

Cabin alterations are often necessary, yet costly and time-consuming for airlines. The motivations behind interior retrofits and reconfigurations must be governed by airline individual policy in order to mitigate costs, while optimising appearance and presence in the commercial marketplace.

# Interior refurbishment of medium widebodies

**T**he wear and deterioration caused to cabin furnishings and interior items mean that these items require a periodic degree of refurbishment to maintain a clean and acceptable appearance.

Medium widebodies include the 767-300ER, 767-400ER, A330-200, A330-300 and A340-300. They all have a twin-aisle layout, with capacities of about 220 to 290 in typical airline configurations. Actual seat numbers depend on the layout of passenger accommodation (LOPA). This includes the type and relative size and configuration of each cabin, and the seat pitch.

Seat pitch depends on cabin class, with first- and business-class seating having longer pitch and legroom. Medium widebodies can operate medium- to long-haul routes globally. They are typically operated by full-service carriers on missions of five to 10 flight hours. Most are configured with three- or two-class arrangements.

Typical seat numbers are 190-220 for the 767-300ER, 210-240 for the A330-200, and 255-280 for the A330-300 and A340-300.

Over the past decade, many operators have reconfigured aircraft from a traditional tri-class LOPA to a two-class LOPA. These new layouts accommodate a business class with luxurious lie-flat seats and sophisticated in-flight entertainment (IFE) systems and a range of cabin connectivity devices. Many economy-class cabins have had their seating and IFE systems upgraded in recent years.

Total seat count and aircraft capacity are clearly affected by the relative size of the premium and economy classes. While premium cabin fares generate a premium, the economy cabin experiences higher passenger load factors. Airlines therefore have to consider which cabin to prioritise

when it comes to refurbishment.

The 767-300ER is operated in both tri- and dual-class configurations. The standard Boeing tri-class specification provides a total of 218 seats in a mix of: 18 first-class seats with a 60-inch pitch, 46 business-class seats with a 38-inch pitch, and 154 economy-class seats with a 32-inch pitch. The 767-300ER has been used mostly for transatlantic services.

Reconfiguring the 767-300ER to have 24 first-class and 245 economy-class seats with a 38-inch and 32-inch pitch respectively, for example, increases seat numbers from 218 in the standard tri-class configuration to 269.

Alterations and reconfigurations undertaken by operators include:

i) Regular refurbishment of interior furnishings, including: renewing seat covers; recoating the laminate on sidewall panels; replacing or refreshing carpets in areas where constant deterioration occurs; refurbishing galleys and toilets; and replacing other items such as curtains and flooring material.

Regular refurbishment may involve replacing only a few elements, for example, changing aisle carpets and seat covers. It may, however, involve changing a larger number of items to refresh the overall appearance of the cabin, without undergoing the major modification work of a larger cabin reconfiguration.

ii) Total cabin reconfiguration, where the aircraft LOPA is modified by adding or removing cabin classes or seats, and changing seats to host a new IFE system.

## The cabin

The interior of an aircraft can be broken down into various elements: seats (including covers and frames), carpets, galleys, IFE systems, ceiling and sidewall panels, passenger service units (PSUs), overhead bins, lavatories, closets (coat

cupboards), lighting, bulkheads, and flooring material. The installations to the cabin that offer storage usage (for example, the closets), toilets and galleys are all referred to as 'monuments'.

These monuments are designed to maximise the floor space utilised, so they often perform multiple functions, such as integrating a coat closet, and provide a trash bin. Galleys contain ovens and fridges, and provide storage for items like meals, meal trays, drinks and cups.

The style, functionality and number of monuments varies with each operator's LOPA and corporate branding.

Some of the furnishings are designated by the aircraft manufacturer and interior equipment supplier, and set as standard for the aircraft type and supporting furnishings. This is known as seller-furnished equipment (SFE).

The remaining items are known as buyer-furnished equipment (BFE), and are specified and developed by the operator.

SFE typically includes the overhead and sidewall panels, PSUs, overhead bins, lavatories, lighting, bulkheads and servicing areas. There are variances in PSUs and lighting, for example, and there are sometimes a few options for an aircraft type.

