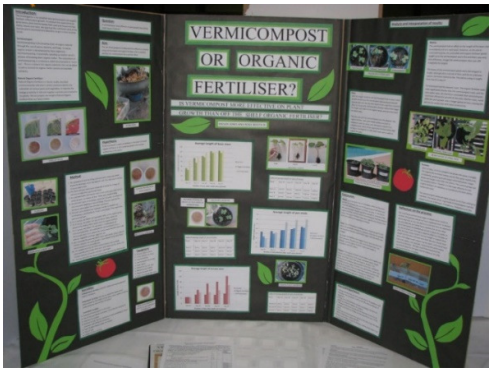
Contents

Course Outcomes

By the end of this course you should be able to do the following:

1. Understand the requirements and fully participate in the judging process;
2. Fairly and without bias judge an EXPO entry;
3. Interpret the scoring sheet;
4. Assess scientific method;
5. Assess the originality and creativity of the project;
6. Assess the written entry component;
7. Conduct and assess an interview with the young scientist;
8. Provide feedback to the young scientist about the entry.



View ***Chapter 1: Introduction*** on the DVD ***A Guide to Judging Science Projects*** (see Appendix H Page 51 in this handbook)

Module 1 – Characteristics of a Good EXPO Judge

In this module you will participate in an ice-breaker activity while sharing ideas about the characteristics of a good EXPO judge.

Judges should keep in mind that participating in the Expo for Young Scientists is not only a competition, but an educational and motivating experience for the learners.

1. Use this space to record at least FIVE characteristics of a good Eskom EXPO for Young Scientists Judge.
    a.
    b.
    c.
    d.
    e.

Give One Get One

You will conduct five conversations. In each conversation you will divide into pairs with someone you do not know.

2. In each pair have a conversation with the other individual. Each individual shares at least **one** idea or strategy in each conversation. Write down the name of the person and the idea you have learned from each conversation.

Name:_____ Idea:_____

Name:_____ Idea:_____

Name:_____ Idea:_____

Name:_____ Idea:_____

Name:_____ Idea:_____

3. Use these ideas and the checklist at Appendix A (Page 13 of this booklet) to rate your potential as a judge. What can you do to become a better judge in the Eskom EXPO for Young Scientists?

View ***Chapter 2: Profile of a Judge*** on the DVD ***A Guide to Judging Science Projects*** (see Appendix H Page 52 in this handbook)

Module 2 - The Scoring Sheet

View ***Chapter 3: Judging Criteria*** on the DVD ***A Guide to Judging Science Projects.*** (see Appendix H Page54 in this handbook)

You will find a copy of the Scoring Sheet in Appendix B of this booklet (Page 14). The first section of the first page is self-explanatory. Be sure to record the sample size which you will find in the Project Report File or Abstract. Alternatively establish this during the interview.

Eskom EXPO FOR YOUNG SCIENTISTS Est. 1980	**NAME(S) OF LEARNER(S) :** Bongani Khumalo	Primary	6	7	Project Number : 1163
		Junior	8	9	
		Senior	10	X 11	12
	PROJECT TITLE : Go organic with worm tea				
	SAMPLE SIZE: 159				

In the MARKS ALLOCATED section you will record the marks based on your assessment of the written report (Sections I and II) and the interview (Section III).

The score reached by consensus with judge peers may differ from your total. Leave them like that

MARKS ALLOCATED				
SECTION I VALUE OF PROJECT	SECTION II WRITTEN COMMUNICATION POSTER, REPORT, FILE	SECTION III ORAL COMMUNICATION	INITIAL TOTAL	FINAL TOTAL AFTER PANEL DISCUSSION
34 / 50	24 / 30	18 / 20	76 / 100	71 / 100

You can alter this score after the interview

This may not be altered after adding the three section scores

NAME OF JUDGE (PRINT PLEASE):	JUDGE'S SIGNATURE:	CONVENOR'S NAME:
Aneesa Basha	A Basha	Robin Pule This is your category judge convenor

COMMENTS : please complete this section in detail.

1. **Do you think this project is of a standard to be selected to participate in an International Science Fair in 2015? Yes/No Motivation.**

If you answered Yes above please complete this section: What improvements would you recommend for this project? Please specify.

If you answered Yes above please complete this section: Who could mentor this finalist if selected for an International Science Fair in 2015? Please print the name and email address of this person.

2. **For ALL projects**: Please write comments on the following for your panel discussion and for use by the International Selection Panel.

Poster

Project data book/rough work

Scientific report

General

This entire section is drafted after judging and immediately prior to the judges panel discussion, then completed prior to finally signing and submitting the completed scoring sheet

1. Divide into small groups at your table and discuss:
   What would the standout qualities be of a project that is suitable for the International Science Fair?

2. Report on your group's thoughts to the whole class.

View ***Chapter 4: Ethics and Safety*** on the DVD ***A Guide to Judging Science Projects.***
(See Appendix H Page 59 of this handbook)

Module 3 – Judging Value of the Project

This is done through the use of Section I of the Scoring Sheet. The page is a matrix and you have to first judge the Scientific Method/Engineering Procedure (Red Arrow 1 below) and then the Originality (Red Arrow 2 below). The two shaded lines from the row and column that you select will intersect and that will determine the score.

SECTION I: VALUE OF PROJECT ***(Total / 50)***

To assess project start with the vertical axis and then move across the horizontal axis.

