Aerospace Systems 2019 v1.1

IA3 high-level annotated sample response

June 2018

Project — folio (25%)

This sample has been compiled by the QCAA to assist and support teachers to match evidence in student responses to the characteristics described in the instrument-specific marking guide (ISMG).

Assessment objectives

This assessment instrument is used to determine student achievement in the following objectives:

1. recognise and describe the aircraft performance systems and/or human factors problem, aerospace technology knowledge, concepts and principles, and systems thinking habits and systems thinking strategies in relation to aircraft performance systems and/or human factors
2. symbolise and explain ideas, a solution and relationships in relation to aircraft performance systems and/or human factors
3. analyse the aircraft performance systems and/or human factors problem and information in relation to aircraft performance systems and/or human factors
4. determine solution success criteria for the aircraft performance systems and/or human factors problem
5. synthesise information and ideas to propose a possible aircraft performance systems and/or human factors solution
6. generate an aircraft performance systems and/or human factors solution to provide data to assess the feasibility of the proposal
7. evaluate and refine ideas and a solution to make justified recommendations
8. make decisions about and use mode-appropriate features, language and conventions to communicate development of the solution.

Instrument-specific marking guide (ISMG)

Criterion: Retrieving and comprehending

Assessment objectives

1. recognise and describe the aircraft performance systems and/or human factors problem, aerospace technology knowledge, concepts and principles, and systems thinking habits and systems thinking strategies in relation to aircraft performance systems and/or human factors
2. symbolise and explain ideas, a solution and relationships in relation to aircraft performance systems and/or human factors

The student work has the following characteristics:	Marks
• accurate and discriminating recognition and discerning description of the aircraft performance systems and/or human factors problem, aerospace technology knowledge, concepts and principles, and systems thinking habits and systems thinking strategies in relation to aircraft performance systems and/or human factors • adept symbolisation and discerning explanation of ideas, a solution and relationships in relation to aircraft performance systems and/or human factors with visual frameworks, causal and feedback loops, flow charts, diagrams, sketches and/or pictures.	4–5
• accurate recognition and appropriate description of the aircraft performance systems and/or human factors problem, aerospace technology knowledge, concepts and principles, and some systems thinking habits and systems thinking strategies in relation to aircraft performance systems and/or human factors • competent symbolisation and appropriate explanation of some ideas, a solution and relationships in relation to aircraft performance systems and/or human factors with visual frameworks, causal and feedback loops, flow charts, diagrams, sketches and/or pictures.	2–3
• variable recognition and superficial description of aspects of the aircraft performance systems and/or human factors problem, concepts or principles in relation to aircraft performance systems and/or human factors • variable symbolisation or superficial explanation of aspects of ideas, a solution or relationships in relation to aircraft performance systems and/or human factors.	1
• does not satisfy any of the descriptors above.	0

Criterion: Analysing

Assessment objectives

3. analyse the aircraft performance systems and/or human factors problem and information in relation to aircraft performance systems and/or human factors
4. determine solution success criteria for the aircraft performance systems and/or human factors problem

The student work has the following characteristics:	Marks
• insightful analysis of the aircraft performance systems and/or human factors problem and relevant aerospace systems, technology, and research information in relation to aircraft performance systems and/or human factors to identify the relevant elements, components and features, and their relationship to the structure of the problem • astute determination of essential solution success criteria for the aircraft performance systems and/or human factors problem.	6–7
• considered analysis of the aircraft performance systems and/or human factors problem and relevant aerospace systems, technology, and research information in relation to aircraft performance systems and/or human factors to identify the relevant elements, components and features, and their relationship to the structure of the problem • logical determination of effective solution success criteria for the aircraft performance systems and/or human factors problem.	4–5
• appropriate analysis of the aircraft performance systems and/or human factors problem and aerospace systems, technology, and research information in relation to aircraft performance systems and/or human factors to identify some of the elements, components and features of the problem • reasonable determination of some solution success criteria for the aircraft performance systems and/or human factors problem.	2–3
• statements about the aircraft performance systems and/or human factors problem, or information in relation to aircraft performance systems and/or human factors • vague determination of some solution success criteria for the aircraft performance systems and/or human factors problem.	1
• does not satisfy any of the descriptors above.	0

Criterion: Synthesising and evaluating

Assessment objectives

5. synthesise information and ideas to propose a possible aircraft performance systems and/or human factors solution
6. generate an aircraft performance systems and/or human factors solution to provide data to assess the feasibility of the proposal
7. evaluate and refine ideas and a solution to make justified recommendations

The student work has the following characteristics:	Marks
• coherent and logical synthesis of relevant aerospace systems, technology, and research information and ideas to propose a possible aircraft performance systems and/or human factors solution • purposeful generation of an aircraft performance systems and/or human factors solution to provide valid data to critically assess the feasibility of a proposal • critical evaluation and discerning refinement of ideas and a solution using success criteria to make astute recommendations justified by data and research evidence.	8–9
• logical synthesis of relevant aerospace systems, technology, and research information and ideas to propose a possible aircraft performance systems and/or human factors solution • effective generation of an aircraft performance systems and/or human factors solution to provide valid data to effectively assess the feasibility of a proposal • reasoned evaluation and effective refinement of ideas and a solution using success criteria to make considered recommendations justified by data and research evidence.	6–7
• simple synthesis of aerospace systems, technology, and research information and ideas to propose a possible aircraft performance systems and/or human factors solution • adequate generation of an aircraft performance systems and/or human factors solution to provide relevant data to assess the feasibility of a proposal • feasible evaluation and adequate refinement of ideas and a solution using some success criteria to make fundamental recommendations justified by data and research evidence.	4–5
• rudimentary synthesis of partial aerospace systems, technology, or research information and/or ideas to propose an aircraft performance systems and/or human factors solution • partial generation of an aircraft performance systems and/or human factors solution to provide elements of data to partially assess the feasibility of a proposal • superficial evaluation of ideas or a solution using some success criteria to make elementary recommendations.	2–3
• unclear combinations of information or ideas • generation of elements of an aircraft performance systems and/or human factors solution • identification of a change about an idea or the solution.	1
• does not satisfy any of the descriptors above.	0

Criterion: Communicating

Assessment objective

8. make decisions about and use mode-appropriate features, language and conventions to communicate development of the solution

The student work has the following characteristics:	Marks
• discerning decision-making about, and fluent use of, – written and visual features to communicate about a solution – language for a technical audience – grammatically accurate language structures – folio and referencing conventions.	3–4
• variable decision-making about, and inconsistent use of, – written and visual features – suitable language – grammar and language structures – folio or referencing conventions.	1–2
• does not satisfy any of the descriptors above.	0

Task

Context
An Australian media company has been commissioned to film a documentary on unique Australian landmarks for the Asian market. The documentary must include landmarks from Queensland (Great Barrier Reef), Northern Territory (Kakadu National Park) and Western Australia (Bungle Bungle Range). The media company has allocated two members of its media team to film the documentary, and they will use between 60 kg and 70 kg of various media equipment during filming, including lighting, cameras and sound equipment. The company has allocated ten days maximum to complete the operation and will require at least two days at each location. The company has requested that the operation be conducted as economically and efficiently as possible given their requirements. The operation is to originate and conclude at Brisbane's Archerfield Airport during the month of July.
Task
Your task is to use the problem-solving process in Aerospace Systems to: • develop a solution to the documentary operation problem that cost-effectively and safely transports the media team and their equipment to meet the media company's requirements • document the problem-solving process used to propose the solution in a folio • provide the media company with a summary report of the preferred documentary operation solution.