BFE includes the main 'cosmetic' elements, including seat covers, seat frames, carpets, galleys, the IFE equipment, closets, and monuments.

Some equipment and furnishings have a life limit and require certification. These are: fire retardant materials on seat covers, carpets and curtains; and oxygen masks, life jackets, and fire extinguishers.

Seatbelt and seat safety integrity has to be tested, so it is included in the operator's approved maintenance programme (AMP). The AMP must also include regular safety inspections on seat cushions and textile materials.

For example, the AMP will typically



require inspection of seat structure, seatbelt integrity and attachment of the seat to the floor rails every 36 months.

A revision of an aircraft's LOPA may be referred to as a 'Re-LOPA'. Both the processes of refurbishment and reconfiguration, and the motivations for performing them, are examined.

## Interior refurbishment

Regular cleaning, redecoration and refurbishment of the majority of interior furnishings is not mandatory. It is primarily performed at an operator's discretion, and is done to maintain an airline's corporate image.

The regular refurbishment of interior items is predominantly managed by the operator, and determined via its own interior programme. This is in addition to mandatory tasks in the maintenance planning document (MPD).

There are few mandatory tasks relating to the interior in the MPD to maintain the cabin in a particular condition, other than the safety inspections described. "The MPD contains only a few plain cabin-related tasks that are relevant to safety," says Nina Shulz, head of product sales and partnerships for overhaul services at Lufthansa Technik. "Operators add inspections for interior refurbishment and testing of IFE systems to their AMPs. Heavy airframe checks, therefore, include extensive cabin tasks. Some MPD inspections require deep access for structural checks, and these provide an opportunity to monitor cleanliness and corrosion underneath linings, major monuments, floor beams, and in the

aircraft structure."

Jose de Almeida, fleet engineering and fleet and projects manager at TAP Maintenance & Engineering, elaborates: "From a maintenance provider's perspective, the only driver that will lead an engineer to raise the need for a cabin retrofit activity is obsolescence of a furnishing item."

Each operator's AMP will vary for the same aircraft type. Each Air Operator Certificate (AOC) holder is responsible for adhering to its AMP. TAP Air Portugal has incorporated interior condition monitoring into its AMP, referred to as its Quality Programme. It contains procedures and recurring tasks.

## Corporate image

Regular wear and tear of furnishings requires rejuvenation. The items most frequently affected are seat covers, carpets, sidewall panels, PSUs, electrical or mechanical items and flooring material in lavatories and galleys. This deterioration will be brought to the attention of an airline's engineering department through entries made in the cabin tech log by flight attendants. Most airlines, therefore, monitor the cabin's appearance, which is helped by line mechanics, and perform a certain level of refurbishment on an 'as-is' or 'as-required' basis. This process ensures that interiors stay in an acceptable and safe condition between major airframe checks.

Besides marketing and corporate image considerations, there are other factors. "Other main drivers are product development, request for increased passenger capacity, new technologies like

*Reconfiguring and upgrading premium cabins is a prime factor driving the interior refurbishment of widebodies. This can involve the installation of new-generation, lie-flat seats and the latest generation IFE systems.*

IFE and connectivity, the introduction of new cabin classes, adaptation to existing fleets, and new aircraft being delivered to the operator," says Shulz.

"Refurbishment projects vary from 'cosmetic changes', such as changing carpet and seat cushions, to a new colour scheme, to a complete reconfiguration of seats and monuments," continues Shulz.

In 2012, TAP Portugal undertook an interior refurbishment of its four A340-300s. The new configuration has a dual-class layout, seating 36 in business class with 54-inch seat pitch, and 238 in economy with 34-inch pitch. Business class is in a 2-2-2 layout, whereas economy is in a standard 2-4-2 configuration. This type of cabin LOPA refurbishment and reconfiguration is often called a 'retrofit'.

A retrofit updates the cabin with new furnishings and equipment that may not have been available when an aircraft was first manufactured. A retrofit upgrades interior appearance, and can apply to IFE and connectivity systems, lavatories, lighting and galley equipment. Many part numbers (P/Ns) will be changed, and so require revisions to the operator's AMP.