GUIDELINES FOR ASSESSING VALUE OF PROJECT:	**ORIGINALITY** The learner is able to think and act independently. Refers to background reading, originality of approach, use of resources, depth of planning and execution of investigation			
1. Identify the type of project done by the learner: *A- PURE SCIENCE – basic knowledge and fundamental principles* *B - APPLIED SCIENCE – science applied to human needs* *C- TECHNOLOGY AND APPLIED TECHNOLOGY including engineering projects* *2. Criteria below refer to specific kinds of projects as listed above – apply relevant criteria to project being assessed.* *NB: a project could be a combination of A/B/C above.*	Rank 1 (poor)	Rank 2 (fair)	Rank 3 (good)	Rank 4 (excellent)
	Little imagination shown. Project design is simple with minimum learner input.	Some creativity shown in a project of fair to good design. Standard approach using common resources or equipment.	Imaginative, well thought out, above ordinary approach. Good use of available resources. Creativity in design and/or use of materials.	A novel approach which shows resourcefulness and creativity throughout the project.
SCIENTIFIC METHOD/ENGINEERING PROCEDURE Application of the scientific method, range of investigation, results, analysis, conclusions (Check for validity of the investigation and reliability of results – sample size, repetitions, etc.)				
Level 1 (poor) Duplication of existing work A/B : Little understanding of scientific process. A/B: Duplication of a known experiment. Study of existing printed material but little reference to data. B: Copy of an existing solution. Duplication of a known process, existing material. Minimal testing undertaken. C: Duplication of existing technology.	9…10…11 12…13…14	15…16…17 18…19…20	21…22…23 24…25…26	X
Level 2 (fair) A known investigation that has a new angle which adds value to the results. A/B: Limited range, basic application of scientific method. A/B: Research of existing printed material and of existing data with extension of a known experiment. B: Indication of input and knowledge of some existing applications. C: Improvement or demonstration of new applications for existing technology.	15…16…17 18…19…20	21…22…23 24…25…26	27…28…29 30…31…32	33…34…35 36…37…38
Level 3 (good) A new investigation undertaken beyond the borders of the school curriculum with limited testing and results. A/B: Good application of the scientific method. A/B: Devised and carried out original experiment with controls. Variables are identified and significant variables are controlled. Analysis with graphs or simple well thought out statistics. B: New solution to problem after prototyping and testing. Analysis of observations and investigation using graphs / statistics. C: Design and build innovative technology.	X	27…28…29 30…31…32	33…34…35 36…37…38	39…40…41 42…43…44
Level 4 (excellent) Genuinely unique, substantial testing and results. A/B: Full application of scientific method, extension of level 3. A/B: Variables are identified and most significant variables are controlled. Illustration of cause and effect. Devised and carried out original experiment. B: Novel solution to current problem(s). Integrate several existing technologies / solutions where applicable. C: Unique solution and complete mastery of all technologies used, need technology solution chain.	X	33…34…35 36…37…38	39…40…41 42…43…44	45…46…47 48…49…50

Section 1 of the Scoring Sheet

View ***Chapter 5: Judging Tools*** on the DVD ***A Guide to Judging Science Projects*** from the 32:30 minute to 36:20 minute mark. (See Appendix H Chapter 50 of this handbook).

There are two example projects included in this booklet and they can be found at Appendix F (Page 21) and Appendix G (Page 39). You will use one of these to practice your use of the scoring sheet.

1. Work in groups of three (as a judge you will normally work in a team of three).

2. Consult the checklist for scientific method (Appendix C – on Page 18) and the checklist for Originality (Appendix D on Page 19)

3. Select one example project and apply Section 1 of the Scoring Sheet.

4. Report your conclusions to the whole group and discuss any differences that you may have. Both the judging and the report will simulate the panel discussion you will have with your team of judges after judging the actual projects at the Expo.

Module 4 – Judging the Written Communication

This is carried out using Section II of the Scoring Sheet. In this case you refer to all the written components of the project, including the poster presentation.

SECTION II: WRITTEN COMMUNICATION OF PROJECT (POSTER, REPORT, FILE) *(Total / 30)*

Criteria	Levels of performance: 0 = Not done, 0.5 = Poor, 1.5 = Good, 2 = Excellent
Report file neatly and logically organised File with clearly labelled sections, etc. **Plagiarism pledge** and **abstract** at the front of the file.	1.5
Evidence of background research in **introduction of report in file and on poster** Background information and knowledge, summarised with articles in appendix. Introduction in report file Including focus question/problem statement and supporting evidence	1.5
Written language in report and on poster Legible, scientific, suitable headings, no spelling mistakes. Appropriate for research topic, not biased.	2
Aim / hypothesis / goal of project reflected in report and on poster Clearly stated, unambiguous, achievable	2
Methods (and materials) used or technologies used in report and on poster Presented in logical order, correct expression, repeatable, more extensive in report than on poster.	0.5
Variables identified in report and on poster Dependent and independent variables.	0.5
Results in report and on poster Full observations, with findings, presented in tabular form and in graphs in report. Summary in graph or diagram form on poster. These are scientifically and mathematically suitable and correct.	2
Analysis of results in report and on poster Results / findings / graphs explained in words, more extensive in report than on poster.	1.5
Discussion of results in report and on poster Patterns and trends are noted and explained, anomalies / unusual results are discussed, limitations noted and clarified.	1.5
Future possibilities of research in report Future extensions and possibilities are identified.	1.5
Conclusions are reflected in report and on poster They are valid, based on findings and linked to the aim / hypothesis / goals.	1.5
References in report Reference of books, magazines, newspaper articles, journals and internet addresses given in the correct format as laid out in the Expo Guide Book.	2
Acknowledgements in report and on poster It is important to find out depth of adult assistance received and how this assistance has been used.	2
Poster board – summarises project and is neatly organised This makes an impact and captures the attention. Colour and contrast are used in a relevant, attractive and suitable way. Presentation has a logical flow – left to right and must include introduction/problem/background and goal, aim/hypothesis, method, important results in graphs and/or diagram form, analysis, short discussion of results and conclusion, acknowledgements	2
Project data book To include: **research plan**/ rough work / original data sheets / plans / diagrams / photos / questionnaires / sketches of previous models / emails / records of interviews - showing what was done and when, where and how, observations, circumstances, results, etc.	2
TOTAL	24/30
NOTES: *Well presented and generally well-written up but the method and variables were neglected in the poster.*	

View ***Chapter 5: Judging Tools*** on the DVD ***A Guide to Judging Science Projects*** from the 36:20 minute to 45:50 minute mark. (See Appendix H Page 60 of this handbook)

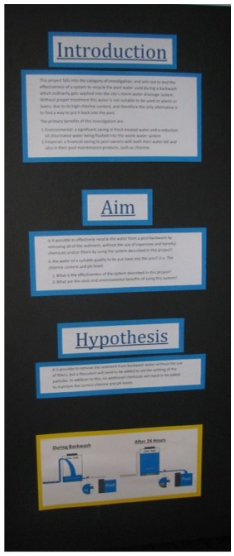
1. Work in the same groups of three.

