A powerful enhancement to the DMAP alter capability has been developed by RPK Corporation and is available on all RPK-supported versions of COSMIC/NASTRAN. This enhancement involves the addition of two new alter control cards, called INSERT and DELETE, to the Executive Control Deck. These cards allow for DMAP alters to be made by referencing DMAP statements by their module names rather than by their statement numbers in the rigid format DMAP sequence. This allows for increased user convenience and flexibility and makes alters more meaningful to the user. In addition, DMAP alter packages employing the new alter control cards will be much less susceptible to future changes in rigid format DMAPs than alter packages employing the standard ALTER control cards. The usage of the new cards is illustrated by examples.

INTRODUCTION

The most general way of using NASTRAN is by means of a user-written Direct Matrix Abstraction Program (DMAP). However, in order to relieve the user of the burden of constructing DMAP sequences for each of his analyses, standard DMAP sequences, called rigid formats, are provided with NASTRAN to handle different types of analyses.

It is often desirable for the user to make changes to the DMAP sequences in the rigid formats. This can be accomplished by using the DMAP alter capability (see Reference 1). Typical situations that may call for using DMAP alters are to schedule an exit prior to completion, to request additional intermediate output, to schedule diagnostic printing of tables and/or matrices and to modify the standard solution sequences by the addition and/or deletion of functional modules.

DESCRIPTION OF THE STANDARD ALTER FEATURE

DMAP alters to the rigid formats are accomplished by means of ALTER control cards in the Executive Control Deck (Reference 1). ALTER control cards are of two types.

An ALTER control card of the form

\[ \text{ALTER n $} \]

indicates that DMAP instructions following this card are to be inserted after DMAP instruction 169.
number n in the rigid format under consideration.

An ALTER control card of the form

\[ \text{ALTER } n1, n2 \$ \quad (n1 \leq n2) \]

indicates that DMAP instructions in the range \( n1 \) through \( n2 \) (inclusive) in the rigid format are to be deleted and replaced by any DMAP instructions that may follow this card.

The ALTER control cards serve a very useful purpose. However, the usage of these cards has the following two distinct disadvantages:

* The ALTER control cards refer to DMAP statements by their numbers in the rigid format DMAP sequence. This does not give a "feel" for the DMAP changes as the numbers do not have any particular significance to the user. In other words, the ALTER control cards are by design really more programmer-oriented than user-oriented.

* Because the ALTER control cards refer to DMAP statements by numbers, they are very susceptible to changes in rigid formats from one release to a subsequent one. Thus, even minor changes in a rigid format, particularly in the earlier portion of the DMAP sequence, may require wholesale revamping of the ALTER cards in an alter package.

**DESCRIPTION OF THE ENHANCED ALTER FEATURES**

In order to overcome the above shortcomings, RPK has developed a very attractive enhancement to the DMAP alter capability. This enhancement involves the addition of two new alter control cards, called INSERT and DELETE, for use in the Executive Control Deck. This feature is available on all RPK-supported versions of COSMIC/NASTRAN, beginning with the 1988 release.

Detailed descriptions of the INSERT and DELETE cards are given in Appendix A. An updated description of the ALTER card that takes into account the existence of the INSERT and DELETE cards is also given in that appendix.

The INSERT control card identifies a specific module in the rigid format DMAP sequence after which DMAP instructions following the INSERT card are to be inserted. The DELETE control card identifies a specific module (or a range of modules) in the rigid format DMAP sequence which is (or are) to be deleted and replaced by any DMAP instructions that may follow the DELETE card.

The INSERT control card is specified as follows:

\[ \text{INSERT specmod } \$
\]

where specmod has the following general form:

\[ \text{nommod } [(\tau)] [, n] \]
The various terms in the above specification have the following meanings and connotations:

**nommod** is the *nominal* module (alphanumeric value, no default). This must be a valid name of a module in the rigid format DMAP sequence. (It must be recognized in this context that every DMAP instruction or DMAP statement is a module with a specific name.)

**r** is the occurrence flag (integer > 0, default = 1). The \( r \)th occurrence of the nominal module in the rigid format DMAP sequence (counting from the beginning of the DMAP sequence) defines the *reference* module.