Sample response

Criterion	Marks allocated	Result
Retrieving and comprehending Assessment objectives 1, 2	5	5
Analysing Assessment objectives 3, 4	7	7
Synthesising and evaluating Assessment objectives 5, 6, 7	9	9
Communicating Assessment objective 8	4	4
Total	25	**25**

The annotations show the match to the instrument-specific marking guide (ISMG) performance-level descriptors.

Part A

Communicating [3–4]

discerning decision-making about, and fluent use of, folio and referencing conventions

The response includes the folio convention of a contents page (not included in the page count). Headings display thoughtful and astute choices used to organise and communicate the student's thinking during the problem-solving process in Aerospace Systems.

Table of Contents

1

Retrieving and comprehending [4–5]

accurate and discriminating recognition and discerning description of the aircraft performance systems and/or human factors problem, aerospace technology knowledge, concepts and principles, and systems thinking habits and systems thinking strategies in relation to aircraft performance systems and/or human factors

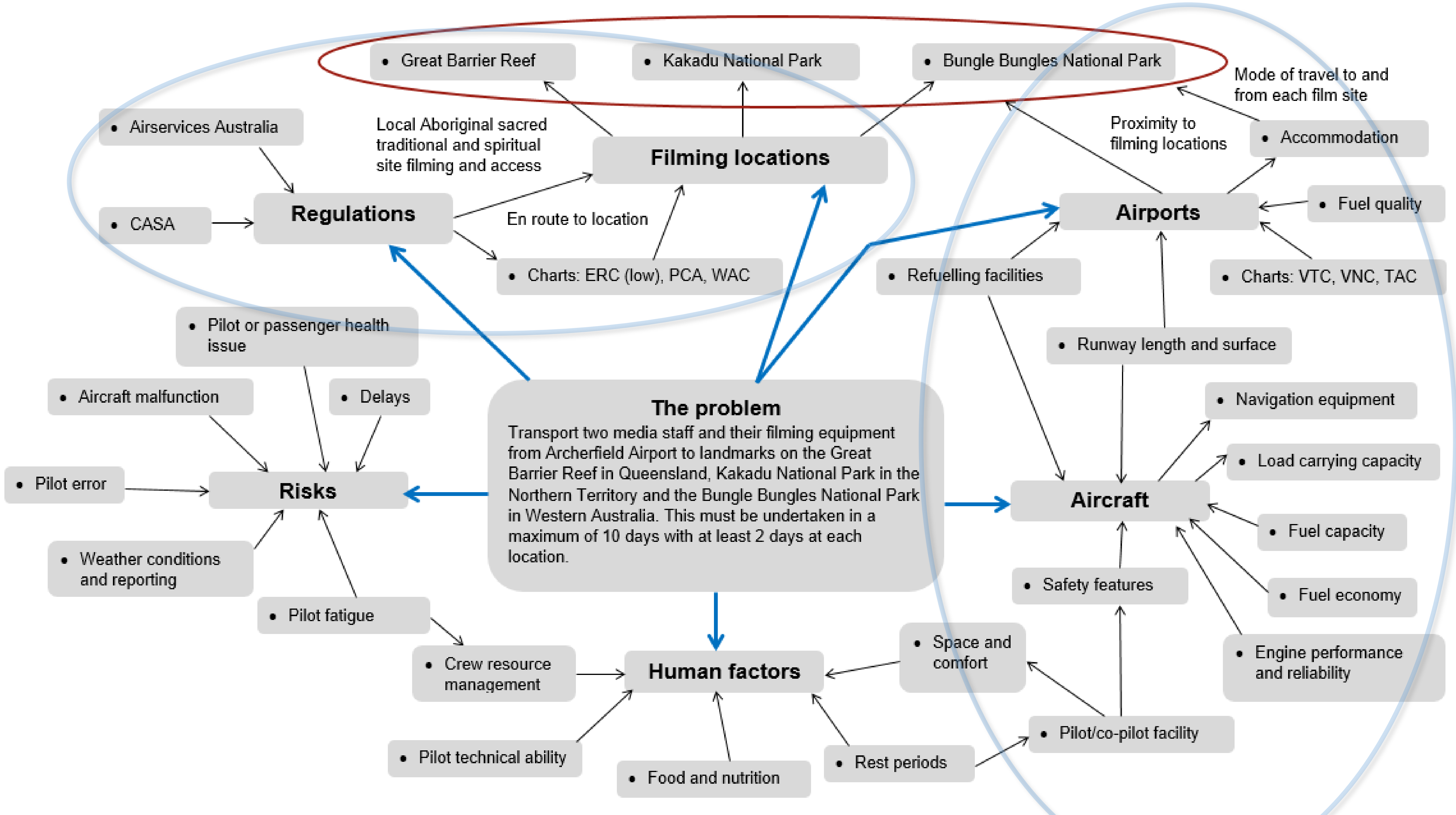
The response includes information accurately drawn from the context but not simply restated.

The response shows accurate and discriminating recognition and discerning description through use of what the student knows about the context of the problem and the incorporated and interrelated systems.

The mind map demonstrates intellectual perception in the thoughtful selection of the relevant systems and the interrelationships that exist in the context of the problem.

Problem exploration

What is known about the problem and the interrelated aerospace systems



2

Retrieving and comprehending [4–5]
adept symbolisation and discerning explanation of ideas, a solution and relationships in relation to aircraft performance systems and/or human factors with visual frameworks, causal and feedback loops, flow charts, diagrams, sketches and/or pictures

The response provides evidence of a very high level of skill and proficiency when sketching or drawing frameworks that display the relationships between the systems associated with the documentary problem.

Analysing [6–7]

insightful analysis of the aircraft performance systems and/or human factors problem and relevant aerospace systems, technology, and research information in relation to aircraft performance systems and/or human factors to identify the relevant elements, components and features, and their relationship to the structure of the problem

The response analyses research information that has a direct bearing on understanding the documentary problem.

The response identifies the relevant elements, components and features, and their relationship to the structure of the documentary problem.

Clarifying unknowns and system relationships

Landmarks

Map 1 (SEDAC Maps, 2011) displays the relationship between the landmarks that must be filmed during the ten-day documentary operation. The Great Barrier Reef is approximately 2300km long and extends from the northern tip of Queensland to just north of Bundaberg (Australian Government - The Great Barrier Reef Marine Park Authority, 2017). A decision will need to be made about where to fly to access the reef. Some possible choices are Mackay, Townsville and Cairns as these large coastal communities have good access to the reef, accommodation and airport facilities.