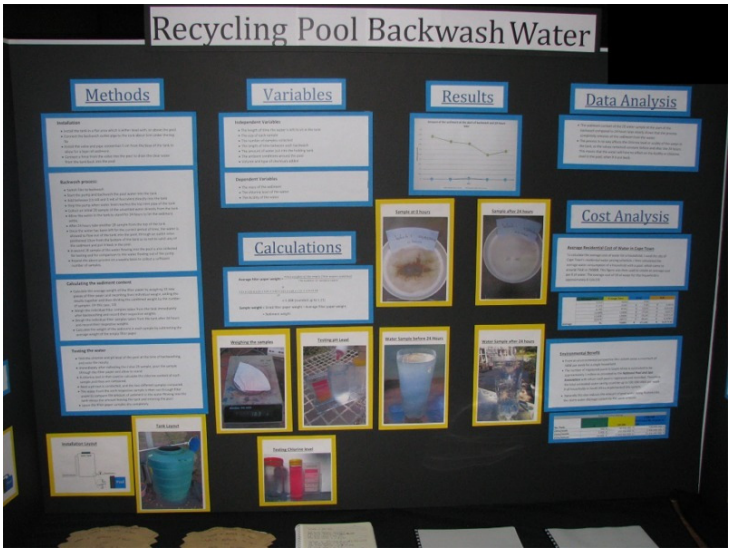
2. Use the same example project. Look for these components in the written format:
   a. A project report file containing these sections:
      i. Title of the project
      ii. State problem/aim and hypothesis/engineering goals
      iii. Introduction, including information collected and description of the project literature review
      iv. Procedures (Method) including the variables
      v. Results including record of data in tables and graphs
      vi. Analysis/discussion and interpretation of results (including errors and modifications)
      vii. Conclusion(s)
      viii. Bibliography/References
      ix. All images and photos referenced
      x. Acknowledgements of people that supported the project
   b. Plagiarism form
   c. Research Plan – written in the future tense at the time of the initial planning of the project and signed by the teacher/mentor
   d. Abstract – a summary of the report, written in the past tense.
   e. The poster (see example on Page 9 of this booklet)
      i. Introduction and background
      ii. Aim
      iii. Hypothesis or Engineering Goal
      iv. Procedure (Method) including variables
      v. Title, Name and Grade
      vi. Results – graphs and analysis
      vii. Discussion and Interpretation
      viii. Conclusions
      ix. Acknowledgements
      x. Photos

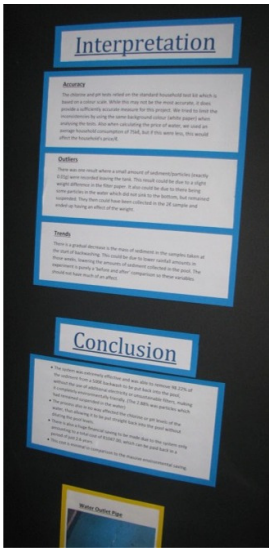
3. Apply Section II of the Scoring Sheet to the project.

4. Report your conclusions to the whole group and discuss any differences that you may have.

These are the three panels of an Expo Project (Appendix F).







To view the full-sized photographs in digital format go to:

www.schoolnet.org.za/Expo/Poster-Left-Panel.jpg

www.schoolnet.org.za/Expo/Poster-Centre-Panel.jpg

www.schoolnet.org.za/Expo/ Poster-Right-Panel.jpg

Module 5 – Judging the Oral Communication

To most students the judge interview is the most nerve-wracking yet memorable experience about the Expo event.

The oral communication is judged entirely during the interview which typically lasts for up to 20 minutes (this depends on the time available and the number of entrants). Section III of the Scoring Sheet is used to score the interview.

View ***Chapter 5: Judging Tools*** on the DVD ***A Guide to Judging Science Projects*** from the 42:55 minute mark until the end of the chapter. (See Appendix H Page 60 of this handbook)

The **students are given the following advice** in their Project Guide Book:

- Introduce yourself by name
- Know your topic
- Be enthusiastic
- Speak clearly with confidence and use appropriate language
- Listen to the judge's questions
- Don't read off notes or recite a prepared speech, answer the questions
- Make sure your answers are to the point
- Be aware of time constraints
- Switch off your cell phone

SECTION III: ORAL COMMUNICATION (INTERVIEW)© *(Total / 20)*

Criteria	Levels of performance: 0 = Not done 0.5 = Poor 1.5 = Good 2 = Excellent
Capture of interest The learner's presentation is exciting and stimulating	2
Enthusiasm / effort A worthwhile effort was made to explain, lots of enthusiasm present.	2
Voice / tone Totally audible, varying intonation.	2
Self-confidence and body language Confident about the project, little nervousness visible.	2
Scientific language Use of appropriate language and vocabulary, verbally fluent.	1.5
Response to questions Carefully listens to questions, responds clearly and intelligently.	1.5
Presentation of project Can present the project in a logical, well organised way (without reciting).	2
Limitations and gaps The learner is fully aware of the limitations and can explain reasons for gaps.	1.5
Possible suggestions for expanding project The learner is fully aware of the possibilities for expanding the project.	1.5
Authenticity The learner takes complete ownership of the project and integrates assistance received in their answers to questions. Can demonstrate all of the methods/techniques used. *It is important to find out the amount of adult assistance received, how this assistance has been used and ask questions.*	2
TOTAL	18/ 20

INTERVIEW NOTES: please complete in detail

Very confident and assertive presence during the interview. He was hesitant about the scientific terminology and temporarily lost confidence. He speaks very well and explains his method very well. He has folowoed good method but has neglected aspects of evaluation and reflection. Was less convincing talking about possibel shortfalls and takin the idea forward.