TAP Portugal's A340-300 fleet has undergone two retrofits since entering service. At midlife, the original business-class seating supplied by Airbus was replaced with fully reclining, 'lie-flat'

## REGULAR INTERIOR REFURBISHMENT A330-200

Interior item	Timing	Equivalent Interval	Material cost-\$	MH used
Aisle carpet replacement	C check	5,500FH	1,600	32
Seat area carpet replacement	3rd/4th C check	17,000-22,000FH	6,400	128
Replacing seat covers	2 C checks	11,000FH	40,000-55,000	300
Replacing seat cushions	4th C check	22,000FH	110,000	500-800
Replace servicing area NTF	4th C check	22,000FH	30,000	300
Replace 3 sidewall panels	4th C check	22,000FH	20,000	100-150
Refurbishment of PSUs, panels, lavatories, galleys, closets, bulkheads & lighting.	D check	45,000FH	30,000	4,000-5,000

seats. TAP Portugal then became the second operator in the world to offer this type of seating at a 54-inch pitch in business class.

In 2012, TAP replaced its previous IFE with a new system, and also replaced the economy seating.

TAP's retrofit was a major modification, so it needed a supplemental type certificate (STC) to be provided by the European Aviation Safety Agency (EASA). STCs are submitted by aviation authorities, such as EASA and the US Federal Aviation Administration (FAA), to indicate that a modification has been approved for a particular aircraft type.

## Upgrading technologies

Two of the three most common upgrades include enabling wireless internet with internal WiFi connectivity, and upgrading satellite communication (satcom) external connectivity.

Satcom provides the external connectivity, which is an essential element of internet access in the cabin. Satcom systems can be upgraded to provide higher data transmission rates. These enable a wider range of cabin services, such as telephone calls, high-speed internet, and live TV.

Telephone calls and internet access on portable devices are only possible, however, when WiFi signals are also provided in the cabin. A server, therefore, is also required.

The third main upgrade is evolution of IFE systems that can make full use of external and internal connectivity. Many airlines have converted from a traditional fully embedded IFE system to a wireless system with portable devices. These are lighter, have a lower capital cost, and

offer an enhanced product in terms of available content.

New embedded systems can also take advantage of internal and external connectivity as well as internet access.

## Aligning fleet characteristics

When new aircraft are integrated into an existing fleet, refurbishment is often required to coordinate fleet appearance.

Iberia is in the process of refurbishing its fleet of 17 A340-600s. "We are installing our new long-haul cabins. As well as new seats in the business and the economy cabins, the aircraft now also have individual IFE systems in the economy class seats and an upgraded IFE system in the business cabin," says Fernando Jurdado, head of aircraft maintenance at Iberia Airport Services. "In addition to replacing the whole aircraft's wiring with optical fibre, we are installing a Satcom system for WiFi and GSM text message capability in the business and economy cabins.

"We have already retrofitted 12 aircraft and the other five will be ready by the end of 2015," continues Jurdado.

Iberia would typically look to perform major refurbishments in the first heavy check at a 10-year interval. The airline, however, has had to align the image of its long-haul fleet, and so has brought refurbishment of its A340-600s forward. "Our A340-600 fleet has an average age of 7.8 years. We are refurbishing it to offer the same cabin products as in our new A330-300 fleet. We are retrofitting our A340-600 aircraft at the same time as C and D checks," explains Jurdado. "It was a commercial decision to offer the same service on all Iberia long-haul flights."

## Combining checks

Many MPD heavy check tasks require interior items and furnishings to be removed for the necessary access to be gained. A long downtime and a large number of man-hours (MH) are also used in interior refurbishment to remove flooring, panels and monuments. Duplication of downtime and MH used can, therefore, be mitigated by combining interior refurbishment with a heavy check. Structural inspections occur every five or six years on the A330 and A340, and require the removal of seats and all other interior furnishings. The 767 has a heavy check interval of six years. This presents the opportunity for further seat frame checks, alongside the restoration of galleys and toilets.

Operators will also often schedule small cabin-related work in smaller airframe visits, such as a A or C checks.

Aisle carpets are replaced about every C check, while seat area carpets are generally replaced about once every four or five years.

