Compound verbs and derived verbs
in Swahili to English machine translation

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Abstract

Time, aspect and mood are expressed in Swahili using prefixes attached to the verb stem. More complex specifications are expressed using the auxiliary verb *wa* and the main verb. The auxiliary verb and the main verb inflect, and each of them may have a variety of forms. As a result, there is a large number of compound verb combinations. These forms are a challenge in machine translation, because the target language forms the corresponding expressions in very different ways. This paper discusses such forms and demonstrates methods for handling warious forms of compound verbs, including derived verbs. The performance of Google Translate and SALAMA Translator in handling such structures is demonstrated.

Keywords: *machine translation, compound verbs, derived verbs.*

1 Introduction

The basic units in translating from one language to another are words. A word may have one or more interpretations, depending on the context. In addition to individual words, the language has a large number of multi-word expressions (MWE). A MWE is a cluster of words, the meaning of which cannot be derived directly from the meaning of its member words. In order to make translation possible, MWEs must be isolated and treated as single units. Compound verbs can also be considered as a special case of MWEs. Yet they are different. A MWE is normally either a frozen or inflecting word cluster, which has one or more meanings in target language (TL). The surface form in TL depends on the grammatical features and gloss of the MWE members in the source language (SL).

Compound verbs have an important difference compared with normal MWEs in that the translation must be made in two phases. There is the auxiliary part, which has only one form. Examples are 'would have', 'would have been', 'would not have been'. Then there is the part of the main verb. The gloss of the main verb will be inflected according to the combination of the auxiliary and main verb forms.

It is important to note that the compound verb forms of Swahili cannot be translated combining the separate translation of the auxiliary verb and the main verb. Compound

verbs must be isolated as a single unit and then handled as a unit until the end of translation process. We must remember that all the information of the auxiliary verb and main verb is needed in producing the correct translation of the auxiliary part and the main part of verb in TL. This is somewhat complex, but the demonstration of various translation phases below will clarify the issue.

2 Phases in translating compound verbs

Let us first look at the analysis when the auxiliary verb and the main verb are analysed separately. The example sentence (1) is: *Mwalimu alikuwa anasoma* (The teacher was reading).

```
(1)
( "<*mwalimu>" "mwalimu" N 1/2-SG HUM { the } { teacher } INITCAP
@SUBJ )
( "<alikuwa>" "wa" V 1-SG3-SP VFIN NO-SP-GLOSS PAST INFMARK z [wa]
{ be } AUX-WA SV MONOSLB @FAUXV )
( "<anasoma>" "soma" V 1-SG3-SP VFIN { he } PR:na z [soma] { read
} SVO @-FMAINV-n )
```

When we remove the token and lemma, we get a shorter and clearer representation (2).

```
(2)
( N 1/2-SG HUM { the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS PAST INFMARK z { be } AUX-WA SV
@FAUXV )
( V 1-SG3-SP VFIN { he } PR:na z { read } SVO )
```

If we would translate each word separately, we would get 'The teacher was he reads'. We have to isolate the verbs as one unit. At the same time we remove the subject gloss of the main verb (3).

```
(3)
( N 1/2-SG HUM { the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS PAST INFMARK z { be } AUX-WA SV
@FAUXV V 1-SG3-SP VFIN PR:na z { read } SVO )
```

The isolated verb cluster has two glosses, 'be' and 'read', one for the auxiliary verb and the other for the main verb. Now we need to process the reading so that the auxiliary part will be correct in translation. In (4) we see the result.

```
(4)
( N 1/2-SG HUM { *the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS PAST INFMARK AUX-WA SV @FAUXV V 1-
SG3-SP VFIN PR:na :z { :was } ING { read } SVO )
```

The tag 'z' in front of the verb gloss is to indicate whether a rule has applied to the gloss. If a rule has applied, the tag gets a colon in front of it. Therefore, if a subsequent rule encounters the tag ':z', it is not allowed to apply to the gloss. Using this method it is possible to control that only one rule is applied to the gloss. We see in (4) that the sequence 'z { be }' has disappeared, and the translation of the auxiliary part of the construction is inserted in front of the gloss of the main verb. Note that the translation ':was' is secured with the preceding tag ':z'. The 'z' tag in front of the gloss of the main verb is replaced by the tag ING, which allows the application of one specific rule. The tag ING indicates that the main verb should be converted to the gerund form. When also the gloss of the main verb has been convered to surface form, we get the result as in (5).