Table 1

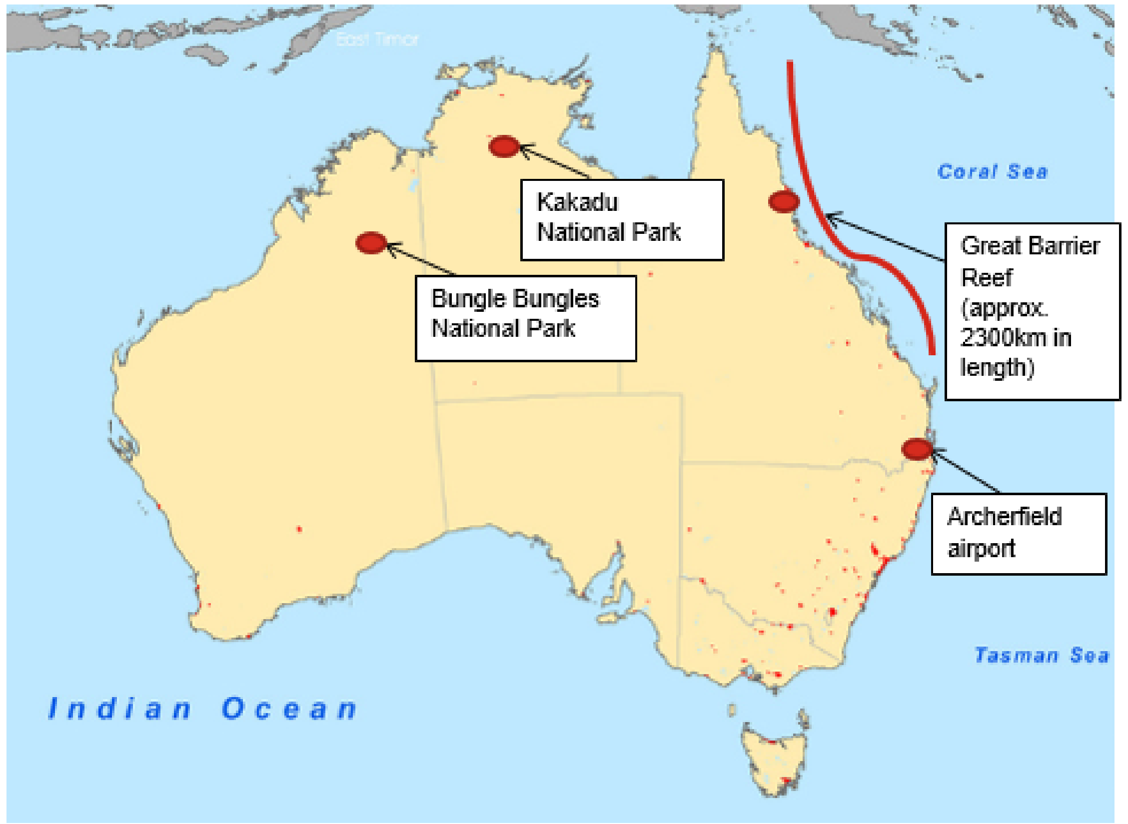
Swot analysis to identify the hypothetical strengths, weaknesses, opportunities and threats to the documentary operation transportation system with relevance to an air transportation company.

Within a transport company organisation	
Strengths	**Weaknesses**
• Excellent safety and efficiency reputation • Experienced pilots with IFR ratings • Knowledge of airports and remote environments • Conservative company operating procedures • Excellent safety record • Low cost base	• May need to hire a larger aircraft from another company • Maintenance staff only based in Archerfield and would need to travel for any mechanical break-down • Limited number of pilots available for existing contracts • Must rely on other organisations providing accommodation and refuelling facilities en route.
External to a transport company organisation	
Opportunities	**Threats**
• Time of year suits favourable winds and weather (i.e. July — dry season) • Success of this venture may lead to future transportation contracts • Opportunity to promote the business • Potential for business growth	• Competition for contracts requires that margins remain tight • Extreme weather in remote Australia • Mechanical issues • Negative human factors • Tight deadline imposed by client

Crew resource management (CRM) will be an important consideration of the documentary operation as the ten-day time-frame for the trip and the long distances that are required to be travelled will require careful management of the crew. The pilots must work well together, as a high level of cooperation will be required to reduce human error and minimise threats to safety. A dedicated crew will also assist the operation to run smoothly and improve the travel experience for the media staff.

3

Map 1



Human factors that may influence performance of the documentary operation transportation system

There are many human factors that require consideration in relation to the documentary operation. The Australian Government's Civil Aviation Safety Authority (2017c) states that, "Human factors are issues affecting how people do their jobs. They are the social and personal skills, such as communication and decision making which complement our technical skills. These are important for safe and efficient aviation. The study of human factors involves applying scientific knowledge about the human body and mind to help understand human capabilities and limitations. Human factors knowledge can be used to reduce the likelihood of errors and build more error tolerant and more resilient systems" (paragraph 1 and 2).

The human factors that impact on the efficient and safe performance of the documentary operation system are analysed in Table 2 using the ICAO SHELL Model (Skybrary, 2016) to determine success criteria for the human factors aspects of the operation.

Analysing [6–7]

insightful analysis of the aircraft performance systems and/or human factors problem and relevant aerospace systems, technology, and research information in relation to aircraft performance systems and/or human factors to identify the relevant elements, components and features, and their relationship to the structure of the problem

The response analyses research information that has a direct bearing on understanding the documentary problem.

The response provides evidence that shows an understanding of the complex relationship between the human factors associated with the documentary problem.

astute determination of essential solution success criteria for the aircraft performance systems and/or human factors problem.

The response displays evidence of an accurate assessment of the documentary problem to identify success criteria that are of critical importance.

Determining success criteria

Human factors analysis

Table 2

SHELL Model Component	Human Performance Factor	Mitigation strategies
Software	Planning and schedules	Thorough planning of the operation with cross-checking across individuals. The timeframe of 10 days needs to be carefully planned with alternatives pre-assessed and possible disruptions investigated prior to departure. Senior Operations Management on-call during the duration of the operation to assist with possible operation difficulties or issues.
Hardware	Aircraft and systems familiarity	Pilots trained in applicable aircraft systems and regularly checked on their emergency procedures. Minimum requirement of 150 hours on type.
Environment	Cockpit conditions	Ergonomic with comfortable seating for the long operation. Additional stowage for media equipment that does not impact on cockpit and passenger compartment conditions.
Live-ware (person)	Pilot Fatigue	Two pilots will be required on the trip to share the responsibility of flying and to reduce the risk of disruption if a pilot becomes ill during the trip. No drugs or alcohol policy. Plentiful water will be carried to keep both pilots and passengers hydrated. Comfortable accommodation will be required so that each pilot can have restful sleep each night.
	Safety and risk-taking attitude	Safety Management System that promotes a strong, positive culture of safety and safety reporting. Pilots should be experienced and conservative.
	Pilot Health	Pilots should be physically and medically fit. Healthy meals should be provided for the duration of the trip.
Live-ware (relationships)	Crew Resource Management (CRM)	Pilots should be trained in CRM. The pilot-in-command has leadership in the cockpit. Decision-making should be based on defining the problem, considering options, implementing the selected option and then reviewing the implementation. The pilots selected for the trip should have a proven ability to work collaboratively on long trips.