Seat covers are vacuumed daily, and cloth covers are dry cleaned about once every C check. Cloth covers are usually replaced once every several C checks. Leather seat covers are easier to clean, and last longer than cloth covers.

The seat base, back and head cushions are life-limited by flame-retardant properties. They get replaced at every heavy check on the A330/A340, and so every 4-5 years.

Sidewall panels, overhead bins, PSUs and servicing areas are cleaned every C check, which has a 20-month interval. They undergo refurbishment during heavy airframe checks when they are likely to be removed from the aircraft.

Operators tend to start considering replacement of major interior items in the first 10-15 years of an aircraft's life. This will be combined with the first heavy check set by OEMs. This is at a five- or 10-year interval in the case of the A330 and A340, and during the C4/S4C, or D check for the 767-300ER.

Cabin refurbishment requires the disassembly of all monuments to inspect connection points, and removal of all seats for floor structure inspection. "This creates the opportunity to inspect any non-textile flooring," says Almeida.

There is difficulty in segregating and allocating costs, however, when MPD and interior refurbishment tasks are combined. "What cost is due to MPD findings and what is due to cosmetic changes becomes unclear," says de Almeida. "The time saved by combining access generates an overall saving of 10%, so there is a benefit to doing this."

KLM also includes interior refurbishment in heavy maintenance visits. It operates 12 A330-200s and five

A330-300s, among other widebodies. “In some cases, D checks are used to incorporate a cabin update. A separate modification line is still regularly planned for refurbishment programmes that are required prior to planned D checks,” says Jacco Hoekstra, project manager at KLM Engineering & Maintenance.

“We look to refurbish cabins about every 10 years,” continues Hoekstra. “We may replace business-class seats more frequently. The IFE systems also have to be replaced when seats are replaced or upgraded. In some cases, the aircraft are retired after 20 years, so no second refurbishment is required after a midlife update at 10 years,” says Hoekstra. “Each seat and its IFE system is checked every A, C and D check. At the homebase, the seats and IFE system are checked daily, and safety items and aesthetic failures are fixed immediately.”

Many airlines have a light refurbishment, including the refreshment of fabrics, seat cushions and electrical items, which takes place every four to five years. This is about halfway between heavy checks for some aircraft types.

## Cleaning

To prevent frequent heavy refurbishment events, deep cleaning is implemented into airframe checks to

minimise the need to replace furnishings. This provides a chance to inspect equipment for any anomalies that may have arisen through use. If an item requires replacing or repairing, the situation can be rectified while the aircraft is in the shop.

Regular cleaning will occur during line and light maintenance. “Cabin crews perform cosmetic inspections daily,” adds de Almeida. “In addition to pre-flight cleaning, a weekly deep clean will thoroughly inspect the various elements of the interior.”

At KLM, “visual items are inspected daily, except the sidewall panels and overhead bins,” says Hoekstra. “These are monitored on-condition, and cleaning is combined with the A check.”

With deep cleaning comes consideration of whether individual items have deteriorated or have exceeded their life limits. Fire-retardant materials, such as seat covers, can only be cleaned a fixed number of times before losing fire-retardant properties. That number of times is driven by OEM guidelines.

For KLM, the carpet is monitored on-condition. “Carpet is normally worn out over time by passenger and trolley movements. It is replaced in checks on an on-condition basis or during C checks. Seat covers are also replaced on-condition during small checks. Cloth seat covers

can be washed up to 10 times before fire-resistance is affected,” he adds.

While airlines ensure carpets are regularly vacuumed, scheduling a deep clean with hot water extraction helps restore carpets to peak condition during A checks.

## Regular refurbishment

There are certain items in the cabin section that are regularly replaced throughout an aircraft’s life. Others will be refurbished, but then may be replaced when a cabin reconfiguration occurs. Iberia will replace some BFE and SFE items on an on-condition basis. Major refurbishments can happen in the interim, however, to offset the replacement of some items.

The cost of replacing seat covers will vary, depending on whether it is business- or economy-class seating. The frequency of replacement depends on the use of cloth or leather seat covers.

