META-HEURISTICS GRASP AND ILS APPLIED TO THE AIRCRAFT ROTATION PROBLEM

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Abstract

The Aircraft Rotation Problem refers to the designation of each airplane available at airlines companies such that all planned flights are covered. This is a light constrained problem since any aircraft can be assigned to an unlimited quantity of duty work. However, there are many lower cost solutions that can be obtained by simply adjusting the time of departure of a flight, or even positioning some aircraft by executing ferry flights between two near airports. We describe an algorithm based on GRASP meta-heuristic using ILS as local search, which calculates a sub-optimal way to organize the flights. This is a good solution to large scaled problems, considering that in this case, an exact method would require some years to be applied. Some computational results are presented for a real world problem at Rio-Sul Brazilian Airline.

Keywords: Aircraft Routing, Optimization, Meta-heuristic, GRASP

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1 Introduction

The airline industry has been a rich source of problems related to operational research, mainly due to combinatorial explosive nature of these problems. Typically, planning problems involve the creation of lines of work for both aircraft and crew.

On the literature, there are two well-known problems associated to aircraft planning, the Fleet Assignment and the Aircraft Rotation Problem (ARP). The first deals with the allocation of the fleet, determining the type of aircraft used in each flight [1]. The second is the one covered on this paper, and will be explained on the next section.

Due to the combinatorial explosion of the problems involving airlines, they should be solved separately, though each problem should be solved giving conditions to the next one be solved.

Many techniques have been used to give a solution to the ARP, some of them using exact methods, which always obtain the best result, but uses lots of CPU, and in practice is unfeasible, due to the size of real problems. Other techniques try to find a good solution, instead of the best, and try to do that in a fast way. To do so, they use meta-heuristics, a heuristic method that uses some historical knowledge of the solutions combined with some characteristic of the problem to find a good solution for big instances.

1.1 The ARP problem

After solving the Fleet Assignment problem, the one that chooses the kind of airplane that will cover the flights, the problem becomes the organization of the flights. It means, how flights will be connected. The ways to group them can have a very big impact on the cost of the flight network. This cost comes from several factors, like the numbers of aircrafts needed to cover all the flights, the delay between them, the downtime of the flights, and others.

To solve this problem, we must be aware of some constraints involving time and space. For example, an airplane cannot leave before the arrival of the flight that precedes it, neither from a different city that it has arrived on the last flight. Though these are obvious constraints, they make the problem really hard to solve in a large scale, as we could have a very big number of combinations between the connections of the flights. There is also another constraint, related to the time that the airplane has to be on the ground before it leaves. This restriction is usually related to an airport.

Considering these restrictions, we should arrange the flights looking for a cheap network. Its known that finding the cheapest is almost impossible for big instances, but finding a good one can be achieved with some meta-heuristics.

Another important aspect is the maintaining restrictions. It is known that a plane must have periodic checks. Opportunities to perform these tasks occur only on some connections that are potentially available. As consequence, a sequence of flights must be constructed so that these restrictions are not violated. In order to easily incorporate these constraints in our framework, we assume that the rotations are not assigned to specific types of aircraft. Thus, if an aircraft needs maintenance, is created a special flight depart and arrive from the maintenance base chosen. The time of flight is exactly the service time [1].

2 Methodology

In order to find a good solution to the ARP problem, two meta-heuristics were implemented using java Language. On this section, it will be exposed how to represent a solution, as well as some details about the application of the meta-heuristics on the ARP problem.

2.1 Problem Concepts

Each solution has the flight network, with all the connections between the flights. To represent the flights covered by a unique airplane, the concept of a track was applied. So, the goal is to find the smallest number of tracks needed to cover all flights.

Each track is composed by any number of flights, considering the restrictions described on last section. The connection between flights is called arc. An arc has to be one of the followings:

- Simple Connection Arc (type 1): This arc connects flights that dont need to be changed. There is no need to create another flight to connect them too. The cost of this arc is zero.

- Connection With Delay Arc (type 2): With this arc, the second flight needs to be delayed, in order to conform the time restriction. The cost of this arc is the delay (in minutes) of the second flight.
- Connection With Repositioning Arc (type 3): This arc creates a third flight between the two previously selected, in order to conform the space condition. The third flight goes from the destination of the first flight to the origin of the second flight. The cost of this arc is the duration of the created flight.
- Connection With Repositioning and Delay Arc (type 4): Besides creating a new flight to connect the two ones, this type of arc also delays the second flight, so it obeys both space and time restrictions. The cost of this arc is the addition of the delayed time plus the duration of the created flight.