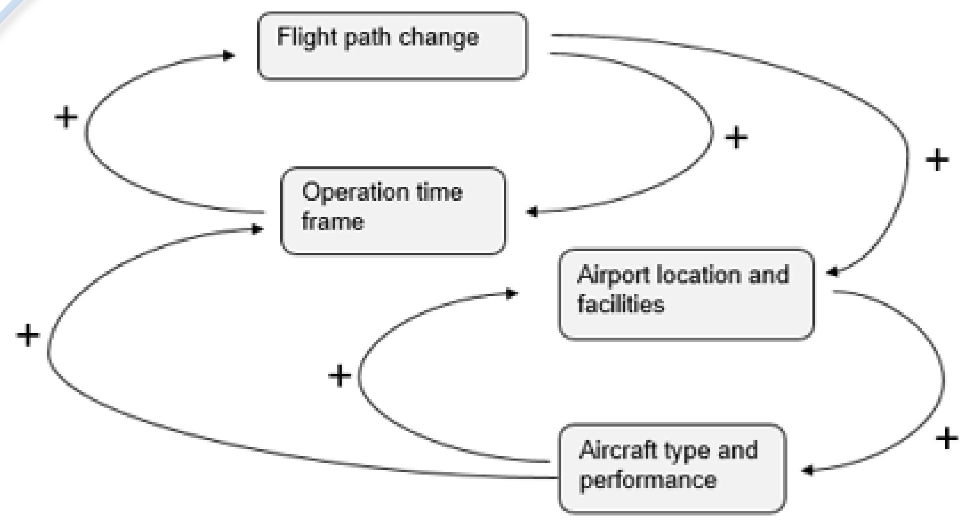
Success criteria

- the operation must be completed as cost effectively as possible in 10 days with 2 days allocated to each filming location during July
- crew and passengers must have their physical needs met in terms of food, water, sleep and rest
- aircraft choice must allow for the stowage of equipment, crew and passenger comfort, reliability and safety, navigation aids and performance
- airports chosen should be close to filming locations, have adequate facilities to support aircraft landing, maintenance and refuelling
- the chosen flight path should be selected to use the available time efficiently, reduce the fuel requirements for the operation and minimise potential safety risks due to poor weather, mechanical failure or pilot error.

Figure 1

Weather risks to profitability (associated costs)

Reinforcing feedback loops



The feedback loops represented in Figure 1 indicate that any flight path changes made due to poor weather conditions will result in additional costs and loss of time. Careful planning will provide the flight crew with flight path and landing options in the case of poor weather or mechanical failure. For example, a larger more powerful aircraft may be able to carry more equipment, food, water and fuel, which would allow the flight times to be extended and increase the number of airports available if a diversion is required. However, larger aircraft consume more fuel and may not be able to land at more remote locations. Many factors must be considered during the development of ideas for the documentary operation flight itinerary.

4

Retrieving and comprehending [4–5]

adept symbolisation and discerning explanation of ideas, a solution and relationships in relation to aircraft performance systems and/or human factors with visual frameworks, causal and feedback loops, flow charts, diagrams, sketches and/or pictures

The response provides evidence of a very high level of skill and proficiency when sketching or drawing feedback loops to display the causal relationships between the systems associated with the documentary problem.

Analysing [6–7]

insightful analysis of the aircraft performance systems and/or human factors problem and relevant aerospace systems, technology, and research information in relation to aircraft performance systems and/or human factors to identify the relevant elements, components and features, and their relationship to the structure of the problem

The response analyses research information that has a direct bearing on understanding the documentary problem.

Synthesising and evaluating [8–9]

critical evaluation and discerning refinement of ideas and a solution using success criteria to make astute recommendations justified by data and research evidence

The response provides critical evaluation of ideas using the success criteria. A range of recommendations are proposed (positives, negatives) that accurately assess the problem with reference to the success criteria.

Developing ideas

Aircraft selection

Aircraft choice must allow for the stowage of equipment, crew and passenger comfort, reliability and safety, navigation aids and performance. Therefore, an aircraft with a proven track record of safe performance and reliability will be selected for the operation.

Cessna 210 Centurion - touring utility aircraft

- a high-performance aircraft that has been continually upgraded during its production from 1957 to 1985. A pressurised cabin model was produced in 1978 (P210) that enabled the craft to fly at 17,350 ft. with a cabin pressure of 8000 ft. (Airliners, 2018a).

Table 4

Cessna 210 Centurion

Positives	Negatives
Well known aircraft, easy to fly, and readily available for hire	Small
Can carry 2 crew and 4 passengers with 110 kg of baggage	Age of aircraft
800nm (1970 km) range and uses AVGAS fuel capacity 450L (120g) (long range tanks) fuel consumption 60L/hr (16 g/hr)	Not as stable as a larger aircraft
Reasonable maximum cruise speed of 170 knots	Single GNS
Landing distance 400 m	
IFR and VFR and all weather capable.	

(AOPA, 2017; Disciples of flight, 2014)

Pilatus PC-12 - multi-purpose transport aircraft

- used by the Royal Flying Doctor service and has renowned reliability – "The willingness of Pilatus to look at the type of work and environment the RFDS operated in, assisted with the final choice of the PC12. It has a single turbine engine driving a variable pitch propeller, developing a great deal of power, enabling short take offs. It is pressurized and can fly in the stratosphere above the weather" (South Australia Medical Heritage Society Inc, 2017).

Table 3

Pilatus PC-12	Positives	Negatives
	Reliable Turbine Engine 1327 kW	Expensive to operate and hire
	Spacious and can carry 9 people.	Availability of aircraft to hire
	Long range capability of 1845nm (2704 km) Fuel	Availability of AVTUR in remote locations
	Is fast – max cruise speed 285 knots (528 km/h) (excluding pilot)	Complex aircraft with complex systems
(Don Ramey Logan, Pilatus PC-12 at Mariposa Yosemite Airport. Photo taken 7 March 2015)	maximum payload with full fuel of 458 kg (max fuel 1590 litres)	Fuel consumption 250 L/hr
	Auto pilot, all weather despatch capable, dual global navigation systems (GNS)	Take off distance 793 m Landing distance 661 m

(Fly Pilatus, 2018; Flugzeuginfo.net, 2017a; Jato Aviation, 2017)

Piper PA32 Cherokee 6 - trainer / touring aircraft

- a high-performance utility aircraft that has proved to be a reliable and popular model that continues to maintain its value in the used aircraft market (McNeilly, 2010).

Table 5

Piper PA32 Cherokee 6	Positives	Negatives
	Well known aircraft, easy to fly, and readily available for hire	Small
	Can carry 2 crew and 4 passengers with 90 kg of baggage	Age of aircraft
	700nm range and uses AVGAS fuel consumption of 57 L/hr – capacity 318 litres	Not as stable as a larger aircraft
(Alan Wilson, Piper PA-32-260 Cherokee six taxiing at Fowlmere. Photo taken on 29 June 2012)	Reasonable speed of 165 knots cruise	Multiple fuel tank system requires manual changeover

(Airliners, 2018b; Flugzeuginfo.net, 2017b)

5

Retrieving and comprehending [4–5]

adept symbolisation and discerning explanation of ideas, a solution and relationships in relation to aircraft performance systems and/or human factors with, diagrams, sketches and/or pictures

Pictures and annotations (text) provide discerning explanations that clarify the decision-making about ideas and possible solutions.