The covers for each economy-class seat on an A330-200 can cost \$150-200, while it is more than \$300-500 for business class seats. Cloth covers are cheaper than leather. The total cost of covers will be in the region of \$40,000-55,000 for a full shipset (see table, page 46). The cost of cleaning seat covers is extra, but will be less for leather seats.

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Time spent to remove and replace all seat covers on the A330-200 is about 300MH (see table, page 46). Assuming an average labour rate of \$75, this would incur a labour cost of about \$22,500. Dividing the amount into a per-seat basis, assuming 260 seats on an A330-200, the cost per seat is close to \$90.

Replacement of seat cushions costs about \$150-200 per economy class seat, and \$550-600 for each business class seat. Replacement of a shipset costs about \$110,000 (see table, page 46).

Seat frames will hardly ever be altered in the case of regular refurbishment. This is due to the certification procedures behind approval for seat structures.

Carpets are also both replaced and refurbished, most frequently in the aisle. While a deep clean occurs during most A checks, a C check provides an opportunity to replace aisle carpets that are losing fire-retardant properties and have become worn. Seat area carpets are usually replaced once every three to four C checks (see table, page 46).

A shipset of carpet for an A330-200 costs about \$8,000 in materials, and takes 160 man-hours (MH) to install and cut to size (see table, page 46). The labour cost is, therefore, about \$12,000. The cost of labour for installation and materials would be about \$20,000.

Aisle carpets are about 20% of the total carpeted area, so the cost of removing and replacing aisle carpets every C check is about \$4,000. The remaining \$16,000 for seat area carpet replacement will be allocated once every three or four base checks.

The flooring material in servicing areas will often be replaced with material of the same P/N on heavy checks. The cost of this is \$30,000 for forward and

aft galley areas and door areas on an A330-200, and may use about 300MH (\$7,500) to remove and replace with new material (see table, page 46).

Obviously, if an IFE system is faulty, it will be replaced by an item with the same P/N. Replacement of an entire IFE system with a new P/N occurs less often, mainly during a cabin reconfiguration.

Overhead bins and sidewall panels rarely need replacing. They are usually relaminated or repainted during heavy checks to maintain appearance. A sidewall or ceiling panel is only usually replaced when it has been damaged. A sidewall panel can cost about \$6,500 to replace. As an example, three panels may be replaced during a major refurbishment that would incur a cost of about \$20,000 (see table, page 46).

Applying decorative foil to the sidewall panels can be complex, since they have contoured shapes in line with the passenger windows. This redecoration is performed in the refurbishment process during heavy checks.

Similarly, PSUs, sidewall and ceiling panels, lavatories, galleys, closets, cabin dividers, bulkheads and lighting are usually cleaned, refurbished and redecorated during heavy airframe checks. This takes place when they have been removed from the cabin. This process uses a large number of MH, including for removal and reinstallation, and materials and consumables. These costs are an element of the inputs for a heavy check. As a broad guide, labour can be in the region of 4,000-5,000MH, and materials and consumables about \$30,000 for an A330-200 or A330-300/A340-300 (see table, page 46).

The demand for LED lighting is increasing, however, so LED retrofits to

*Regular interior refurbishment will often be planned together with heavy airframe checks. This provides the opportunity to inspect and maintain seat frames, and refurbish major items such as toilets and galleys.*

replace traditional lighting may become more common. This would represent a one-off cost.

Bulkheads, for example class dividers, are often refurbished and redecorated during heavy checks. They are replaced during LOPA retrofits, such as changing cabin sizes.

## Cabin reconfiguration

A task larger than regular interior refurbishment is cabin reconfiguration. It involves altering or changing the LOPA, so it is defined as major modification work. This is more common with first- and business-class cabins than with economy cabins.

Priority is given to the reconfiguration of premium cabins. This may involve upgrading the IFE system, installing new seats or changing cabin sizes.

KLM broadened its range of seating configurations in economy class, and this required a cabin reconfiguration. "KLM operates two classes across its medium widebodies, and in economy one can opt for more pitch in a certain zone," explains Hoekstra. "The seats and IFE systems had to be replaced simultaneously to prevent double downtime, as well as a potential of installing new seats for a second time."