2.2 Problem Solution and Representation

The generation of a solution was divided into two steps. The first one constructs a good solution and the second tries to improve the given solution with some local search algorithms.

To generate a solution, the algorithm GRASP (Greedy Randomized Adaptive Search Procedure) was applied. This algorithm utilizes a greedy heuristic, mixed with a nondeterministic choice of the next element to the solution [FONTE]. To do so, each time an element is to be added to the solution, it is chosen randomically between a fraction of the best ones, according to a greedy algorithm. The algorithm runs several times, and only the best solution goes to the next step.

The second meta-heuristic applied to the ARP is the Iterated Local Search (ILS). It takes a given solution, found on the first phase, and makes some search on different neiborghoods. With this, local minimums can be avoided [Fonte].

It was developed a visual interface to show the solution found by the algorithms. It can be viewed in the results section, picture 1.

3 The constructive algorithm

In this phase, the computer generates a good solution, following the steps:

3.1 Track formation

3.1.1 Initializing a track

To initialize a track, a flight is randomically chosen between the N flights that have the lower departure time and that have not been chosen by another track.

3.1.2 Composing and finalizing a track

After choosing the first flight, or with the previous flight, it is made the choice of the next arch k, $K \in \{1, 2, 3, 4\}$. This choice is made with a probability associated with each arch type P1, P2, P3, P4. The next flight should obey the arch rule and should not have a departure time very far from the arrival of the last. With all the candidates, only the a% best are chosen to be a part of the possible set. So it is randomically picked one and added to the track.

The value of a was defined as 15%, to type 1 arches, and variable, according to the number of candidates, to the other arches.

If the generated set dont have any flight, then the arch type will be changed. If no arch have any possible flight, then the last flight ends the track.

3.2 Composing a network

It is generated as much tracks as all the flights are covered. The constructive algorithm stops when all the flights are already corered.

4 The local search Algorithm

After selecting the best solution generated in construction, it is used some algorithms to try to find a way to improve the solution. It was used the swap and compaction methods and the ILS (Iterated Local Search) meta-heuristic.

There were three kinds of swaps implemented, the Swap-1, Swap-2 and the Swap 3. The swap-n procedure is done by trying to change n connected flights with 1 to n + 1 flights. The change is accepted if there is a cost reduction. The compaction method tries to merge two different tracks into one.

The ILS algorithm was implemented in a way of disturbing the current solution, and then applying the methods described before. Forcing four Swaps-2, not considering if they improve the solution, makes this disturbance.

4.1 Computational results

To run the tests, it was used a small daily flight network from Rio-Sul airlines [1]. All data is described on Appendix A to D. With this information, any program can be tested with the same entrance, verifying its efficiency.

All tests run on a Intel Core 2 T5300 1.73GHz, with 1GB DDR-2 RAM. The algorithm was implemented using Java, on NetBeans IDE 6.0.1.

The table below shows details of the achievement of the best solution:

Number of tracks	Cost	Time(seconds)
21	21335	0.039
17	17100	0.113
17	17078	0.315
17	17074	0.346
17	17066	6.012
17	17054	9.612
17	17048	14.179
17	17040	15.0
17	17033	19.484

Below we have a visualization of the best result obtained:

This result can be viewed in more detail in Attachment C.

In the test described was set a ground time standard for all airports, which is 20 minutes. The time between two airports can be found in Attachment B

4.2 Conclusion and Future Researches

The aircrafts are one of the most expensive resources on aeronautics, so every flight planning should be done for a cost reduction. The ARP is one of the problems that can lead to a very high operational cost to a company, if erroneously treated or ignored.

With simple time changing or creating a repositioning flight, the flight network could have a substantial improvement, decreasing aircrafts downtime and reducing the number of planes needed to cover all the defined flights.

For next researches, some efforts are being made to idealize a more complete model of the ARP, leading with weekly tasks, and also solve the next problem to the ARP, the Crew Scheduling. On this next approach, not only the flights will be organized, but also all the crew will be designated to cover the network.