Analysing [6–7]

insightful analysis of the aircraft performance systems and/or human factors problem and relevant aerospace systems, technology, and research information in relation to aircraft performance systems and/or human factors to identify the relevant elements, components and features, and their relationship to the structure of the problem

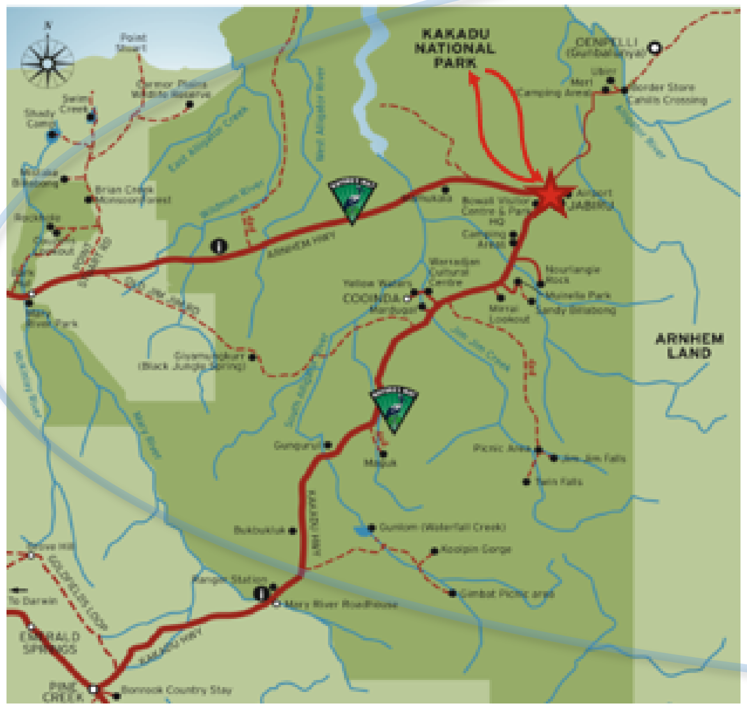
The response analyses research information that has a direct bearing on understanding the documentary problem.

Aircraft technologies for consideration

There is a risk of reduced navigational safety, in the remote parts of Australia where the selected aircraft will operate. Therefore, selecting an aircraft with the latest navigation technology will reduce this risk. Technologies that will need to be considered include an approved GNS and backup, Mode S transponder and an approved autopilot system, linked to the GNS. The Mode S transponder will allow for "increased safety as air traffic control surveillance will be available over the whole of Australia at higher levels, and with substantial coverage at lower levels" (Australian Government – Civil Aviation Australia, 2017d). The autopilot helps reduce pilot fatigue, especially in poor weather conditions. "Manual flying, especially on long cruise legs, is a very fatiguing task, autopilots make it much easier to fly smoothly en route with precision, and they are certified for use in all phases of flight except take-off" (Aviation Knowledge, 2017, paragraph 1).

Route options

Map 2



The operation requires the use of the correct charts. These charts will be chosen based on the range of possible routes and associated airports that may be selected with reference to the success criteria. Archerfield aerodrome is the origin and final destination for the operation. There are various airports that would satisfy the requirement for the media crew to film the Great Barrier Reef. Airports to consider would be Mackay, Townsville and Cairns. Each airport has the required fuel and adequate accommodation available. The closest airport to Kakadu National Park is Jabiru Airport (refer to Map 2). Kununurra is the closest practical airport to The Bungle Bungles (refer to Map 3).

Much of the proposed trip will take place over remote areas which requires the aircraft to carry appropriate survival equipment (Australian Government – Civil Aviation Australia, 2017a). July is the middle of northern Australia's dry season and conditions should be favourable for air travel during the operation (Australian Government – Bureau of Meteorology, 2016).

Map 3

Airports that are to be considered are Archerfield, Mackay, Townsville, Cairns, Normanton, Jabiru, Kununurra, Mount Isa, Alice Springs, Charleville. These airports are suitable in terms of runway surface (bitumen, all-weather), runway lengths, fuel availability, lighting (if required) and are close to suitable accommodation options. Airports will be evaluated in more detail when a decision is made regarding the preferred route. Given the information above, it is possible to formulate possible routes that can be evaluated against the solution success criteria.

The selected aircraft will determine the distance between airports/fuel stops and indicate possible routes. Therefore, aircraft choice will be made considering the major costs associated with running each aircraft; hire rate, fuel burn and speed (refer to Table 6).

Table 6

	Pilatus PC-12	Cessna 210 Centurion	Piper PA32 Cherokee 6
Hire Rate	$1200/hr dry	$209/hr dry	$253/hr dry
Fuel Burn	66 g/hr=250L/hr	16 g/hr=60L/hr	16 g/hr=60L/hr
Fuel cost/hr (Est)	Avtur $1.50 x 250 = $375	Avgas $2.00 x 60 = $120	Avgas $2.00 x 60 = $120
Speed	240 knots	170 knots	165 knots
Example cost for 10 hrs, distance travelled, cost/nm	($1200+$375) x 10=$15750 Distance 2400nm $6.56/nm	($209+$120) x 10=$3290 Distance 1700nm $1.94/nm	($253+$120) x 10=$3730 Distance 1650nm $2.26/nm

(Fly Hire, 2017)

Three possible route options are considered with reference to the data provided in Table 6. These are outlined in Tables 7, 8 and 9 and evaluated in table 10. The difficulty with planning an operation of this type is that there are always compromises that need to be made between cost and efficiency as outlined in the reinforcing feedback loop diagram in Figure 1. The decisions made regarding the most favoured solution to the documentary operation must take into consideration the filming locations, airports, regulations, risks, human factors and the appropriate aircraft as these systems are interrelated. For example, the Pilatus PC-12 can travel much further in 10 hours than the Cessna 210 Centurion. However, this benefit comes at an additional cost to the operation and may not provide substantial benefits given the many variables that need to be considered during the selection of a proposed solution.

6

Synthesising and evaluating [8–9]

coherent and logical synthesis of relevant aerospace systems, technology, and research information and ideas to propose a possible aircraft performance systems and/or human factors solution

The response provides evidence of sound reasoning and an ordered, well-structured synthesis of aerospace and technology information to propose a documentary operation solution.

critical evaluation and discerning refinement of ideas and a solution using success criteria to make astute recommendations justified by data and research evidence

A range of justifications are made that accurately evaluate the proposed solution with reference to the success criteria.

Table 7

Route 1 – Archerfield – Townsville – Jabiru – Kununurra – (Mount Isa fuel) – Archerfield				
Departure Airport	**Arrival Airport**	**Distance (nautical miles)**	**Time (hours) (@170 knots)**	**Note**
Archerfield	Townsville	610	3.6	
Townsville	Jabiru	900	5.3	
Jabiru	Kununurra	300	1.8	
Kununurra	Mount Isa	690	4.1	Fuel Stop
Mount Isa	Archerfield	860	5.1	
Total	5	3360	~ 20	1

Table 8

Route 2 – Archerfield – Mackay – (Normanton fuel) – Jabiru – Kununurra – (Alice Springs fuel) – (Charleville fuel) – Archerfield				
Departure Airport	**Arrival Airport**	**Distance (nautical miles)**	**Time (hours) (@170 knots)**	**Note**
Archerfield	Mackay	440	2.6	
Mackay	Normanton	510	3.0	Fuel Stop
Normanton	Jabiru	560	3.3	
Jabiru	Kununurra	300	1.8	
Kununurra	Alice Springs	560	3.3	Fuel Stop
Alice Springs	Charleville	690	4.1	Fuel Stop
Charleville	Archerfield	380	2.3	
Total	7	3440	~ 20.5	3

Table 9

Route 3 – Archerfield – Cairns – Jabiru – Kununurra – (Mount Isa fuel) – Archerfield.				
Departure Airport	**Arrival Airport**	**Distance (nautical miles)**	**Time (hours) (@170 knots)**	**Note**
Archerfield	Cairns	760	4.5	
Cairns	Jabiru	790	4.7	
Jabiru	Kununurra	300	1.8	
Kununurra	Mount Isa	690	4.1	Fuel stop
Mount Isa	Archerfield	860	5.1	
Total	5	3400	~ 20.2	1

Accommodation options

The operation will require 9 nights away. An important success criteria for the operation is to minimise costs. Therefore, the two media company staff and two crew (pilots) will each share a twin room. Camping was considered and disregarded, because of the additional weight of camping gear the maximum take-off weight (MTOW) of the aircraft may be exceeded. To reduce pilot fatigue modest but comfortable accommodation has been investigated in the 3/4-star standard range, providing a comfortable bed in preferred and quiet locations (See Table 11).