The default value of 1 for the occurrence flag implies that the reference module is the first occurrence of the nominal module in the rigid format DMAP sequence.

**n** is the offset flag (integer, default = 0). The DMAP module that is offset from the reference module by \( n \) DMAP statements in the rigid format DMAP sequence defines the *specified* module.

Depending upon the sign of the offset flag \( n \), the specified module may follow (\( n \) positive) or precede (\( n \) negative) the reference module in the rigid format DMAP sequence. The default value of 0 for the offset flag implies that the reference module is the specified module.

**specmod** is the module defined as per the above scheme after which DMAP statements following the INSERT card are to be inserted.

The DELETE control card is specified as follows:

```
DELETE specmod_1 [, specmod_2 ] $
```

where specmod_1 has the following general form:

```
nommod_1 [(r_1)] [, n_1 ]
```

The various terms in the above specification have the same meanings and connotations as in the case of the INSERT control card.

If only specmod_1 is specified on a DELETE card, it identifies a single specified module that is to be deleted and replaced by any DMAP statements that may follow the DELETE card. If both specmod_1 and specmod_2 are specified, they identify a range of specified modules that are to be deleted and replaced by any DMAP statements that may follow the DELETE card.
The new INSERT and DELETE cards described above and the existing ALTER card together form a triad of alter control cards available to the user on all RPK-supported versions of COSMIC/NASTRAN. When using these cards, the most important requirement that must be satisfied is the one that has always existed with the usage of the standard ALTER control cards, namely, that the DMAP statements (or modules) that are referenced on the ALTER, INSERT and DELETE control cards in an alter package (either explicitly or implicitly, when a range is specified) must be referenced in ascending order of their occurrence in the rigid format DMAP.

The new INSERT and DELETE cards can be used in conjunction with standard ALTER control cards and any combination of the three control cards is acceptable. As a corollary, RPK-supported versions of COSMIC/NASTRAN also support alter packages containing only ALTER control cards. This ensures compatibility with standard versions of COSMIC/NASTRAN.

Table 1 lists several examples of the usage of alter control cards on RPK-supported versions of COSMIC/NASTRAN. For each example, the table shows an alter using standard ALTER control cards and indicates suggested usages by which the same alter can be accomplished by employing equivalent INSERT or DELETE control cards. (All of the examples in the table refer to the DMAP sequence of Rigid Format 3 - Displacement Approach, Release 1988, that is given in Appendix B.)

RPK encourages the users of its versions of COSMIC/NASTRAN to use the new alter control cards. In order to demonstrate their usage, RPK has modified the data for all NASTRAN Demonstration Problems that contain ALTER cards by commenting out all such cards and replacing them by equivalent INSERT and/or DELETE cards. This is reflected in the data and the output of the NASTRAN Demonstration Problems that are delivered to RPK's clients.

ADVANTAGES OF THE ENHANCED ALTER FEATURES

The new alter control cards have several distinct advantages over the standard ALTER control card. Some of these are obvious from the examples in Table 1. These advantages are discussed in detail below.

1. Increased User Friendliness and Convenience

Unlike standard ALTER control cards, which refer to DMAP instructions by their statement numbers in the rigid format DMAP, the new INSERT and DELETE control cards refer to DMAP statements by their module names. This is certainly more user friendly and convenient as DMAP module names are clearly more meaningful to the user than DMAP statement numbers. The user thus has a better "feel" for the alters.

2. Increased Flexibility

The general manner in which the specified module is identified on the INSERT and DELETE control cards gives tremendous flexibility to the user.
Using ALTER cards, a given alter can be accomplished only by a very specific and unique ALTER card. However, by using INSERT (or DELETE) cards, the same alter can be accomplished in several apparently different, but equivalent, ways. The user thus has a choice of ways in which he can specify a given alter.

The above point can be best illustrated by an example. Consider Example 2 in Table 1 which indicates that alters are to be made by inserting new DMAP statements after DMAP statement no. 69 (the PARAM module just before the READ module) in the DMAP.