## Aircraft leasing

If an aircraft is acquired on operating lease, conditions will be set with respect to interior condition and configuration when the aircraft is returned to the lessor at the end of the lease. These are known as lease return conditions.

Lease return conditions prompt a review of an aircraft's interior layout and condition on return to a lessor, and may lead to another LOPA change being carried out as a requirement of the lessor or next lessee.

Major elements of return conditions will include the interior's status, and the certification of safety properties of materials used for the seats, carpets, curtains, floor mats, laminates and other materials installed for the previous operator. It will also consider the condition of the IFE. The standard of these may also prompt an interior review of an aircraft entering or exiting a lease.

More than 90% of the cost needed for a complete reconfiguration lies in

design, certification and materials.

The remainder is accounted for by the cost of MH used to remove old items and replace them with new equipment, and by the cost of engineering support.

In 2014, TAP Portugal phased in two used A330s from a lessor. Not only was it necessary to alter the cosmetic elements and 'rebrand' in accordance with its corporate branding scheme, but the aircraft's LOPA was completely changed from a tri- to a dual-class interior. The

IFE system was removed and replaced.

It is rare that such a project can be performed under one roof, and in this case design and certification requirements were subcontracted to a UK supplier. The IFE was referred to an IFE supplier.

## Costs

Material costs for reconfiguration can vary widely, depending on type and quality of materials used. The LOPA that

the cabin is being reconfigured to will also affect overall costings because the ratio between business and economy classes will vary among operators.

Costs below relate to material costs for an A330-200.

Seating comes in three parts: seat frames; base, seatback and head cushions; and fire-retardant seat covers. For a basic economy class seat with new electrical ports or IFE equipment installed, a new seatframe costs about \$1,600. These are usually produced in shipsets of two or four seats.

As previously related, a standard seat cover can cost about \$150-200 per seat, while cushions for the base, seatback and head can cost about the same. A standard economy class seat can cost \$1,900-2,000 in materials and parts. A shipset of about 210 economy seats will, therefore, cost about \$220,000 (see table, page 51).

A more sophisticated economy class seat with all IFE equipment and electrical ports can cost three to four times that for a basic specification.

Business class seats are more expensive, due to the higher quality materials and sophisticated design. The frame can cost up to \$70,000 for a lie-flat, hi-spec business class seat. A shipset of 24 could therefore cost up to about \$1.7 million (see table, page 51).

As described, a shipset of carpets can cost about \$8,000, and the A330-200 covers around 160 square metres of material (see table, page 51).

Reflooring the servicing areas typically requires a wipe-clean, fire-retardant and non-toxic material. This can cost about \$30,000 in the forward and aft galley floor areas (see table, page 51).

The basic PSU is about \$4,500 per pair of economy class seats, although the oxygen generator required is an added \$2,200 per PSU, leading to a total cost of \$6,700 per PSU set.

PSUs on an A330/340 come in shipsets of two. If required, the average cost to replace all economy class PSUs on an A330-200 will be about \$700,000 (see table, page 51).

Adding material costs to a typical A330-200 LOPA means that seats and related materials alone will cost in excess of \$2.6 million.

A single overhead bin set costs about \$6,500, whereas sidewall panels are typically kept and relaminated.

If bins need to be replaced, they come in a set that accommodates two seat rows, equal to four seats. Each bin costs \$6,500. An A330-200, with an economy class of 200-210 seats will incur a cost of about \$350,000 (see table, page 51).

Several other major items are also likely to be required. The A330-200 typically has six toilets. Each unit has a cost of about \$200,000, and so a new

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shipset would cost about \$1.2 million. A full complement of galleys would have a similar cost of about \$1.3 million (see table, this page).

Another major element would be the installation of a new IFE system. While the cost is difficult to separate from the seats, a new embedded system for an A330-200 can cost \$3.5-4.0 million. An attraction of a wireless IFE system is their light weight and low cost compared to an embedded system. A wireless IFE system costs \$350,000-400,000.

The cost of these additional major items is \$6.0-6.5 million when an embedded IFE system is included, and lower at about \$3.0 million when a wireless IFE system is used.