Judges are looking for the following from the student during the interview:

- Ability to communicate scientific work verbally
- Appropriate use of technical terminology
- Extent of Research
- Extent of Ownership – how much did THEY do?

For guidelines on the typical questions that you could ask the student see APPENDIX E (Page 20)

During the interview you should try to do the following:

- Please introduce yourself to the pupils
- Remind pupil of time constraint
- Language barrier? Call your convener
- Respect cultural / language differences
- Must be objective (i.e. no bias)
- Try to sit to speak to small children – eye-level

- Use notes made in the morning for questions
- Do not access your cellphone
- Ask student for a SUMMARY of their project
- Recited speech? Stop them & ask questions
- If two entrants, ensure that they:
    - share the talking
    - share answering questions
    - Shared the workload
    - Understand what the other did

After the interview you will use Section III to score the interview. You may, as a result of the interview, revise scores in Section I only.

1. Working in groups of three, simulate a judge-student interview by talking about a science or engineering project with which you are familiar from your daily lives.

2. Play the following roles. Swop roles after 5 minutes until everyone has had the opportunity to play each role:
    a. Student
    b. Judge
    c. Assessor of the role play

3. Use Section III of the Scoring Sheet to assess the role-play interviews.
   It is optional to capture the interview on video if you have the appropriate device.

4. Report back any issues that may arise to the whole group.

Module 6 - Assessing an Actual Expo Entry

View ***Chapter 6: The Judging Process*** on the DVD ***A Guide to Judging Science Projects***. (See Appendix H Page 64 of this handbook).

You will reconvene with your judging coordinators to view at least one actual Eskom Science Expo project from the category in which you will be judging. Further discussion about the judging will take place at this meeting.

Module 7 - Assessment

When you view an actual project after this workshop, use that opportunity to assess Section I and Section II of one of the projects that you have discussed and submit a copy of that assessment to your workshop facilitator. This will assessed according to the following criteria:

	Level 1	Level 2	Level 3	Level 4
Accuracy of scoring	Your scoring was very inaccurate.	Your scoring deviated substantially from the mean on more than 3 areas and your totals were inaccurate as a result.	Your scoring was mostly accurate but there were 2 and 3 areas in which your score deviated substantially.	Your scoring was accurate given that different judges may have slightly different perspectives.
Depth of comment	Your comments were off the point and lacked depth.	Your comments were useful at times, but too often inaccurate or too brief to make sense.	Your comments were useful and detailed.	Your comments were accurate, detailed, interesting and insightful.
Value of advice	Your advice was not useful or constructive.	The advice you gave was not always useful or clear.	Your advice for improving the project was useful.	Your advice for improving the project was very valuable and constructive.

Acknowledgements

Olga Peel of the Cape Town Expo Region

Brian Cox of the Cape Town Expo Region

Parthy Chetty, Executive Director, Eskom Expo for Young Scientists

APPENDIX A - Qualities of an Expo Judge

Use this checklist to conduct a self-assessment of your own qualities as a potential EXPO judge:

A good judge is…	✓
a volunteer who is committed to the entire judging process including using the Expo judging sheet when assessing the projects	
professional in their dress and demeanor	
a good team worker who values the opinion of his/her co-judges	
qualified to judge in a particular category either academically or vocationally	
interested in children and their view of the world	
empathetic towards others and a good listener who is willing to learn from a child	
non-judgmental and unbiased / fair/impartial/objective rather than subjective	
good at communicating both verbally and non-verbally	
understand the impact of the judging process especially the interview on the participant(s)	
able to find something good about every project even if it has been done many times before by other learners	
discrete in his/her assessment and discussion with co-judges	
non-confrontational in his/her relationship with the participants and co-judges	
able to make the interview experience a positive one for every participant which fulfills the aim of the Expo which is to inspire individuals and their love of science	

ISF 2014: Judges Scoring Sheet

Eskom EXPO FOR YOUNG SCIENTISTS Est. 1980	**NAME(S) OF LEARNER(S) :**	Primary	6	7	Project Number :
		Junior	8	9	
		Senior	10	11	12
	PROJECT TITLE :				
	SAMPLE SIZE:				

MARKS ALLOCATED				
SECTION I VALUE OF PROJECT / 50	SECTION II WRITTEN COMMUNICATION POSTER, REPORT, FILE / 30	SECTION III ORAL COMMUNICATION / 20	INITIAL TOTAL / 100	**FINAL TOTAL AFTER PANEL DISCUSSION** **/ 100**

NAME OF JUDGE (PRINT PLEASE):	JUDGE'S SIGNATURE:	CONVENOR'S NAME:

COMMENTS : please complete this section in detail.

1. **Do you think this project is of a standard to be selected to participate in an International Science Fair in 2015? Yes/No Motivation.**

If you answered Yes above please complete this section: What improvements would you recommend for this project? Please specify.

If you answered Yes above please complete this section: Who could mentor this finalist if selected for an International Science Fair in 2015? Please print the name and email address of this person.

2. **For ALL projects**: Please write comments on the following for your panel discussion and for use by the International Selection Panel.

Poster

Project data book/rough work

Scientific report

General

ISF 2014: Judges Scoring Sheet

SECTION I: VALUE OF PROJECT *(Total / 50)*

To assess project start with the vertical axis and then move across the horizontal axis.

GUIDELINES FOR ASSESSING VALUE OF PROJECT:

1. Identify the type of project done by the learner:

- *A- PURE SCIENCE – basic knowledge and fundamental principles*
- *B - APPLIED SCIENCE – science applied to human needs*
- *C- TECHNOLOGY AND APPLIED TECHNOLOGY including engineering projects*

2. Criteria below refer to specific kinds of projects as listed above – apply relevant criteria to project being assessed.