Table 10

PMI Chart to evaluate route options			
Route Option	**PLUS**	**MINUS**	**INTERESTING**
Route 1 Archerfield – Townsville – Jabiru – Kununurra – (Mount Isa fuel) – Archerfield	Townsville has ample accommodation. Access to the reef is good. Reasonable short number of legs (5). Less time over the Designated Remote Areas Fuel available.	Flight over lots of desert and rugged terrain. Some legs of the journey are reasonably long and may impact on the comfort of the passengers. The crew will be expected to manage fatigue while flying over remote areas where little ground support is available in situations of high risk e.g. poor weather or mechanical failure.	Restricted airspace around Townsville may pose a problem and impact on flight times.
Route 2 Archerfield – Mackay – (Normanton fuel) – Jabiru – Kununurra – (Alice Springs fuel) – (Charleville fuel) – Archerfield	Mackay has ample accommodation. Access to reef is reasonable. Fuel available.	Access to reef may not be as good as Townsville or Cairns The longest of all routes which presents more issues in relation to passenger comfort and crew fatigue. Aircraft choice will need to take this into consideration. More time over the Designated Remote Areas. Requires more charts than the other routes 7 legs with more fuel stops	Chance to visit Alice Springs (might be of interest to the media company as there are filming opportunities available in this region e.g. Uluru)
Route 3 Archerfield – Cairns – Jabiru – Kununurra – (Mount Isa fuel) – Archerfield.	Cairns has ample accommodation. Access to the reef is the best of all routes. More likely to be the shortest route. 5 legs Fuel available.	Some very long legs. May require additional stops if winds are not favourable. Flight time over a large stretch of the Gulf of Carpentaria is required and will need additional safety equipment for this leg.	Probably the most scenic of the route options

Table 11

Location	**Accommodation type and cost**
Townsville	Beach House Motel, 3 ½-star, $140 twin share per night
	Quest Townsville, 4-star, $205 twin share per night
Cairns	Double-Tree by Hilton Cairns, 4 ½-star, $169 twin share per night
	Rydges Plaza, 4-star, $158 twin share per night
Mackay	Oaks Carlyle, 4-star, $159 twin share per night
	Riviera Mackay, 4-star, $170 twin share per night
Jabiru	Kakadu Lodge, 3 ½-star, $160 twin share per night
	Mercure Kakadu, 3 ½-star, $239 twin share per night
Kununurra	Discovery Parks, 4-star, $221 twin share per night
	East Kimberley Apartments, 4 ½-star, $224 twin share per night

(Wotif, 2017)

7

Synthesising and evaluating [8–9]

critical evaluation and discerning refinement of ideas and a solution using success criteria to make astute recommendations justified by data and research evidence

A range of justifications are made that accurately evaluate the predicted solution with reference to the success criteria.

purposeful generation of an aircraft performance systems and/or human factors solution to provide valid data to critically assess the feasibility of a proposal

The response provides evidence of the generation of a solution that has the intended and desired result.

The proposed solution provides legitimate and defensible virtual performance data to objectively analyse the solution's merits and faults to assess the accuracy of the predictions made.

Proposing a solution for generation

Aircraft

From the aircraft selection information provided in Tables 3, 4 and 5, the Cessna 210 Centurion best meets the 'cost effective' success criteria. It is also considered a comfortable and relatively easy aircraft to fly. The aircraft is IFR, VFR and all weather capable. As the aircraft has a single GNS a backup handheld GPS device will be included in the safety equipment for the flight. Some crew and passenger comfort will be sacrificed as the aircraft is slightly smaller than the Pilatus PC-12 or Piper PA32 Cherokee 6. However, the Cessna has ample space for the crew, passengers, and media and safety equipment. Therefore, regardless of the concessions that will need to be made, the Cessna 210 Centurion will be the aircraft used for the documentary operation, because it provides best value for cost, safety, reliability and usability.

Route

Route options will be based on the Cessna 210's performance data. Table 4 indicates that the Cessna 210 has a fuel burn of 16 g/hr and 120 gallons of fuel (with long range tanks). Allowing for 60 minutes reserve fuel, the approximate endurance of the aircraft is 6.5 hours. The estimated range (in nil wind) is therefore approximately 1275 nm. With a 30-knot headwind, range would be approximately 900 nm. Therefore, selection of an appropriate route will be based on a 900 nm range, available fuel (AVGAS) and suitable airports.

The selected route (see Map 4) optimises operation safety, timeframe, costs, and crew and passenger comfort. A small amount of time is taken to fly over gulf waters, however this is near the Australian mainland and various coastal islands and the risks have been considered and mitigation strategies identified.

The route selected allows for a successful documentary operation over 10 days with 2 days available in each filming location. Further efficiencies could be found if filming time could be reduced to one or one and a half days. However, the reduction in costs would be minimal as the major costs associated with the operation are aircraft and aircrew hire, and fuel. Flying at night has not been considered as an option due to the additional associated risks to the safe and successful completion of the operation.

Map 4

Proposed itinerary

Day 1 - Depart Archerfield, Arrive Townsville (Flying time of 3.6 hours)
Day 2 - Great Barrier Reef media shoot
Day 3 - Great Barrier Reef media shoot
Day 4 - Depart Townsville, Arrive at Jabiru (Flying time of 5.3 hours)
Day 5 - Kakadu National Park media shoot
Day 6 - Kakadu National Park media shoot
Day 7 - Depart Jabiru, arrive at Kununurra (The Bungle Bungles) (Flying time of 1.8 hours) **(Note: a day could be saved here by travelling early day 7 and filming the Bungle Bungles later day 7 and on day 8)**
Day 8 - The Bungle Bungles media shoot
Day 9 - The Bungle Bungles media shoot
Day 10 - Depart Kununurra, refuel at Mount Isa, Arrive Archerfield (Flying time of 9.2 hours with one rest and fuel stop)

8

Synthesising and evaluating [8–9]

purposeful generation of an aircraft performance systems and/or human factors solution to provide valid data to critically assess the feasibility of a proposal

The response provides evidence of the generation of a solution that has the intended and desired result.

The proposed solution provides legitimate and defensible virtual performance data to objectively analyse the solution's merits and faults to assess the accuracy of the predictions made.

critical evaluation and discerning refinement of ideas and a solution using success criteria to make astute recommendations justified by data and research evidence

The proposed solution is refined to provide an alternative proposal that includes savings to the costing by reducing the number of days allocated to the documentary operation.