By using ALTER control cards, the above alter can be accomplished only by using the following very specific and unique alter:

\[ \text{ALTER 69 $} \]

However, by using INSERT control cards, the above alter can be accomplished in many different ways. The following are some ways of achieving this (the first two alters given below are shown in Table 1 for this example):

\[ \text{INSERT DPD,2 $} \]
\[ \text{INSERT READ,-1 $} \]
\[ \text{INSERT RBMG4,4 $} \]
\[ \text{INSERT SDR1,-5 $} \]
\[ \text{INSERT BEGIN,68 $} \]
\[ \text{INSERT END,-30 $} \]

All of the above INSERT cards (the last two INSERTs shown above are admittedly extreme examples), though different in appearance, are all equivalent since they identify the same specified module, namely, the PARAM module just before the READ module in the DMAP. They differ from one another in that each of them employs a different reference module in conjunction with a correspondingly different offset flag.

In a similar manner, if alters involve the deletion of DMAP modules, DELETE control cards can be used to accomplish it in more than one way.

Assume that the number of DMAP statements in a rigid format DMAP sequence is \( m \). Then, by using INSERT control cards, a given alter of the form

\[ \text{ALTER n $} \quad \text{or} \quad \text{ALTER n,n $} \]

can be accomplished in \( m \) different, but equivalent, ways by selecting each of the \( m \) DMAP modules in the rigid format as a reference module with an appropriate offset flag.

In a similar manner, a given alter of the form

\[ \text{ALTER n1,n2 $} \quad (n1 \neq n2) \]

can be accomplished in \( m^2 \) different ways since each of \( n1 \) and \( n2 \) can be specified in \( m \) different,
but equivalent, ways.

3. Reduced Susceptibility to Future Changes in Rigid Format DMAPs

Because the new alter control cards refer to DMAP statements by their module names, alter packages that contain these new cards will be much less susceptible to future changes in rigid formats than if standard ALTER cards were used.

Consider, for instance, Example 1 in Table 1. This involves the insertion of new DMAP statements after the SDR2 module. (This is the normal alter that is used to obtain NASTRAN output for subsequent interface with post-processing programs like PATRAN.)

The only way of accomplishing the above alter by using standard ALTER control cards is to use the following alter:

\[ \text{ALTER 79} \$

The above alter will no longer be valid if future changes to the rigid format involve additions or deletions to the DMAP ahead of the SDR2 module. In that case, the new DMAP statement number for the SDR2 module must be used in the above alter.

By using INSERT control cards, the above alter can be accomplished by the following alter:

\[ \text{INSERT SDR2} \$

Because the above alter refers to the DMAP module by name, it will be unaffected by any future additions or deletions to the DMAP.

CONCLUDING REMARKS

This paper has described a powerful enhancement to the DMAP alter capability that has been developed by RPK Corporation and that is available on all RPK-supported versions of COSMIC/NASTRAN. This enhancement involves the addition of two new alter control cards, called INSERT and DELETE, to the Executive Control Deck. These cards allow for DMAP alters to be made by referencing DMAP statements by their module names rather than by their statement numbers in the rigid format DMAP sequence. This allows for increased user convenience and flexibility and makes alters more meaningful to the user. In addition, DMAP alter packages employing the new alter control cards will be much less susceptible to future changes in rigid format DMAPs than alter packages employing the standard ALTER control cards. The usage of the new cards is illustrated by examples.

REFERENCE

Table 1. Examples on the Usage of Alter Control Cards
(see Note 1 below)

<table>
<thead>
<tr>
<th>Example no.</th>
<th>Alters using ALTER cards</th>
<th>Equivalent alters using INSERT or DELETE cards (see Note 2 below)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ALTER 79 $</td>
<td>INSERT SDR2 $</td>
</tr>
</tbody>
</table>
| 2           | ALTER 69 $                | INSERT DPD,2
              | INSERT READ,-1 $                                              |
| 3           | ALTER 31 $                | INSERT EMA(2) $                                              |
| 4           | ALTER 30 $                | INSERT EMA,2 $                                               |
              |                           | INSERT EMA(2),-1 $                                           |
| 5           | ALTER 82,82 $             | DELETE SCAN $                                                |
| 6           | ALTER 2,3 $               | DELETE PRECHK,FILE $                                         |
| 7           | ALTER 32,35 $             | DELETE GPWG,-1,GPWG,2 $                                      |
| 8           | ALTER 84,87 $             | DELETE PLOT(2),-1,PLOT(2),2 $                                |

Notes:
1. All of the alters given above refer to the DMAP sequence of Rigid Format 3 - Displacement Approach, Release 1988, given in Appendix B.