References

[1] Pimentel, A. G., *Uma abordagem heurística para a solução de problemas de recobrimento de conjuntos de grande porte, com aplicação à alocação de tripulações para companhias aéreas*, Tese de Doutorado, Universidade Federal do Rio de Janeiro (2002).

[2] Pontes, R., Lucena, A. e Cabral, L., *Exact and Heuristic Techniques for Solving the Aircraft Rotation Problem*, Technical report Department of Statistics UFPB (2002).

[3] Rezende, M, *Greedy Randomized Adaptative Search Procedures (GRASP)* , Technical Report, ATT Labs Research (1998).

[4] Rubin, J. , "A Technique for the Solution of Massive Set Covering Problems with Application to Airline Crew Scheduling," Transportation Science (1973).

[5] Clarke L, Johnson E, Nemhauser G, Zhu ZX, "The Aircraft Rotation Problem," Annals of Operations Research (1997) 69: 33-46

[6] Klabjan, D. Johnson, E. Nemhauser, G., "Solving Large Airline Crew Scheduling Problems: Random Pairing Generation and Strong Branching," Technical Report, Georgia Institute of Technology (1999).

A Flights Network

001 SL166 08:00 08:31 GYN BSB
002 SL155 08:32 10:33 GYN CGH
003 SL330 08:34 09:59 CGH VIX
004 SL595 08:40 11:11 POA CGH
005 SL596 08:44 10:39 CGH POA
006 SL533 08:50 10:01 BSB PLU
007 SL280 08:52 09:43 CGH CWB
008 SL587 09:00 10:01 PLU CGH
009 SL520 09:02 09:47 SDU PLU
010 JH559 09:04 10:35 BSB CGH
011 SL406 09:06 09:55 SDU CGH
012 SL419 09:16 11:03 FLN CGH
013 SL542 09:28 10:31 CGH PLU
014 SL408 09:30 10:21 SDU CGH
015 JH345 09:30 12:23 SSA CGH
016 SL589 09:58 11:01 PLU CGH
017 JH502 10:02 11:33 CGH BSB
018 SL281 10:08 10:59 CWB CGH
019 SL521 10:16 11:01 PLU SDU
020 SL532 10:20 11:31 PLU BSB
021 SL510 10:22 11:13 CGH CWB
022 SL544 10:32 11:33 CGH PLU
023 SL331 10:40 12:11 VIX CGH
024 SL409 11:00 11:49 CGH SDU
025 SL543 11:00 12:03 PLU CGH
026 SL590 11:06 12:44 CGH POA
027 SL336 11:16 15:05 CGH REC
028 SL597 11:30 13:27 POA CGH
029 SL522 11:32 12:17 SDU PLU
030 SL150 11:42 13:33 CGH GYN
031 SL511 11:50 12:41 CWB CGH
032 JH503 12:02 13:33 BSB CGH
033 SL545 12:04 13:05 PLU CGH
034 SL470 12:28 13:19 SDU CGH
035 SL523 12:46 13:31 PLU SDU
036 JH342 13:00 15:45 CGH SSA
037 JH500 13:02 14:33 CGH BSB
038 SL147 13:10 18:03 BSB BSB
039 JH340 13:22 18:25 CGH JPA
040 SL591 13:30 14:57 POA CGH
041 SL402 13:38 15:33 CGH POA
042 SL471 13:54 14:39 CGH SDU
043 SL390 13:56 15:41 CGH FLN
044 SL564 13:58 14:59 CGH PLU
045 SL151 13:58 15:59 GYN CGH
046 SL563 14:00 15:01 PLU CGH
047 SL272 14:12 15:51 CGH SJP
048 SL282 14:22 15:13 CGH CWB
049 SL508 14:56 15:41 SDU PLU
050 JH501 14:58 16:29 BSB CGH
051 SL480 15:30 16:21 SDU CGH
052 SL283 15:42 16:37 CWB CGH
053 SL337 15:46 19:29 REC CGH
054 SL347 16:00 16:45 PLU SDU
055 SL598 16:00 17:55 CGH POA
056 SL568 16:02 17:03 CGH PLU
057 SL403 16:08 17:59 POA CGH
058 SL273 16:10 17:51 SJP CGH
059 SL391 16:12 17:55 FLN CGH
060 JH343 16:12 18:57 SSA CGH
061 SL481 17:00 17:45 CGH SDU
062 JH506 17:02 18:33 CGH BSB
063 SL405 17:14 19:57 CGH CGH
064 SL569 17:32 18:33 PLU CGH
065 SL152 17:44 19:35 CGH GYN
066 JH546 17:56 19:27 CGH BSB
067 SL572 17:58 18:59 CGH PLU
068 SL482 18:30 19:21 SDU CGH
069 JH341 18:50 00:19 JPA CGH
070 SL592 18:54 20:45 CGH POA
071 JH507 19:00 20:31 BSB CGH
072 SL528 19:02 19:47 SDU PLU
073 JH550 19:04 20:35 CGH BSB
074 SL537 19:22 20:33 BSB PLU
075 SL576 19:26 20:27 CGH PLU
076 SL573 19:34 20:35 PLU CGH
077 SL599 19:46 21:41 POA CGH
078 JH547 20:00 21:31 BSB CGH
079 SL153 20:04 22:05 GYN CGH
080 SL483 20:08 20:53 CGH SDU
081 SL412 20:10 21:29 CGH FLN
082 SL529 20:14 20:59 PLU SDU
083 SL584 20:26 21:27 CGH PLU
084 SL514 20:30 21:21 CGH CWB
085 JH344 20:48 23:39 CGH SSA
086 SL577 21:02 22:03 PLU CGH
087 SL536 21:04 22:13 PLU BSB
088 JH551 21:04 22:35 BSB CGH
089 SL332 21:20 22:31 CGH VIX
090 SL492 21:30 22:21 SDU CGH
091 SL586 21:30 22:31 CGH PLU
092 SL530 21:34 22:19 SDU PLU
093 SL515 21:45 22:37 CWB CGH
094 SL593 21:52 23:19 POA CGH
095 SL585 22:04 23:05 PLU CGH
096 SL518 22:16 23:07 CGH CWB
097 SL413 22:22 23:31 FLN CGH
098 SL407 22:24 23:09 CGH SDU
099 SL167 22:42 23:13 BSB GYN
100 SL531 22:48 23:33 PLU SDU
101 JH558 22:56 00:27 CGH BSB
102 SL493 23:02 23:47 CGH SDU
103 SL333 23:04 00:15 VIX CGH
104 SL588 23:06 00:07 CGH PLU
105 SL594 23:18 01:57 CGH POA
106 SL154 23:22 01:13 CGH GYN
107 SL418 23:32 01:19 CGH FLN