Charts and documentation required for the operation

Table 12

Chart Type	Charts required
World Aeronautical Chart (WAC) 1:1 000 000	Brisbane, Rockhampton, Townsville, Normanton, Groote Eylandt, Darwin, Halls Creek, Newcastle Waters, Alice Springs, Cloncurry, Clermont, Cooper Creek and Charleville
Visual Navigation Chart (VNC) 1:500 000	Brisbane, Rockhampton, Townsville, Darwin and Tindal
Visual Terminal Chart (VTC) 1:250 000	Brisbane, Maroochydore, Rockhampton, Whitsundays, Mackay, Townsville
Terminal Area Chart (TAC)	Brisbane, Rockhampton, Mackay, Townsville, Darwin, Mount Isa
En route Chart (Low) (ERC-L)	Queensland (4) and Northern Australia (6)
Planning Chart Australia (PCA)	All Australia chart
Australia (ERSA), Flight Manual, Maintenance Release, Aircrew licences and Aircrew medicals Note: charts and ERSA are available through an Electronic Flight Bag (EFB) (Australian Government – Civil Aviation Australia, 2017b)	

Table 13

Item	Details	Calculation	Cost
Aircraft hire	Cessna 210 Centurion @ $209/hr	$209 x 25 hrs	$5225
Fuel	Burn rate of 60L/hr and average fuel cost of $2.25/L	(60L/hr x 25hrs) x $2.25/L	$3375
Landing fees	Townsville $15 Jabiru $85 Kununurra $23 Mount Isa $18 Archerfield $20	$15 + $85 + $23 + $18 + $20	$161
Aircrew hire	$65 per flying hour plus $385 per day per pilot	2 x ($65 x 25hrs + 10 days x $385/day)	$10950
Accommodation	Average cost per room per night is $170	2 rooms x 9 nights x $170	$3060
Ground and sea transport hire	2-wheel drive $100/day	3 days at Townsville	$300
	4-wheel drive $200/day	3 days at Jabiru 3 days at Kununurra	$1200
	Boat charter $550/day	2 days Townsville reef charter	$1100
Total Costs (excl GST)			**$25371**

9

Operation costing

Table 13 provides a detailed costing for the operation. The costings are based on the hire of the Cessna 210 Centurion, two aircrew, twenty hours of flight time plus a five-hour safety margin allowance for delays due to adverse weather conditions. Meals and personal costs are not included in the costing. However, adequate meals and plentiful beverages will be provided to maintain crew and media staff health and wellbeing at cost.

It is possible to reduce the length of the operation by one day. This is achieved by flying from Jabiru to Kununurra early in the morning on Day 7. The operation would then proceed as per the itinerary with filming to take place at the Bungle Bungles later that morning. The revised costing is provided in Table 14 with a reduction of $1310 (~5%).

Airport landing fees references

Townsville airport: www.townsvilleairport.com.au/regulatory/airport-charges/

Jabiru airport: estimate only

Kununurra airport: www.thewest.com.au/news/kimberley/airport-landing-cost-reduced-ng-ya-102773

Mount Isa: www.mountisaairport.com.au/regulatory/charges/

Archerfield airport: www.archerfieldairport.com.au/Downloads/ScheduleOfCharges August2017.pdf

Note: aircraft and aircrew hire, vehicle hire, boat charter and fuel costs are accurate up to and including 15/08/18 only and are subject to change without notice after that date.

Table 14

Item	Details	Calculation	Cost
Aircraft hire	Cessna 210 Centurion @ $209/hr	$209 x 25 hrs	$5225
Fuel	Burn rate of 60L/hr and average fuel cost of $2.25/L	(60L/hr x 25hrs) x $2.25/L	$3375
Landing fees	Townsville $15 Jabiru $85 Kununurra $23 Mount Isa $18 Archerfield $20	$15 + $85 + $23 + $18 + $20	$161
Aircrew hire	$65 per flying hour plus $385 per day per pilot	2 x ($65 x 25hrs + 9 days x $385/day)	$10180
Accommodation	Average cost per room per night is $170	2 rooms x 8 nights x $170	$2720
Ground and sea transport hire	2-wheel drive $100/day	3 days at Townsville	$300
	4-wheel drive $200/day	3 days at Jabiru 2 days at Kununurra	$1000
	Boat charter $550/day	2 days Townsville reef charter	$1100
Total Costs (excl GST)			**$24061**

Synthesising and evaluating [8–9]

critical evaluation and discerning refinement of ideas and a solution using success criteria to make astute recommendations justified by data and research evidence

The response provides a detailed evaluation of the predicted solution using the success criteria. A range of recommendations are made that accurately assess the problem situation with reference to the success criteria.

The response provides evidence of intellectual perception in the refinement of the predicted solution to recommend future developments or considerations.

Recommendations

It is recommended that the documentary operation route and itinerary be adopted as proposed (Table 13). This will allow the operation to be completed in the ten days as required. The weather during July should be favourable across all filming locations and en route. A five-hour allowance has been made in case head winds cause flight delays during the operation. The proposed solution provides both the crew and passengers (media staff) with adequate rest time during the intensive trip. The use of two pilots allows for load sharing and limits the possibility that human factors will negatively impact on the safe and successful completion of the documentary operation.

The Cessna 210 Centurion is a safe, reliable and comfortable aircraft. It is adequate for the operation and will carry the required payload economically. The aircraft includes the necessary navigation aids in cases where weather deteriorates and VFR is not possible. The aircraft also has a short take-off and landing distance of 400 m which makes it a good option if an alternate landing location is required. The chosen airports are close to each filming location, have the required fuel and maintenance facilities and have sealed runways. The landing fees are also very reasonably priced.

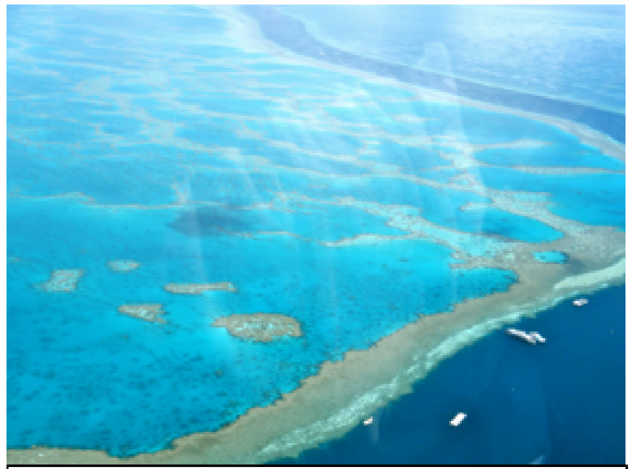
Future considerations

The media company may benefit from amending the itinerary to reduce costs. A reduction of one day produces a saving of $1310 for the media company (Table 14). This saving is provided with only a minimal loss of filming time on the morning of day 7 of the operation.
Time savings may be available if the media company is willing to hire a rotary wing aircraft to travel from local airports to each filming location. The time savings may allow the operation to be reduced to 8 days. The helicopter hire rate is estimated to be $1650 for the transportation of the media team and equipment to each location and return for the periods required (Bungle Bungle Expeditions, 2017; Coolibah Air Scenic Adventures, 2017; Reef Free Tours, 2018). The additional benefits of this proposal are that air and ground filming can be organised in advance at various locations for each of the three sites. While it is likely that there will be no cost saving to the media company, the quality of the final documentary product would be enhanced by the ability of the helicopter to access a range of more remote filming locations. Approvals may be required to access and film places and spaces that have sacred traditional and spiritual importance to the local Aboriginal peoples.