(5)
```
( N 1/2-SG HUM { *the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS PAST INFMARK AUX-WA SV @FAUXV V 1-
SG3-SP VFIN PR:na :z { :was } :ING { :reading } SVO )
```

After final puning the translation is in (6).

(6)
The teacher was reading

The above example was quite simple. A more complicated example is in (7).

(7)
```
"<*kitabu>"
      "kitabu" N 7/8-SG { the } { book } INITCAP @SUBJ
"<kisingalikuwa>"
      "wa" V 7-SG-SP VFIN NO-SP-GLOSS COND-NEG:singali INFMARK z
[wa] { be } AUX-WA SV MONOSLB @FAUXV
"<kimeharibiwa>"
      "haribiwa" V 7-SG-SP VFIN { it } PERF:me z [haribu] { damage
} SVO PASS @-FMAINV-n
```

The auxiliary verb in (7) is in negative past conditional form, and the main verb is in passive perfective form. From the sentence *Kitabu ksingalikuwa kimeharibiwa* we should get the translation 'The book would not have been damaged'. After disambiguation, the analysis of each word is on its own line (8).

(8)
```
( N 7/8-SG { the } { book } INITCAP @SUBJ )
( V 7-SG-SP VFIN NO-SP-GLOSS COND-NEG:singali INFMARK z { be }
AUX-WA SV @FAUXV )
( V 7-SG-SP VFIN { it } PERF:me z { damage } SVO PASS  )
```

The auxiliary verb and the main verb are joined to form a single unit (9).
(9)
```
( N 7/8-SG { the } { book } INITCAP @SUBJ )
```

```
( V 7-SG-SP VFIN NO-SP-GLOSS COND-NEG:singali INFMARK z { be }
AUX-WA SV @FAUXV V 7-SG-SP VFIN PERF:me z { damage } SVO PASS )
```

Then a rule is applied that produces the surface form of the auxiliary verb and makes a number of other changes (10).

(10)
```
( N 7/8-SG { *the } { book } INITCAP @SUBJ )
( V 7-SG-SP VFIN NO-SP-GLOSS COND-NEG:singali INFMARK AUX-WA SV
@FAUXV V 7-SG-SP VFIN PERF:me :z { would not :have been } PART {
damage } SVO PASS )
```

In the analysis above there is a lot of information that has to be taken into account when constructing the correct translation. The auxiliary verb in isolation would be translated as 'would not have been'. We see that the original gloss of the auxiliary verb has disappeared and the new translation has been moved in front of the gloss of the main verb. In front of the gloss is the tag ':z' indicating that no other rule should affect the translation. The gloss of the main verb is preceded by the tag PART, indicating that the main verb is allowed to apply rules and that it should get a participial form. Example (11) demonstrates this process.

(11)
```
( N 7/8-SG { *the } { book } INITCAP @SUBJ )
( V 7-SG-SP VFIN NO-SP-GLOSS COND-NEG:singali INFMARK AUX-WA SV
@FAUXV V 7-SG-SP VFIN PERF:me :z { would not :have been } :PART {
:damaged } SVO PASS )
```

We see above that the tag PART was replaced by :PART to indicate that no further rule application is allowed. The translation is in (12).

(12)
The book would not have been damaged

In (13) is an example that demonstrates the fact that the translation of compound verbs is not the sum of two separate verbs.

(13)
```
"<*mwalimu>"
      "mwalimu" N 1/2-SG HUM { the } { teacher } INITCAP @SUBJ
"<angekuwa>"
      "wa" V 1-SG3-SP VFIN NO-SP-GLOSS COND:nge INFMARK z [wa] {
be } AUX-WA SV MONOSLB @FAUXV
"<hajasoma>"
      "soma" V NEG 1-SG3-SP VFIN { he } PERF-NEG:ja z [soma] {
read } SVO @-FMAINV-n
```

After removing the source language strings and isolating the verb cluster we get the result as in (14).

(14)
```
( N 1/2-SG HUM { the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS COND:nge INFMARK z { be } AUX-WA SV
@FAUXV V NEG 1-SG3-SP VFIN PERF-NEG:ja z { read } SVO )
```

After handling the auxiliary verb we get the result as in (15).