NB: a project could be a combination of A/B/C above.

ORIGINALITY

The learner is able to think and act independently. Refers to background reading, originality of approach, use of resources, depth of planning and execution of investigation

		Rank 1 (poor)	Rank 2 (fair)	Rank 3 (good)	Rank 4 (excellent)
		Little imagination shown. Project design is simple with minimal learner input.	Some creativity shown in a project of fair to good design. Standard approach using common resources or equipment.	Imaginative, well thought out, above ordinary approach. Good use of available resources. Creativity in design and/or use of materials.	A novel approach which shows resourcefulness and creativity throughout the project.
SCIENTIFIC METHOD/ENGINEERING PROCEDURE Application of the scientific method, range of investigation, results, analysis, conclusions (Check for validity of the investigation and reliability of results – sample size, repititions, etc.)	Level 1 (poor) Duplication of existing work A/B : Little understanding of scientific process. A/B: Duplication of a known experiment. Study of existing printed material but little reference to data. B: Copy of an existing solution. Duplication of a known process/existing material. Minimal testing undertaken. C: Duplication of existing technology.	9…10…11 12…13...14	15…16...17 18…19...20	21…22...23 24…25...26	X
	Level 2 (fair) A known investigation that has a new angle which adds value to the results. A/B: Limited range, basic application of scientific method. A/B: Research of existing printed material and of existing data with extension of a known experiment. B: Indication of input and knowledge of some existing applications. C: Improvement or demonstration of new applications for existing technology.	15…16...17 18…19...20	21…22...23 24…25...26	27…28...29 30…31...32	33...34...35 36...37...38
	Level 3 (good) A new investigation undertaken beyond the borders of the school curriculum with limited testing and results A/B: Good application of the scientific method. A/B: Devised and carried out original experiment with controls. Variables are identified and significant variables are controlled. Analysis with graphs or simple well thought out statistics. B: New solution to problem after prototyping and testing. Analysis of observations and investigation using graphs / statistics. C: Design and build innovative technology.	X	27…28...29 30…31...32	33...34...35 36...37...38	39…40…41 42...43...44
	Level 4 (excellent) Genuinely unique, substantial testing and results. A/B: Full application of scientific method, extension of level 3. A/B: Variables are identified and most significant variables are controlled. Illustration of cause and effect. Devised and carried out original experiment. B: Novel solution to current problem(s). Integrate several existing technologies / solutions where applicable. C: Unique solution and complete mastery of all technologies used, need technology solution chain.	X	33...34...35 36...37...38	39…40…41 42...43...44	45...46...47 48...49...50

ISF 2014: Judges Scoring Sheet

SECTION II: WRITTEN COMMUNICATION OF PROJECT (POSTER, REPORT, FILE) ***(Total / 30)***

Criteria	Levels of performance: 0 = Not done 0.5 = Poor 1.5 = Good 2 = Excellent
Report file neatly and logically organised File with clearly labelled sections, etc. **Plagiarism pledge** and **abstract** at the front of the file.	
Evidence of background research **in introduction of report in file and on poster** Background information and knowledge, summarised with articles in appendix. Introduction in report file Including focus question/problem statement and supporting evidence	
Written language in report and on poster Legible, scientific, suitable headings, no spelling mistakes. Appropriate for research topic, not biased.	
Aim / hypothesis / goal of project reflected in report and on poster Clearly stated, unambiguous, achievable	
Methods (and materials) used or technologies used in report and on poster Presented in logical order, correct expression, repeatable, more extensive in report than on poster.	
Variables identified in report and on poster Dependent and independent variables.	
Results in report and on poster Full observations, with findings, presented in tabular form and in graphs in report. Summary in graph or diagram form on poster. These are scientifically and mathematically suitable and correct.	
Analysis of results in report and on poster Results / findings / graphs explained in words, more extensive in report than on poster.	
Discussion of results in report and on poster Patterns and trends are noted and explained, anomalies / unusual results are discussed, limitations noted and clarified.	
Future possibilities of research in report Future extensions and possibilities are identified.	
Conclusions are reflected in report and on poster They are valid, based on findings and linked to the aim / hypothesis / goals.	
References in report Reference of books, magazines, newspaper articles, journals and internet addresses given in the correct format as laid out in the Expo Guide Book.	
Acknowledgements in report and on poster It is important to find out depth of adult assistance received and how this assistance has been used.	
Poster board – summarises project and is neatly organised This makes an impact and captures the attention. Colour and contrast are used in a relevant, attractive and suitable way. Presentation has a logical flow – left to right and must include introduction/problem/background and goal, aim/hypothesis, method, important results in graphs and/or diagram form, analysis, short discussion of results and conclusion, acknowledgements	
Project data book To include: **research plan**/ rough work / original data sheets / plans / diagrams / photos / questionnaires / sketches of previous models / emails / records of interviews - showing what was done and when, where and how, observations, circumstances, results, etc.	
TOTAL	**/ 30**

NOTES:

ISF 2014: Judges Scoring Sheet

SECTION III: ORAL COMMUNICATION (INTERVIEW)© *(Total / 20)*

Criteria	Levels of performance: 0 = Not done 0.5 = Poor 1.5 = Good 2 = Excellent
Capture of interest The learner's presentation is exciting and stimulating	
Enthusiasm / effort A worthwhile effort was made to explain, lots of enthusiasm present.	
Voice / tone Totally audible, varying intonation.	
Self-confidence and body language Confident about the project, little nervousness visible.	
Scientific language Use of appropriate language and vocabulary, verbally fluent.	
Response to questions Carefully listens to questions, responds clearly and intelligently.	
Presentation of project Can present the project in a logical, well organised way (without reciting).	
Limitations and gaps The learner is fully aware of the limitations and can explain reasons for gaps.	
Possible suggestions for expanding project The learner is fully aware of the possibilities for expanding the project.	
Authenticity The learner takes complete ownership of the project and integrates assistance received in their answers to questions. Can demonstrate all of the methods/techniques used. *It is important to find out the amount of adult assistance received, how this assistance has been used and ask questions.*	
TOTAL	**/ 20**

INTERVIEW NOTES: please complete in detail

APPENDIX C – Checklist for Scientific Method

Use this checklist *in conjunction with* the Judges Scoring Sheet. Base your response on *clear evidence* in the Report File or Poster and not on what you assume is in place. If you cannot see it, it's not there (unless the interview clarifies the situation).

