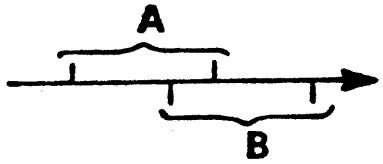
PUNDIT'S TIME COMPONENT

Relations between time intervals:

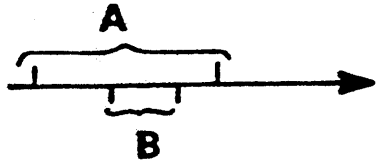
precede (follow)
Oil pressure dropped then increased.



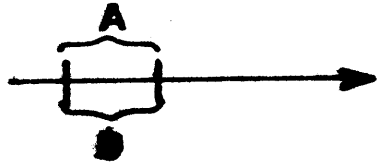
overlap
Alarm sounded while diesel was operating.



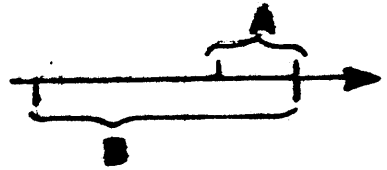
during (include)
Failure occurred during engine start.



same
shaft is dry [at report time].



before__thru (ends)
Will be absent until 9/25.



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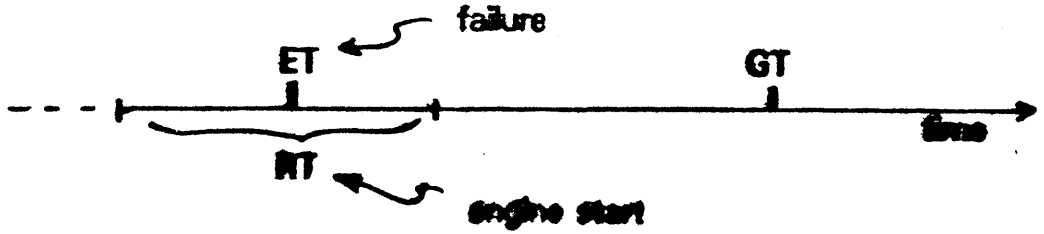
TIME ALGORITHM EXAMPLE

'failure occurred during engine start'

RELATION OF ET TO GT (past tense of *'occur'*)	→	(ET) failure precedes Report Generation Time (GT)
RELATION OF ET TO RT (*'during'*)	→	(ET) failure during engine start (RT)
RELATION OF RT TO GT	→	(RT) engine start precedes Report Generation Time (GT)



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COMPUTATION OF TEMPORAL RELATIONS

TIME PRIMITIVES

Event Time (ET):	Time of predicated State/Event
Reference Time (RT):	Time of a Reference State/Event, i.e., a second State/Event within a time adverbial
Text Generation Time (GT):	Time at which report was filed

ALGORITHM

- Compute the relation of the event time (ET) to the text time (GT)
- Compute the relation of the event time (ET) to the reference time (RT)

SAMPLE SENTENCE

ET		RT		RT
Main Clause	+	Time Adverb	+	Nominalization
'failure occurred'		*'during'*		*'engine start'*

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SUMMARY OF STATES, EVENTS, AND PROPERTIES

CASREP B33:

Oil pressure has been slowly decreasing. Failure occurred during engine start when oil pressure dropped below 60 PSIG. Investigation revealed excessive fine metal particles in oil.

EVENTS/STATES:

Sentence1:
- prop1 decrease(oil pressure)
- prop2 fall(SAC)
- prop3 failure(SAC)

Sentence2:
- prop4 start(engine)
- prop5 drop(oil pressure)
- prop6 dropped(oil pressure)

Sentence3:
- prop7 reveal(investigation, particles)
- prop8 investigate(failure)

PROPERTIES

pressure(oil,SAC)

quantity(pressure, 60 psig)

made_of(particles, metal)
in(oil, particles)
excessive(particles)
fine(particles)
results_in(prop2, prop5)
contamination(particles, oil)

SUMMARY OF STATES, EVENTS, AND PROPERTIES (cont.)

Status of SAC: Last *"status"* event/property of SAC:
prop3 = Failure

Damage: Damage condition:
contamination(particles,location(oil))

Findings: Unusual findings in event/property:
prop1 = decrease(oil pressure1)
prop5 = drop(oil pressure1)
prop6 = dropped(oil pressure1)

Findings co-referential re pressure1;
Use of most specific finding = prop5:
oil pressure below 60 PSIG

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