(15)
```
( N 1/2-SG HUM { *the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS COND:nge INFMARK AUX-WA SV @FAUXV V
NEG 1-SG3-SP VFIN PERF-NEG:ja :z { :would not yet :have } PART {
read } SVO )
```

When we apply the rule for the main verb, the result is as in (16).

(16)
```
( N 1/2-SG HUM { *the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS COND:nge INFMARK AUX-WA SV @FAUXV V
NEG 1-SG3-SP VFIN PERF-NEG:ja :z { :would not yet :have } :PART {
:read } SVO )
```

The translation of the auxiliary verb angekuwa in isolation is 'would be'. The translation of the main verb *hajasoma* in isolation is 'has not yet read'. By combining these two translations we do not get proper English. When we handle the structure as shown above, we get the correct translation (17).

(17)
The teacher would not yet have read

3 Handling derived verb forms

Swahili makes extensive use of verb derivation. The verb root may have one or more extension suffixes for constructing new verbs. The target language English does not have verb extensions. The meaning of the extended verbs in English is conveyed variously with a completely new verb or by using an auxiliary verb, such as 'be', 'make' and 'cause', together with the relevant form of the original main verb.

Extended verbs are handled in two ways. First, there is the default method, which uses rules for producing surface forms. Such rules are applied if nothing else is defined for their handling. In default method the basic verb form is listed in the lexicon, for the possibility to attach various suffixes. These extended forms retain the original gloss, and the rules then modify the gloss to get the desired form. Second, if a derived verb is rendered in English with an entirely different verb, such extended verbs are listed separately in the lexicon. This causes unnecessary ambiguity, because also the basic verb produces analysis of the extended verb. This ambiguity is handled so that the analysis produced by the extended stem, together with its specific gloss, wins and the form

produced by the base form is deleted. With this method it is possible to control the translation of extended verbs.

Let us take examples of the very common verb *soma* 'to read' (18)

```
(18)
"<*mwalimu>"
      "mwalimu" N 1/2-SG HUM { the } { teacher } INITCAP @SUBJ
"<alimsomea>"
      "somea" V 1-SG3-SP VFIN NO-SP-GLOSS PAST 1-SG3-OBJ OBJ { him
} z [soma] { read } SVO SVOO APPL @FMAINVtr+OBJ>
"<mtoto>"
      "mtoto" N 1/2-SG HUM { the } { child } @OBJ
"<kitabu>"
      "kitabu" N 7/8-SG { the } { book } @OBJ
```

The gloss of the verb *soma* is 'read'. The sentence has a double object, which requires that the verb has the applicative extension suffix *e*. Because the second object, or indirect object, comes before the first object, these two objects must be differentiated from each other in translation. This is done by inserting the preposition 'to' or 'for' before the indirect object. This is implemented with a rule (19).

```
(19)
"<*mwalimu>"
      "mwalimu" N 1/2-SG HUM { the } { teacher } INITCAP @SUBJ
"<alimsomea>"
      "somea" V 1-SG3-SP VFIN NO-SP-GLOSS PAST 1-SG3-OBJ OBJ { him
} z [soma] AP { read } { to } SVO SVOO APPL @FMAINVtr+OBJ>
"<mtoto>"
      "mtoto" N 1/2-SG HUM { the } { child } @OBJ
"<kitabu>"
      "kitabu" N 7/8-SG { the } { book } @OBJ
```

In (19) we see that the tag AP is inserted to help in converting the gloss to the correct surface form. Also the preposition 'to' has been added after the verb gloss. In some other cases the preposition 'for' would be selected. The result after conversion is in (20).

```
(20)
( N 1/2-SG HUM { *the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS PAST 1-SG3-OBJ :z AP { :read } { to
} SVO SVOO APPL )
( N 1/2-SG HUM { the } { child } @OBJ )
( N 7/8-SG { the } { book } @OBJ )
```

And the final translation is in (21).

```
(21)
```
The teacher read to the child the book

The causative extension expresses something that is made to happen. From the verb *soma* we can form a sentence as in (22).