B Flight Time Between Airports

BSB CGH 091	BSB CWB 125	BSB FLN 152	BSB GYN 031
BSB JPA 197	BSB PLU 071	BSB POA 185	BSB REC 191
BSB SDU 107	BSB SJP 066	BSB SSA 125	BSB VIX 109
CGH CWB 051	CGH FLN 105	CGH GYN 095	CGH JPA 255
CGH PLU 058	CGH POA 097	CGH REC 246	CGH SDU 049
CGH SJP 049	CGH SSA 171	CGH VIX 087	CWB FLN 028
CWB GYN 114	CWB JPA 293	CWB PLU 095	CWB POA 062
CWB REC 283	CWB SDU 078	CWB SJP 060	CWB SSA 208
CWB VIX 125	FLN GYN 142	FLN JPA 311	FLN PLU 114
FLN POA 042	FLN REC 300	FLN SDU 087	FLN SJP 088
FLN SSA 225	FLN VIX 136	GYN JPA 216	GYN PLU 076
GYN POA 173	GYN REC 210	GYN SDU 109	GYN SJP 054
GYN SSA 143	GYN VIX 118	JPA PLU 198	JPA POA 352
JPA REC 013	JPA SDU 226	JPA SJP 251	JPA SSA 085
JPA VIX 181	PLU POA 155	PLU REC 187	PLU SDU 045
PLU SJP 067	PLU SSA 113	PLU VIX 044	POA REC 342
POA SDU 129	POA SJP 119	POA SSA 267	POA VIX 177
REC SDU 215	REC SJP 242	REC SSA 075	REC VIX 169
SDU SJP 079	SDU SSA 130	SDU VIX 048	SJP SSA 169
SJP VIX 110	SSA VIX 097		