2. The equivalent alters using INSERT or DELETE cards shown above are only suggested usages. As explained in the paper, alters using INSERT or DELETE control cards are not unique and can be accomplished in more than one way.
APPENDIX A

Description of Alter Control Cards
Executive Control Card ALTER - Rigid Format DMAP Sequence Alteration Request

Description: Requests the Direct Matrix Abstraction Program (DMAP) sequence of a rigid format to be changed by additions, deletions or substitutions.

Format and Examples:

ALTER\{K1 [, , K2]\}\$
ALTER 22 $
ALTER 5,5 $
ALTER 38,45 $
ALTER 25,19 $

Option

K1 only
DMAP statement number (Integer > 0) after which DMAP instructions following the ALTER card are to be inserted

K1 and K2
DMAP statement numbers (Integer > 0) identifying a single DMAP statement or a range of DMAP statements to be deleted and replaced by any DMAP instructions that may follow the ALTER card. See Remark 5.

Remarks:
1. See the descriptions of the INSERT and DELETE cards for alternate ways of specifying DMAP sequence alteration requests.
2. The DMAP statements referenced on ALTER, INSERT and DELETE cards (either explicitly or implicitly, when a range is specified) must be referenced in ascending order of their occurrence in the rigid format DMAP.
3. See Volume 2, Sections 2, 3 and 4 for the listings of all rigid format DMAP sequences.
4. See Volume 2, Section 1.1.5 for the manner in which DMAP alters are handled in restarts.
5. If both K1 and K2 are specified and K1 \(\neq\) K2, a range of DMAP statements is implied and either of them can be less than the other. If K1 = K2, a single DMAP statement is implied.
Executive Control Card DELETE - Rigid Format DMAP Sequence Alteration Request

Description: Requests the Direct Matrix Abstraction Program (DMAP) sequence of a rigid format to be changed by deletions or substitutions.

Format and Examples:

DELETE specmod₁[, specmod₂] $

where specmod₁ has the following general form:

nommod₁[(ri)][, ni]

DELETE SSG₁ $
DELETE EMA(2) $
DELETE READ,1 $
DELETE SDR2(2),-1 $
DELETE SSG₃,REPT $
DELETE GP₂,GP₃,-1 $
DELETE SMA₃,1,TA₁,-1 $
DELETE REPT,2,REPT,3 $

Option

nommod₁ Nominal module (Alphanumeric value, no default). See Remark 5.

ri Occurrence flag (Integer > 0, default = 1). The rᵢth occurrence of the nominal module in the rigid format DMAP sequence (counting from the beginning of the DMAP sequence) defines the reference module. See Remark 6.

ni Offset flag (Integer, default = 0). The DMAP module that is offset from the reference module by nᵢ DMAP statements in the rigid format DMAP sequence defines the specified module. See Remark 7.

specmod₁ only Specified module defined as per the above scheme that is to be deleted and replaced by any DMAP instructions that may follow the DELETE card

specmod₁ and specmod₂ Range of specified modules defined as per the above scheme that are to be deleted and replaced by any DMAP instructions that may follow the DELETE card. See Remark 8.

Remarks:

1. See the description of the ALTER card for an alternate way of specifying DMAP sequence deletions and substitutions.

2. The DMAP statements referenced on ALTER, INSERT and DELETE cards (either explicitly or implicitly, when a range is specified) must be referenced in ascending order of their occurrence in the rigid format DMAP.

2.2-8a (09/01/88)
3. See Volume 2, Sections 2, 3 and 4 for the listings of all rigid format DMAP sequences.

4. See Volume 2, Section 1.1.5 for the manner in which DMAP alters are handled in restarts.

5. The nominal module nommod₁ must be a valid name of a DMAP module in the rigid format DMAP sequence.

6. The default value of 1 for the occurrence flag ri implies that the reference module is the first occurrence of the nominal module in the rigid format DMAP sequence.