There is clear evidence of …	✓
REPORT	
Clarity of purpose (aim) and thought in the project.	
Knowledge and understanding of the topic under investigation.	
Thoroughness in research and investigation – written in detail.	
Originality in idea behind topic and unique scientific breakthrough. Beyond the school curriculum.	
Information researched from a variety of sources and references are accurately written.	
Sample size well in excess of 100.	
Full application of scientific method	✓
Title links to project and is descriptive and is the same as sent in with entry form.	
Purpose/aim and/or research question clearly stated either separately or at end of introduction.	
Evidence of background research summarised in introduction.	
Hypothesis or Engineering goals correctly stated and is/are testable.	
Method/procedure stated in bulleted or numbered steps, written in the third person, investigation can be repeated by someone else.	
Controlled (fixed), independent and dependent variables clearly stated.	
Investigation is valid (one independent variable) and data is reliable (repeated testing/large sample size).	
Results recorded in well set out tables with descriptive table headings, correct column headings with units & grid lines separate data.	
Evidence of sufficient testing with explanation. For example, showing an understanding between sample (n) and population (N).	
Graphs drawn up from relevant data in tables, correct graphs used, with descriptive headings, showing independent and dependent variables, accurate axis labels & scales & data correctly plotted.	
Interpretation and discussion of data correctly stated, giving patterns and trends, errors and further extension noted. Critical thought evident.	
Conclusion accurately stated referring to hypothesis/goals and to data and supports/does not support hypothesis or has met needs/goals.	
Information researched from a variety of sources and references are accurately written.	
Shows understanding of the limitations of the investigation.	

APPENDIX D – Checklist for Originality

Use this checklist *in conjunction with* the Judges Scoring Sheet (Section 1: Originality). Base your response on *clear evidence* in the Report File or Poster and not on what you assume is in place. If you cannot see it, it's not there (unless the interview clarifies the situation).

Evidence of clear, original thought and independent action.	
Provides evidence to back up ideas. Refers to research articles read and original data generated	
Consistently original, fresh approach showing entrant's resourcefulness.	
Creativity in presentation of the data and of the project reporting.	
Creativity in presentation of project summary in poster.	

APPENDIX E – Guidelines for Interview Questions

Factors judges use to make decisions	What the judges are trying to determine	Examples of questions a judge might ask during an interview
Creativity / originality	Is this work novel?	Why did you choose this topic and how did you settle on your approach to the problem?
Scientific thought / engineering process	Did the student understand the scientific/engineering method and apply it appropriately?	Can you walk me through how and why you decided on this experimental/engineering design?
Background information / thoroughness	Does the student understand what was done previously in the field?	How does your approach to the question differ from people's previous approaches?
Skill / independence	Who designed and carried out the bulk of the work?	What was the most surprising experimental/engineering challenge you faced during this science project? How did you overcome it?
Thoroughness	Is the completed work sufficient to move the field forward?	What were your goals with this science project and how would you evaluate where you are in respect to those goals?
Clarity	Can the student clearly and easily discuss all aspects of his or her project? During an interview, judges might want to make sure that a student can think and speak well when thrown a curve.	If your tests had shown XYZ instead, what would you have done? Why?
Teamwork (only applicable for team projects)	Was each member of the team fully involved? Does each member, regardless of his or her specific experimental role, understand all aspects of the science project?	The great thing about working together is the synergy between people. What would you say was the most important skill or idea each of you had during the course of this science project?

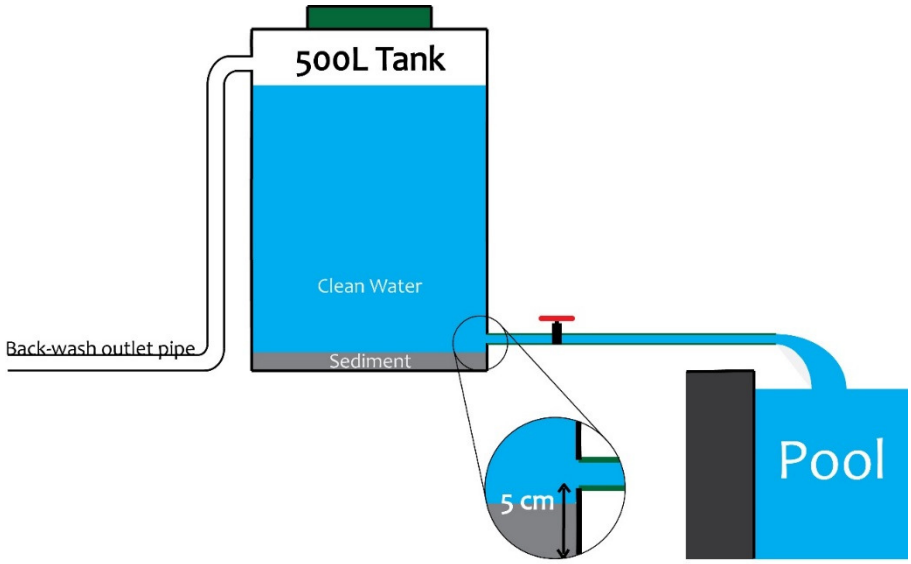
Used with permission: http://www.sciencebuddies.org/science-fair-projects/top_science-fair_judging_perspective.shtml

APPENDIX F - Example Project Report (Recycling Pool Backwash Water)

This project report was presented at a Regional Science Expo and is used with his permission. The plagiarism Pledge was removed and minor format changes were made to save space.