(22)
```
"<*mwalimu>"
      "mwalimu" N 1/2-SG HUM { the } { teacher } INITCAP @SUBJ
"<alimsomesha>"
      "somesha" V 1-SG3-SP VFIN NO-SP-GLOSS PAST 1-SG3-OBJ OBJ {
him } z [soma] { educate } SVO SVOO CAUS @FMAINVtr+OBJ>
"<mtoto>"
      "mtoto" N 1/2-SG HUM { the } { child } @OBJ
```

Here we have an example, where, when causative extension has been used, a natural translation is 'educate'. The rule has chosen this gloss. This needs no auxiliary verb. On the other hand, if we would use the basic gloss 'read', we could use a rule, whereby the result would be as in (23).

(23)
```
"<*mwalimu>"
      "mwalimu" N 1/2-SG HUM { the } { teacher } INITCAP @SUBJ
"<alimsomesha>"
      "somesha" V 1-SG3-SP VFIN NO-SP-GLOSS PAST 1-SG3-OBJ OBJ {
him } z [soma] CS { make } { read } SVO SVOO CAUS @FMAINVtr+OBJ>
"<mtoto>"
      "mtoto" N 1/2-SG HUM { the } { child } @OBJ
```

An auxiliary verb 'make' has been added, and this will be transformed into the surface form (24).

(24)
```
( N 1/2-SG HUM { *the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS PAST 1-SG3-OBJ :z CS { :made } {
:read }  SVO SVOO CAUS )
( N 1/2-SG HUM { the } { child } @OBJ )
```

After reordering constituents the result is as in (25).

(25)
```
( N 1/2-SG HUM { *the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS PAST 1-SG3-OBJ :z CS { :made } )
( N 1/2-SG HUM { the } { child } @OBJ )
( { :read } SVO SVOO CAUS )
```

The final translation is in (26).

(26)
The teacher made the child read

The stative extension expresses often that something is possible to happen. Because English does not have a stative grammatical form, we have to use other methods. Quite often stative can be translated with the auxiliary verb 'be' and an adjective derived from the verb gloss. We can form an example from the verb soma (27).

(27)
```
"<*kitabu>"
      "kitabu" N 7/8-SG { the } { book } INITCAP @SUBJ
"<kinasomeka>"
      "someka" V 7-SG-SP VFIN NO-SP-GLOSS PR:na z [soma] { read }
SV SVOO STAT @FMAINVtr-OBJ>
```

When we apply the rule, the result is as in (28).

(28)
```
"<*kitabu>"
      "kitabu" N 7/8-SG { the } { book } INITCAP @SUBJ
"<kinasomeka>"
      "someka" V 7-SG-SP VFIN NO-SP-GLOSS PR:na z [soma] ST { be
read } SV SVOO STAT @FMAINVtr-OBJ>
```

Now the tag ST precedes the gloss. The auxiliary verb 'be' is added in front of the gloss. The verb 'be' will be inflected according to the time tag PR:na. The lemma 'read' will be inflected with the help of the tag ST. This rule converts the verb to adjective. Below we see the inflected forms (29).

(29)
```
( N 7/8-SG { *the } { book } INITCAP @SUBJ )
( V 7-SG-SP VFIN NO-SP-GLOSS PR:na :z ST { :is :readable } SV SVOO
STAT )
```

And the final translation (30).

(30)
The book is readable

Passive constructions belong actually to the category of inflection. However, because passive is formed with verb suffixes, it can be handled in the same way as derived verb forms. In (31) is an example of passive.

(31)
```
"<*mtoto>"
      "mtoto" N 1/2-SG HUM { the } { child } INITCAP @SUBJ
"<alisomeshwa>"
      "someshwa" V 1-SG3-SP VFIN NO-SP-GLOSS PAST z [soma] {
educate } SVO SVOO CAUS PASS @FMAINVtr-OBJ>
```

We see that the example above has two extensions, causative and passive. The location of the passive marker is always immediately before the word final vowel. Therefore, the causative key comes first. In (31) we see the example after rule application.

```
(31)
"<*mtoto>"
        "mtoto" N 1/2-SG HUM { the } { child } INITCAP @SUBJ
"<alisomeshwa>"
        "someshwa" V 1-SG3-SP VFIN NO-SP-GLOSS PAST z [soma] CS PS {
be make read } SVO SVOO CAUS PASS @FMAINVtr-OBJ>
```

There are two rules that have applied. First, the rule for causative inserted the key CS and added the auxiliary verb 'make' to the slot of the gloss. Then the rule for passive inserted the key PS and added the auxiliary verb 'be' to the slot of the gloss. Thus we have the string 'be make read', where two first ones are auxiliary verbs ad the third one is the gloss of the verb itself.