C Result Obtained By The GRASP

Trilho[1]
SL155 08:32 10:33 GYN CGH
SL590 11:06 12:44 CGH POA
SL591 13:30 14:57 POA CGH
SL481 17:00 17:45 CGH SDU
SL482 18:30 19:21 SDU CGH
SL483 20:08 20:53 CGH SDU
SL492 21:30 22:21 SDU CGH
JH558 22:56 00:27 CGH BSB
SL332 21:20 22:31 CGH VIX
SL333 23:04 00:15 VIX CGH

Trilho[2]
SL595 08:40 11:11 POA CGH
SL402 13:38 15:33 CGH POA
SL403 16:08 17:59 POA CGH
SL592 18:54 20:45 CGH POA
SL593 21:52 23:19 POA CGH
SL480 15:30 16:21 SDU CGH
JH506 17:02 18:33 CGH BSB
JH507 19:00 20:31 BSB CGH

Trilho[3]
SL166 08:00 08:31 GYN BSB
JH559 09:04 10:35 BSB CGH
SL409 11:00 11:49 CGH SDU
SL470 12:28 13:19 SDU CGH
SL471 13:54 14:39 CGH SDU

Trilho[4]
SL330 08:34 09:59 CGH VIX
SL331 10:40 12:11 VIX CGH
JH342 13:00 15:45 CGH SSA
JH343 16:12 18:57 SSA CGH
SL412 20:10 21:29 CGH FLN
SL413 22:22 23:31 FLN CGH
SL586 21:30 22:31 CGH PLU
SL529 20:14 20:59 PLU SDU
SL530 21:34 22:19 SDU PLU
SL531 22:48 23:33 PLU SDU

Trilho[5]
SL596 08:44 10:39 CGH POA
SL597 11:30 13:27 POA CGH
SL272 14:12 15:51 CGH SJP (-1)
SL273 16:10 17:51 SJP CGH
SL572 17:58 18:59 CGH PLU (+13)
SL573 19:34 20:35 PLU CGH
SL528 19:02 19:47 SDU PLU

Trilho[6]
SL520 09:02 09:47 SDU PLU
SL521 10:16 11:01 PLU SDU
SL522 11:32 12:17 SDU PLU
SL523 12:46 13:31 PLU SDU
SL508 14:56 15:41 SDU PLU (-1)
SL347 16:00 16:45 PLU SDU

Trilho[7]
SL280 08:52 09:43 CGH CWB
SL281 10:08 10:59 CWB CGH
SL336 11:16 15:05 CGH REC (+3)
SL337 15:46 19:29 REC CGH
SL584 20:26 21:27 CGH PLU
SL585 22:04 23:05 PLU CGH
SL418 23:32 01:19 CGH FLN
SL407 22:24 23:09 CGH SDU
SL493 23:02 23:47 CGH SDU

Trilho[8]
SL406 09:06 09:55 SDU CGH (-13)
JH502 10:02 11:33 CGH BSB
JH503 12:02 13:33 BSB CGH
SL564 13:58 14:59 CGH PLU
SL569 17:32 18:33 PLU CGH
SL576 19:26 20:27 CGH PLU
SL577 21:02 22:03 PLU CGH
SL515 21:45 22:37 CWB CGH

Trilho[9]
SL587 09:00 10:01 PLU CGH
SL510 10:22 11:13 CGH CWB
SL511 11:50 12:41 CWB CGH
JH500 13:02 14:33 CGH BSB
JH501 14:58 16:29 BSB CGH
SL405 17:14 19:57 CGH CGH
SL514 20:30 21:21 CGH CWB

Trilho[10]
SL542 09:28 10:31 CGH PLU
SL543 11:00 12:03 PLU CGH
JH340 13:22 18:25 CGH JPA
JH341 18:50 00:19 JPA CGH
SL391 16:12 17:55 FLN CGH
JH550 19:04 20:35 CGH BSB
JH551 21:04 22:35 BSB CGH
SL588 23:06 00:07 CGH PLU

Trilho[11]
SL408 09:30 10:21 SDU CGH (-9)
SL544 10:32 11:33 CGH PLU
SL545 12:04 13:05 PLU CGH
SL390 13:56 15:41 CGH FLN
SL153 20:04 22:05 GYN CGH
SL594 23:18 01:57 CGH POA