A complete reconfiguration of an aircraft's LOPA would also have to include new bulkheads and cabin dividers, curtains and lighting. Crew rest areas may also have to be installed.

## Planning

Planning the reconfiguration of a cabin requires three main considerations:

- i) Design of the cabin layout;
- ii) Certification of the revised LOPA and equipment used;
- iii) Equipment suppliers.

These three factors are the most time-consuming element of the reconfiguration process. Design and certification are often outsourced due to specific capabilities needed. In the case of TAP Portugal's A330-200s, an aggressive schedule of less than 10 months was planned.

Design and certification was provided by UK supplier Marshall of Cambridge. TAP Maintenance & Engineering's fleet management department co-ordinated and managed the entire process.

"TAP airline marketing defines the product, and network planning defines the timetable," begins de Almeida. "TAP Maintenance & Engineering then searches for solutions, equipment providers, proposes the phase-in budget and then plans the development phase."

## Design

Due to the complexity of acquiring certifications and design approvals, this element of cabin reconfiguration is often outsourced. Preparation time is lengthy and it will often take several months to complete the initial designs of each element. A lie-flat business class seat can often take a year to design to the point of sign-off by regulatory authorities.

Typical design processes commence with the 'preliminary design' review (PDR), in which initial, conceptual designs are drawn up to accommodate an operator's requirements. This can take place well in advance of an aircraft being purchased. Structural, mechanical and

## CABIN RECONFIGURATION MATERIAL COSTS A330-200

Interior item	Material cost-\$
<b>SFE:</b>	
Replacement of PSUs	700,000
Replacement of overheads bins	350,000
Replacement of 3 sidewall panels	20,000
New toilets - 6 seats @ \$220,000 ea	1,200,000
New servicing NTF	30,000
<b>BFE:</b>	
New carpet	8,000
Business class seats: 24 @ \$70,000	1,700,000
Economy class seats: 210 @ 2,000	220,000
New galleys - 6 @ \$220,000 ea	1,300,000
Complete embedded IFE system	\$3,500,000-4,000,000
Complete wireless IFE system	\$350,000-400,000

electrical engineers are involved throughout the process and liaise with the operator's own technical teams to ensure all requirements are covered. Certification requirements also have to be met, and the design will need to be approved by the operator's local aviation authority.

All BFE items will be specified by the operator. These specifications will be sent to the various equipment manufacturers. SFE items are outlined by the aircraft OEM, which will issue a service bulletin (SB). This needs to be acquired by the operator, and will include cost of materials alongside the design, allocation and installation of the equipment.

Once preliminary design of the BFE items has been approved, the critical design review (CDR) takes place prior to investment in materials. This review phase ensures that all revisions comply with authority and OEM standards. Once the CDR has been signed off, further design revisions are prohibited, the configuration is final, and supply chains providing the different materials are informed. Those involved in the materials supply chain are known as integrators. All materials will subsequently be provided by the integrator to an MRO provider to install on the aircraft.

## Integration

As stated, only once sufficient design data has been disclosed to the integrator, can development of the items commence.

It usually takes 18-24 months to get

from design to the stage where an operator's designated MRO facility is ready to install the kit, and then a further three weeks to install all equipment. Throughout the installation process, engineering deviations often arise that the designer and integrator have to address. To streamline these processes and maximise efficiency, MRO facilities will sometimes turn to acquisitions to keep all the services 'in-house'.

In 2014, Hong Kong Aircraft Engineering Company Limited (HAECO) acquired TIMCO Aviation Services Inc. TIMCO is a US company with interiors design, engineering certification and kit manufacturing capabilities to support the installation capabilities it already possessed as an MRO provider. It can now support the entire process within one corporation, thereby streamlining processes and minimising lead time.

Once an aircraft has been reconfigured, few of the original interior elements will remain. It is often just the seat tracks and the sidewall panels minus the laminate that are refurbished. Everything else, from lavatories to lighting to bulkheads, is usually replaced. Overhead bins are often removed, replaced with new, deeper bins for greater luggage volume. This is the extent of modification that takes place throughout a complete interior overhaul. [AC](#)

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