The production of the surface form is made in three phases. First, using CS as a key, we 'inject' the main verb gloss, so that no other rule can affect it (32).

```
(32)
"<*mtoto>"
        "mtoto" N 1/2-SG HUM { the } { child } INITCAP @SUBJ
"<alisomeshwa>"
        "someshwa" V 1-SG3-SP VFIN NO-SP-GLOSS PAST z [soma] CS PS {
be make :read } SVO SVOO CAUS PASS @FMAINVtr-OBJ>
```

Then, using PS as a key, we transform 'make' into ':made', 'injecting' it at the same time (33).

```
(33)
"<*mtoto>"
        "mtoto" N 1/2-SG HUM { the } { child } INITCAP @SUBJ
"<alisomeshwa>"
        "someshwa" V 1-SG3-SP VFIN NO-SP-GLOSS PAST z [soma] CS PS {
be :made :read } SVO SVOO CAUS PASS @FMAINVtr-OBJ>
```

In the third phase, with the help of the time tag PAST we produce the surface form of 'be' (34).

```
(34)
"<*mtoto>"
        "mtoto" N 1/2-SG HUM { the } { child } INITCAP @SUBJ
"<alisomeshwa>"
        "someshwa" V 1-SG3-SP VFIN NO-SP-GLOSS PAST z [soma] CS PS {
:was :made :read } SVO SVOO CAUS PASS @FMAINVtr-OBJ>
```

The final translation is in (35).

(35)
The child was made read

4 Derived verbs as part of compound verbs

The process becomes even more complicated when we handle derived verbs as part of the compound verb structure. Below we see how these two processes can be combined. We take examples from causative, stative, and passive forms. First we handle the derived verb in isolation, without considering its context (36).

(36)
```
( N 1/2-SG HUM { the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS PAST INFMARK z { be } AUX-WA SV
@FAUXV )
( V NEG 1-SG3-SP VFIN { he } PERF-NEG:ja z CS { make :read } SVO
SVOO CAUS )

( N 1/2-SG HUM { the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS PAST INFMARK z { be } AUX-WA SV
@FAUXV )
( V 1-SG3-SP VFIN { he } PERF:me CS PS { be make :read } SVO SVOO
CAUS PASS )

( N 7/8-SG { the } { book } INITCAP @SUBJ )
( V 7-SG-SP VFIN NO-SP-GLOSS PAST INFMARK z { be } AUX-WA SV
@FAUXV )
( V NEG 7-SG-SP VFIN { it } PERF-NEG:ja ST { be :readable } SV
SVOO STAT )
```

We see above that each derived verb is marked with a tag, such as CS, ST and PS. The gloss of each verb is modified accordingly. In the next phase we isolate the auxiliary verb and main verb as one unit (37).

(37)
```
( N 1/2-SG HUM { *the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS PAST INFMARK AUX-WA SV @FAUXV V NEG
1-SG3-SP VFIN PERF-NEG:ja :z { had not yet } PART CS { make :read
} SVO SVOO CAUS )

( N 1/2-SG HUM { *the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS PAST INFMARK AUX-WA SV @FAUXV V 1-
SG3-SP VFIN PERF:me CS { had } PART PS { be make :read } SVO SVOO
CAUS PASS )

( N 7/8-SG { *the } { book } INITCAP @SUBJ )
( V 7-SG-SP VFIN NO-SP-GLOSS PAST INFMARK AUX-WA SV @FAUXV V NEG
7-SG-SP VFIN PERF-NEG:ja :ST { had not yet } PART { be :readable }
SV SVOO STAT )
```

The gloss of the auxiliary verb is removed and the partial translation is moved before the gloss of the main verb. Also a new tag PART is added to help the realisation of the surface form of the main verb. This will be done in a later phase. In the phase below we modify the gloss of the derived verb (38).