Scientific Report

(Includes Research Plan, Abstract, and Signed Plagiarism Pledge)



Science Expo Project

Introduction

This project falls into the category of investigation, and sets out to test the effectiveness of a system to recycle the water used during a swimming pool backwash, which ordinarily gets washed into the city's storm water drainage system. Without proper treatment this water is not suitable to be used on plants or lawns, due to its high chlorine content, and therefore the only alternative is to find a way to put it back into the pool.

The primary benefits of this investigation are:

1. Environmental: a significant saving in fresh treated water and a reduction of chlorinated water being flushed into the waste water system
2. Financial: a financial saving to pool owners with both their water bill and also in their pool maintenance products, such as chlorine.

Aim

It is possible to effectively recycle the water from a pool backwash by removing all of the sediment, without the use of expensive and unsustainable chemicals and/or filters by using the system described in this project?

Is the water of a suitable quality to be put back into the pool? (I.e. The chlorine content and pH level)

What is the effectiveness of the system described in this project?

What are the costs and environmental benefits of using this system?

Hypothesis

It is possible to remove the sediment from backwash water without the use of filters, but a flocculent will need to be added to aid the settling of the particles. In addition to this, no additional chemicals will need to be added to maintain the correct chlorine and pH levels.

Method

Installation

- Install the tank in a flat area which is either level with, or above the pool.
- Connect the backwash outlet pipe to the tank about 5cm under the top lip
- Install the valve and pipe connection 5 cm from the base of the tank to allow for a layer of sediment.
- Connect a hose from the valve into the pool to drain the clear water from the tank back into he pool

Backwash process:

- Switch filer to backwash
- Start the pump and backwash the pool water into the tank
- Add between 2.5 ml and 5 mℓ of flocculent directly into the tank
- Stop the pump when water level reaches the top inlet pipe of the tank
- Collect an initial 2ℓ sample of the unsettled water directly from the tank
- Allow the water in the tank to stand for 24 hours to let the sediment settle
- After 24 hours take another 2ℓ sample from the top of the tank
- Once the water has been left for the correct period of time, the water is allowed to flow out of the tank into the pool, through an outlet valve positioned 10cm from the bottom of the tank so as not to catch any of the sediment and put it back in the pool.
- A second 2ℓ sample of the water flowing into the pool is also collected for testing and for comparison to the water flowing out of the pump
- Repeat the above process on a weekly basis to collect a sufficient number of samples

Testing the water

- Test the chlorine and pH level of the pool at the time of backwashing, and note the results
- Immediately after collecting the initial 2ℓ sample, pour the sample through the filter paper and allow to stand
- A chlorine test is then used to calculate the chlorine content of each sample and they are compared.
- Next a pH test is conducted, and the two different samples compared.
- The water from the each respective sample is then run through filter paper to compare the amount of sediment in the water flowing into the tank versus the amount leaving the tank and entering the pool.
- Leave the filter paper samples dry completely

Calculating the sediment content

- Calculate the average weight of the filter paper by weighing 10 new pieces of filter paper and recording their individual weight, adding the results together and then dividing the combined weight by the number of samples. (In this case, 10)
- Weigh the individual filter samples taken from the tank immediately after backwashing and record their respective weights
- Weigh the individual filter samples taken from the tank after 24 hours and record their respective weights
- Calculate the weight of the sediment in each sample by subtracting the average weight of the empty filter paper.

Calculations

Average filter paper weight = $\frac{Total\ weights\ of\ the\ empty\ filter\ papers\ combined}{The\ number\ of\ samples\ taken}$

= $\frac{1.21 + 1.21 + 1.22 + 1.21 + 1.20 + 1.21 + 1.20 + 1.21 + 1.21 + 1.20}{10}$

= 1.208 (rounded up to 1.21)

Sample weight = Dried filter paper weight – Average filter paper weight

= Sediment weight

Variables

Independent Variables

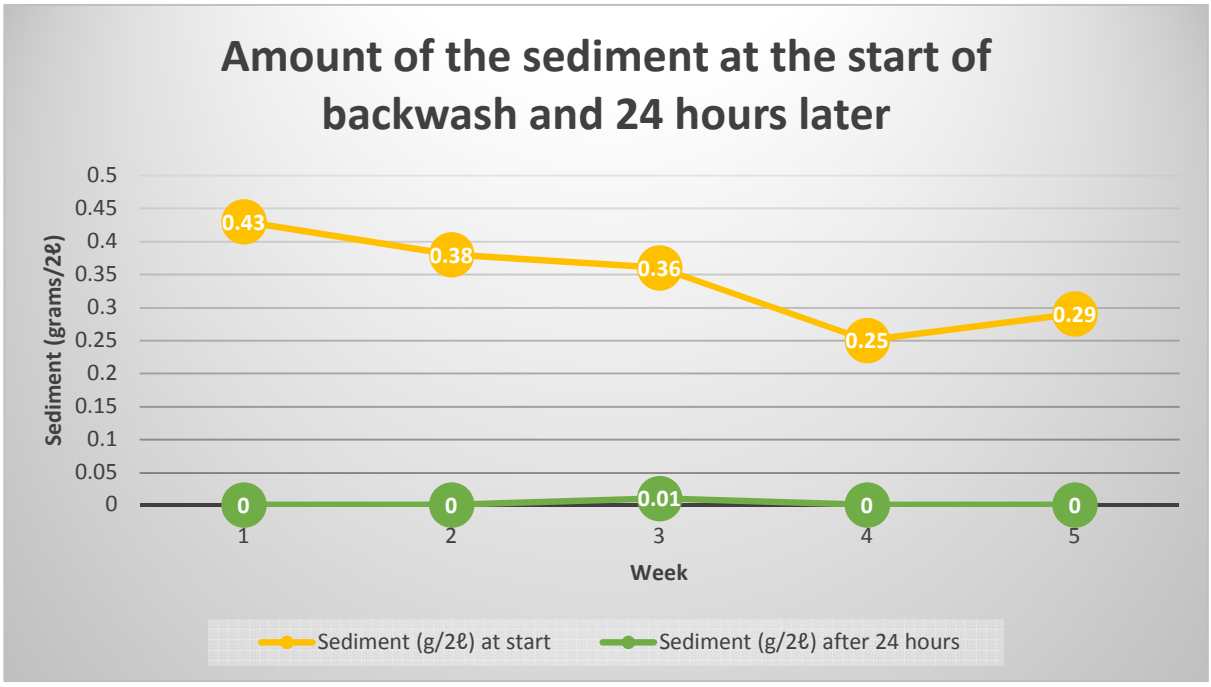
- The length of time the water is left to sit in the tank
- The size of each sample
- The number of samples collected
- The length of time between each backwash
- The amount of water put into the holding tank
- The ambient conditions around the pool
- Volume and type of chemicals added