Helicopter charter Great Barrier Reef

Alternate itinerary
Day 1 - AM: Depart Archerfield, Arrive Townsville (Flying time of 3.6 hours)
PM: Great Barrier Reef media shoot
Day 2 - Great Barrier Reef media shoot
Day 3 – AM: Great Barrier Reef media shoot
PM: Depart Townsville, Arrive at Jabiru (Flying time of 5.3 hours)
Day 4 - Kakadu National Park media shoot
Day 5 – AM: Kakadu National Park media shoot
PM: Depart Jabiru, arrive at Kununurra (The Bungle Bungles) (Flying time of 1.8 hours)
Day 6 - The Bungle Bungles media shoot
Day 7 - The Bungle Bungles media shoot
Day 8 - Depart Kununurra, refuel at Mount Isa, Arrive Archerfield (Flying time of 9.2 hours with one rest and fuel stop)

Helicopter view of the Great Barrier Reef



Sarah Ackerman, 2009. Helicopter ride over the Great Barrier Reef at the Whitsunday Islands, Australia. Photo taken 27 December. CC Attribution 2.0 Generic

Helicopter view of Jim Jim Falls Kakadu NP.

Nigel Malone, 2006. Jim Jim Falls Kakadu National Park. Photo taken July. CC Attribution-share alike1.0 Generic

10

Part B

Communicating [3–4]

discerning decision-making about, and fluent use of,

- written and visual features to communicate about a solution
- language for a technical audience
- grammatically accurate language structures

The response includes written and visual features selected for value and relevance to communicate about a solution.

The response includes good judgment concerning the use of grammatically accurate language structures.

Summary report

Documentary Operation

Introduction

This document summarises the findings and outcomes of the documentary operation developed and virtually tested between February and March 2018.

Background

The project team was commissioned by an Australian media company to develop a solution to a documentary operation problem. The solution required the cost effective, efficient and safe transport of two media staff members and their 60kg - 70kg of media equipment from Brisbane's Archerfield Airport to filming locations and return to Archerfield Airport in July 2018. Landmarks from Queensland (The Great Barrier Reef), Northern Territory (Kakadu National Park) and Western Australia (Bungle Bungles National Park) were selected by the media company for the operation. The media company has allocated ten days maximum to complete the operation and will require at least two days at each filming location.

Project objectives

The project objectives were to document the development and generation of a folio that includes a detailed costing and itinerary for the documentary operation that meets the requirements of the media company's specifications. The success criteria for the project were determined to be that the documentary operation must:

- be completed as cost effectively as possible in 10 days with 2 days allocated to each filming location during July
- allow the crew and passengers to have their physical needs met in terms of food, water, sleep and rest
- select an aircraft that provides for the stowage of equipment, crew and passenger comfort, reliability and safety, navigation aids and performance
- select airports that are close to filming locations, have adequate facilities to support aircraft landing, maintenance and refuelling
- select a flight path that uses the available time efficiently, reduces the fuel requirements for the operation and minimises potential safety risks associated with poor weather, mechanical failure or pilot error.

Options considered

The project team conducted research to understand the nature of the problem and the relationships between the various systems incorporated in the documentary operation.

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Aircraft

The Pilatus PC-12, Piper PA32 Cherokee 6 and Cessna 210 Centurion were investigated to evaluate each aircraft's appropriateness in relation to the operation's success criteria. The decision was made to select the Cessna 210 Centurion (Figure 1), because it meets the 'cost effective' success criteria best. It is also considered a comfortable and relatively easy aircraft to fly, which reduces the likelihood of fatigue being a factor during the operation. The aircraft is IFR, VFR and all weather capable. As the aircraft instrumentation provides only a single GNS, a backup handheld GPS device will be included in the safety equipment for the flight. The Cessna is large enough for the crew, passengers, and media and safety equipment. As the aircraft is slightly smaller than the Pilatus PC-12 or Piper PA32 Cherokee 6, some crew and passenger comfort will be sacrificed. However, regardless of the concessions that need to be made, the Cessna 210 Centurion is the aircraft type proposed for the documentary operation, because it provides best value for cost, safety, reliability and usability.

Figure 1

Route

Route options were considered based on the Cessna 210's performance data. The selected route optimises operation safety, timeframe, costs, and crew and passenger comfort. The flight path includes a short flight over Gulf of Carpentaria waters. However, the path takes the aircraft near to the Australian mainland and various coastal islands and so any associated risks have been considered and mitigated. The route selected allows for a successful documentary operation over 10 days with 2 days available in each filming location. Further efficiencies could be found if filming time could be reduced by one day (see itinerary). However, the reduction in costs would be minimal as the major costs associated with the operation are aircraft and aircrew hire and fuel. Flying at night has not been considered as an option due to the additional associated risks to the successful completion of the operation. All the associated charts and documentation required under CASA flight regulations for the route have been accessed and will be used to ensure a safe documentary operation.

12

Communicating [3–4]

discerning decision-making about, and fluent use of,

- written and visual features to communicate about a solution
- language for a technical audience
- grammatically accurate language structures

The response demonstrates the thoughtful and astute choice of written and visual information to eloquently communicate about the solution to a technical audience.

Itinerary

Options for the itinerary acknowledge the health and safety of the air crew and media staff. Time has been allocated to allow for unforeseen circumstances that may cause delays. This provides the pilots with options in cases where alternate airports and accommodation may need to be accessed en route.

Day 1 - Depart Archerfield, Arrive Townsville (Flying time of 3.6 hours)
Day 2 - Great Barrier Reef media shoot
Day 3 - Great Barrier Reef media shoot
Day 4 - Depart Townsville, Arrive at Jabiru (Flying time of 5.3 hours)
Day 5 - Kakadu National Park media shoot
Day 6 - Kakadu National Park media shoot
Day 7 - Depart Jabiru, arrive at Kununurra (The Bungle Bungles) (Flying time of 1.8 hours)
(**Note**: a day could be saved by including travel on the media shoot day at either Kakadu or Bungle Bungles – cost saving of $1310)
Day 8 - The Bungle Bungles media shoot
Day 9 - The Bungle Bungles media shoot
Day 10 - Depart Kununurra, refuel at Mount Isa, Arrive Archerfield
(Flying time of 9.2 hours with one rest and fuel stop)

The predicted solution was costed on Monday 22/03/18 to provide data to evaluate the operation's capacity to cost effectively and efficiently meet the success criteria for the project. Costs associated with the use and access to the various systems incorporated in the documentary operation are $25371.

Note: Meals and personal costs are not included in the costing. However, adequate meals and plentiful beverages will be available to maintain crew and media staff health and wellbeing at cost price.

Recommendations

Based on the findings of this investigation as documented in the folio Part A, the project team recommends that the documentary operation be implemented as presented in the itinerary. This will provide the media company with a solution that meets with the success criteria for the project.

Future considerations

Time savings may be available if the media company is willing to hire a rotary wing aircraft to travel from local airports to each filming location. The time savings may allow the operation to be reduced to 8 days. The helicopter hire rate is estimated to be $1650 for the transportation of the media team and equipment to each location and return for the periods required. The additional benefits of this proposal are that air and ground filming can be organised in advance at various locations for each of the three film sites. While it is likely that there will be no cost saving to the media company, the quality of the final documentary product would be enhanced by the ability of the helicopter to access a range of more exotic and remote filming locations. Approvals may be required to access and film places and spaces that have sacred traditional and spiritual importance to the local Aboriginal peoples.

13

Communicating [3–4]

discerning decision-making about, and fluent use of, folio and referencing conventions

The response includes the folio convention of a reference list and a recognised system of in-text referencing used in a way that shows intellectual perception and good judgment.

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