(38)
```
( N 1/2-SG HUM { *the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS PAST INFMARK AUX-WA SV @FAUXV V NEG
1-SG3-SP VFIN PERF-NEG:ja :z { had not yet } PART CS { :made :read
} SVO SVOO CAUS )

( N 1/2-SG HUM { *the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS PAST INFMARK AUX-WA SV @FAUXV V 1-
SG3-SP VFIN PERF:me CS { had } PART PS { be make :read } SVO SVOO
CAUS PASS )

( N 7/8-SG { *the } { book } INITCAP @SUBJ )
( V 7-SG-SP VFIN NO-SP-GLOSS PAST INFMARK AUX-WA SV @FAUXV V NEG
7-SG-SP VFIN PERF-NEG:ja :ST { had not yet } PART { be :readable }
SV SVOO STAT )
```

Then we produce the surface form of the main verb (39).

(39)
```
( N 1/2-SG HUM { *the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS PAST INFMARK AUX-WA SV @FAUXV V NEG
1-SG3-SP VFIN PERF-NEG:ja :z { had not yet } :PART CS { :made
:read } SVO SVOO CAUS )

( N 1/2-SG HUM { *the } { teacher } INITCAP @SUBJ )
( V 1-SG3-SP VFIN NO-SP-GLOSS PAST INFMARK AUX-WA SV @FAUXV V 1-
SG3-SP VFIN PERF:me CS { had } :PART PS { :been :made :read } SVO
SVOO CAUS PASS )

( N 7/8-SG { *the } { book } INITCAP @SUBJ )
( V 7-SG-SP VFIN NO-SP-GLOSS PAST INFMARK AUX-WA SV @FAUXV V NEG
7-SG-SP VFIN PERF-NEG:ja :ST { had not yet } :PART { :been
:readable } SV SVOO STAT )
```

The final translation is in (40).

(40)
The teacher had not yet made read
The teacher had been made read
The book had not yet been readable

Finally a couple of verb constructions that produce strange looking but yet grammatical translations (41).

(41)
```
( N 7/8-PL { *the } { books } INITCAP @SUBJ )
( V 8-PL-SP VFIN NO-SP-GLOSS COND-NEG:singali INFMARK AUX-WA SV
@FAUXV V 8-PL-SP VFIN COND:ki :z { would not :have :had } :PART {
:been damaged } SV :STAT PREFR )

( N 7/8-PL { *the } { books } INITCAP @SUBJ )
( V 8-PL-SP VFIN NO-SP-GLOSS COND-NEG:singali INFMARK :z { :would
} { not } { :have been } { be } AUX-WA SV @FAUXV V 8-PL-SP VFIN
COND:ki PS { :being :damaged } SVO PASS )
```

The final (strange) translation is here (42)

(42)
The books would not have had been damaged.
The books would not have been being damaged.

5 Discussion

Rule-based machine translation is considered tedious and difficult to implement. This is true, of course, but it is also very rewarding. Unlike in statistical translation, where translation mistakes are often very hard to trace, in rule-based translation bugs are always traceable and also relatively easy to trace and correct.

The difference between statistical and rule-based translation can be demonstrated by comparing translation result of Google Translate and Salama Translator.

Mwalimu asingalikuwa akiharibu.
GT: Teacher had not been destroyed.
ST: The teacher would not have had damaged.

Kitabu kisingalikuwa kikiharibiwa.
GT: Book kisingalikuwa kikiharibiwa.
ST: The book would not have been being damaged.

Kitabu kisingalikuwa kikiharibika.
GT: Book kisingalikuwa kikiharibika.
ST: The book would not have had been damaged.

Vitabu visingalikuwa vikiharibika.
GT: Books visingalikuwa vikiharibika.
ST: The books would not have had been damaged.

Kitu kilikuwa hakivunjiki.
GT: Something was not inviolable.
ST: The thing did not get broken.

Vitu vilikuwa havivunjiki.

GT: Things were not inviolable.
ST: The things did not get broken.

Kitu kilikuwa hakijavunjika.
GT: Something was not kijavunjika.
ST: The thing had not yet got broken.

Vitu vilikuwa havijavunjika.
GT: Things were not vijavunjika.
ST: The things had not yet got broken.

Kitu kimekuwa hakijavunjika.
GT: Nothing has been no kijavunjika.
ST: The thing has not yet got broken.

Vitu vimekuwa havijavunjika.
GT: Things have been no vijavunjika.
ST: The things have not yet got broken.

6 Conclusion

This report has demonstrated various problems in implementing the translation of compound verbs, of derived verbs, and of the combination of compound verbs and derived verbs. By carefylly constructing the phases of translation, while at the same time controlling the application of rules, it is possible to implement even the most complex translation tasks.