Trilho[12]
SL419 09:16 11:03 FLN CGH
SL150 11:42 13:33 CGH GYN
SL151 13:58 15:59 GYN CGH
SL152 17:44 19:35 CGH GYN

Trilho[13]
SL589 09:58 11:01 PLU CGH
SL282 14:22 15:13 CGH CWB
SL283 15:42 16:37 CWB CGH
JH546 17:56 19:27 CGH BSB
JH547 20:00 21:31 BSB CGH
SL518 22:16 23:07 CGH CWB

Trilho[14]
SL532 10:20 11:31 PLU BSB
SL147 13:10 18:03 BSB BSB
SL537 19:22 20:33 BSB PLU
SL536 21:04 22:13 PLU BSB
SL167 22:42 23:13 BSB GYN

Trilho[15]
SL533 08:50 10:01 BSB PLU
SL563 14:00 15:01 PLU CGH
SL598 16:00 17:55 CGH POA
SL599 19:46 21:41 POA CGH
SL154 23:22 01:13 CGH GYN

Trilho[16]
JH345 09:30 12:23 SSA CGH
SL568 16:02 17:03 CGH PLU
NOVO 17:23 18:21 PLU CGH
JH344 20:48 23:39 CGH SSA

D Colision with window

All ground time is fixed in 20 minutes.

16 Flights with up to 1 minute window	15 Flights with up to 17 minute window	14 Flights with up to 33 minute window
001 SL155 0 08:32 0 10:33 GYN CGH	068 JH341 0 18:50 1 00:19 JPA CGH	001 SL155 0 08:32 0 10:33 GYN CGH
002 SL330 0 08:34 0 09:59 CGH VIX	069 SL592 0 18:54 0 20:45 CGH POA	002 SL330 0 08:34 0 09:59 CGH VIX
003 SL595 0 08:40 0 11:11 POA CGH	070 JH507 0 19:00 0 20:31 BSB CGH	003 SL595 0 08:40 0 11:11 POA CGH
004 SL596 0 08:44 0 10:39 CGH POA	072 JH550 0 19:04 0 20:35 CGH BSB	004 SL596 0 08:44 0 10:39 CGH POA
005 SL533 0 08:50 0 10:01 BSB PLU	073 SL537 0 19:22 0 20:33 BSB PLU	005 SL533 0 08:50 0 10:01 BSB PLU
006 SL280 0 08:52 0 09:43 CGH CWB	074 SL576 0 19:26 0 20:27 CGH PLU	006 SL280 0 08:52 0 09:43 CGH CWB
007 SL587 0 09:00 0 10:01 PLU CGH	075 SL573 0 19:34 0 20:35 PLU CGH	007 SL587 0 09:00 0 10:01 PLU CGH
008 SL520 0 09:02 0 09:47 SDU PLU	076 SL599 0 19:46 0 21:41 POA CGH	008 SL520 0 09:02 0 09:47 SDU PLU
009 JH559 0 09:04 0 10:35 BSB CGH	077 JH547 0 20:00 0 21:31 BSB CGH	009 JH559 0 09:04 0 10:35 BSB CGH
010 SL406 0 09:06 0 09:55 SDU CGH	078 SL153 0 20:04 0 22:05 GYN CGH	010 SL406 0 09:06 0 09:55 SDU CGH
011 SL419 0 09:16 0 11:03 FLN CGH	079 SL483 0 20:08 0 20:53 CGH SDU	011 SL419 0 09:16 0 11:03 FLN CGH
012 SL542 0 09:28 0 10:31 CGH PLU	080 SL412 0 20:10 0 21:29 CGH FLN	012 SL542 0 09:28 0 10:31 CGH PLU
013 SL408 0 09:30 0 10:21 SDU CGH	081 SL529 0 20:14 0 20:59 PLU SDU	013 SL408 0 09:30 0 10:21 SDU CGH
014 JH345 0 09:30 0 12:23 SSA CGH	082 SL584 0 20:26 0 21:27 CGH PLU	014 JH345 0 09:30 0 12:23 SSA CGH
015 SL589 0 09:58 0 11:01 PLU CGH	083 SL514 0 20:30 0 21:21 CGH CWB	
016 JH502 0 10:02 0 11:33 CGH BSB		