7. The value of the offset flag ni may be positive, negative or 0. A positive value means that the specified module follows the reference module by ni DMAP statements in the rigid format DMAP sequence. A negative value indicates that the specified module precedes the reference module by ni DMAP statements in the DMAP sequence. A value of 0 (the default) implies that the reference module is the specified module.

8. If both specmod₁ and specmod₂ are specified, it implies a range of DMAP statements and either of them can precede the other in the rigid format DMAP sequence.
Executive Control Card **INSERT** - Rigid Format DMAP Sequence Alteration Request

**Description:** Requests the Direct Matrix Abstraction Program (DMAP) sequence of a rigid format to be changed by additions.

**Format and Examples:**

```markdown
INSERT specmod]

where specmod has the following general form:

nommod [(r)] [, n]

INSERT GP4]
INSERT EMA(2)]
INSERT READ,1]
INSERT SDR2(2),-1]
```

**Option**

- **nommod**
  - Nominal module (Alphanumeric value, no default). See Remark 5.

- **r**
  - Occurrence flag (Integer > 0, default = 1). The rth occurrence of the nominal module in the rigid format DMAP sequence (counting from the beginning of the DMAP sequence) defines the reference module. See Remark 6.

- **n**
  - Offset flag (Integer, default = 0). The DMAP module that is offset from the reference module by n DMAP statements in the rigid format DMAP sequence defines the specified module. See Remark 7.

- **specmod**
  - Specified module defined as per the above scheme after which DMAP statements following the INSERT card are to be inserted.

**Remarks:**

1. See the description of the ALTER card for an alternate way of specifying DMAP sequence additions.

2. The DMAP statements referenced on ALTER, INSERT and DELETE cards (either explicitly or implicitly, when a range is specified) must be referenced in ascending order of their occurrence in the rigid format DMAP.

3. See Volume 2, Sections 2, 3 and 4 for the listings of all rigid format DMAP sequences.

4. See Volume 2, Section 1.1.5 for the manner in which DMAP alters are handled in restarts.

5. The nominal module nommod must be a valid name of a DMAP module in the rigid format DMAP sequence.

6. The default value of 1 for the occurrence flag r implies that the reference module is the first occurrence of the nominal module in the rigid format DMAP sequence.
7. The value of the offset flag $n$ may be positive, negative or 0. A positive value means that the specified module follows the reference module by $n$ DMAP statements in the rigid format DMAP sequence. A negative value indicates that the specified module precedes the reference module by $n$ DMAP statements in the DMAP sequence. A value of 0 (the default) implies that the reference module is the specified module.
APPENDIX B

DMAP Listing of Rigid Format 3 - Displacement Approach, Release 1988
OPTIONS IN EFFECT

1 BEGIN
2 PRECHK
3 FILE
4 PARAM
5 GP1
6 PLTTRAN
7 GP2
8 PARAML
9 PURGE
10 COND
11 PLTSET
12 PRTMSG
13 PARAM
14 PARAM
15 COND
16 PLOT
17 PRTMSG
18 LABEL
19 GP3
20 TA1
21 EQUIV
22 COND
23 PARAM
24 PARAM

LEVEL 2.0 NASTRAN DMAP COMPILER - SOURCE LISTING
26$ PURGE KGGX/NOKGGX $
27$ COND JMPKGG, NOKGGX $
28$ EMA GPECT, KDICT, KELM/KGGX $
29$ LABEL JMPKGG $
30$ COND ERROR1, NOMGG $
31$ EMA GPECT, MDict, MELM/MGG/-1/C, Y, WTMASS=1.0 $\$
32$ COND LGPWG, GRDPNT $\$
33$ GPWG BGPD, CSTM, EQEXIN, MGG/OGPWG/V, Y, GRDPNT=-1/C, Y, WTMASS $\$
34$ OFP OGPWG, ..., /S, N, CARDNO $\$
35$ LABEL LGPWG $\$
36$ EQUIV KGGX, KGG/NOGENL $\$
37$ COND LBL11, NOGENL $\$
38$ SMA3 GEI, KGGX/KGG/LUSET/NOGENL/NOSIMP $\$
39$ LABEL LBL11 $\$
40$ GPSTGEN KGG, SIL/GPST $\$
41$ PARAM //"MPY"/NSKI P/0/0 $\$
43$ OFP OGPST, ..., /S, N, CARDNO $\$
44$ COND ERROR3, NOL $\$
45$ PURGE KRR, KLR, DM, MLR, MR/REACT/GM/MPCF1/GO/OMIT/KFS/SINGLE/QG/NOSET $\$
46$ EQUIV KGG, KNN/MPCF1/MGG, MNN/MPCF1 $\$
47$ COND LBL2, MPCF1 $\$
48$ MCE1 USET, RG/GM $\$
49$ MCE2 USET, GM, KGG, MGG, /KNN, MNN, $
50 LABEL LBL2 $ 
51 EQUIV KNN,KFF/SINGLE/MNN,MFF/SINGLE $ 
52 COND LBL3,SINGLE $ 
53 SCE1 USET,KNN,MNN,,/KFF,KFS,,MFF,, $ 
54 LABEL LBL3 $ 
55 EQUIV KFF,KAA/OMIT $ 
56 EQUIV MFF,MAA/OMIT $ 
57 COND LBL5,OMIT $ 
58 SMP1 USET,KFF,,/GO,KAA,KOO,LOO,....., $ 
59 SMP2 USET,GO,MFF/MAA $ 
60 LABEL LBL5 $ 
61 COND LBL6,REACT $ 
62 RBMG1 USET,KAA,MAA/KLL,KLR,KRR,MLL,MLR,MRR $ 
63 RBMG2 KLL/LLL $ 
64 RBMG3 LLL,KLR,KRR/DM $ 
65 RBMG4 DM,MLL,MLR,MRR/MR $ 
66 LABEL LBL6 $ 
67 DPD DYNAMICS,GPL,SIL,USET/GPLD,SILD,USETD,.....,EED,EQDYN/ LUSET/LUSETD/NOTFL/NODLT/NOPSDL/NOFRL/ NONLFT/NOTRL/S,N,NOEED/NOEU $ 
68 COND ERROR2,NOEED $ 
69 PARAM //"MPY"/NEIGV/1/-1 $ 
70 READ KAA,MAA,MR,DM,EED,USET,CASECC/LAMA,PHIA,MI,OEIGS/*MODES*/ S,N,NEIGV $ 
71 OFP OEIGS,.....//S,N,CARDNO $ 
72 COND FINIS,NEIGV $ 
73 OFP LAMA,.....//S,N,CARDNO $ 
74 SDR1 USET,,PHIA,,GO,GM,,KFS,,/PHIG,,QG/1/*REIG* $ 
75 COND NOMPCF,GRDEQ $ 
76 EQMC CASECC,EQEXIN,GPL,BGPDT,SIL,USET,KGG,GM,PHIG,LAMA,QG,CSTM/ OQM1/V,Y,OPT=0/V,Y,GRDEQ/-1 $ 

185
OQP
LABEL NOMPCF $
SDR2 CASECC,CSTM,MPT,DIT,_EQEXIN,SIL,,BGPDP,LAMA,QG,PHIG,EST,,
PCOMPS/,OQG1,OPHIG,OES1,OEFL,PPHIG,OES1L,OEFL/
"REIG"///COMPS $
OQP OPHIG,OQG1,OEFL,OES1,///S,N,CARDNO $
OQP OEFL,OES1L,,,///S,N,CARDNO $
SCAN CASECC,OES1,OEFL/OESFL/*RF* $
OQP OES1L,,,///S,N,CARDNO $
COND P2,JUMPPLOT $
PLOT PLOTX2// $ 
LABEL P2 $ 
JUMP FINIS $ 
LABEL ERROR1 $ 
PRTPARM //3/*MODES* $ 
LABEL ERROR2 $ 
PRTPARM //2/*MODES* $ 
LABEL ERROR3 $ 
PRTPARM //3/*MODES* $ 
LABEL ERROR4 $ 
PRTPARM //4/*MODES* $ 
LABEL FINIS $ 
PURGE DUMMY/ALWAYS $ 
END $