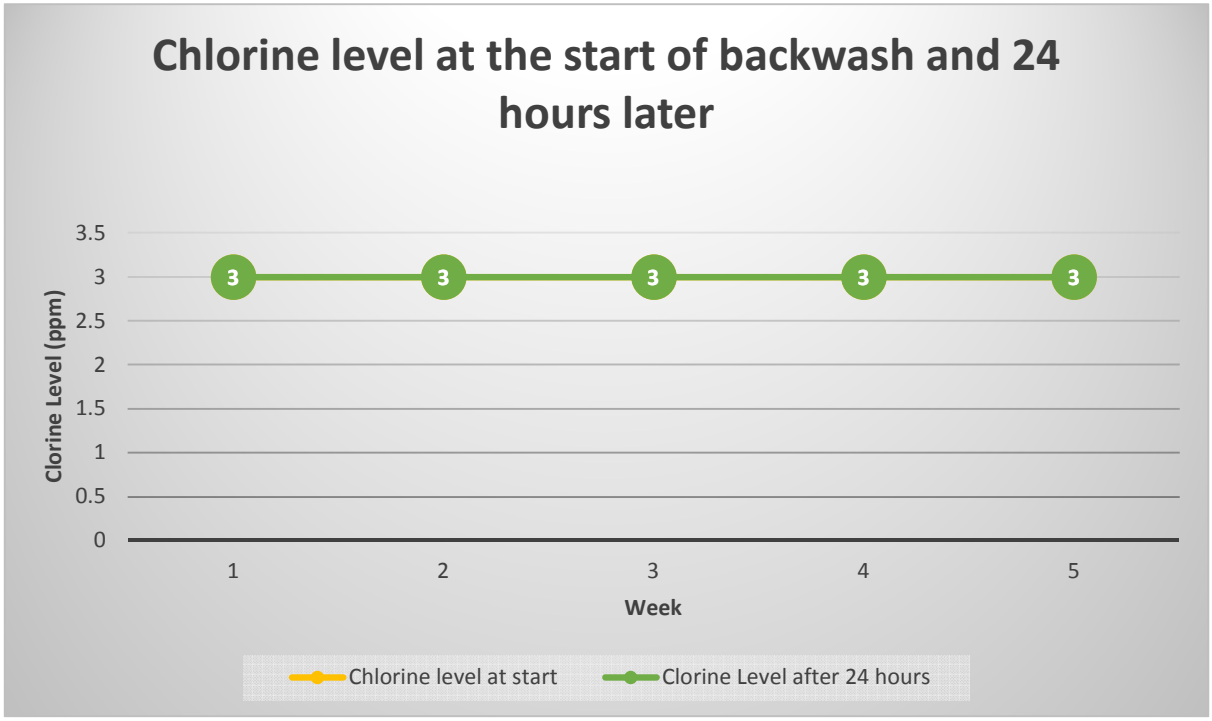
Dependent Variables

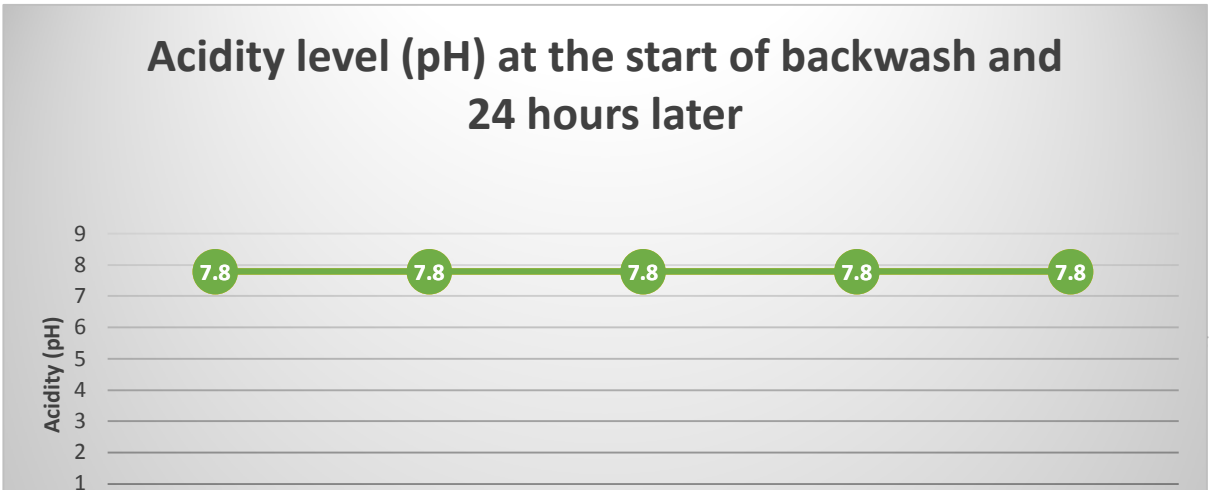
- The mass of the sediment
- The chlorine level of the water
- The Acidity of the water

Results

Week	At time of backwash				24 Hours after backwash			
	Chlorine (ppm)	Acidity (pH)	Time of day	Sediment (grams/2ℓ)	Chlorine (ppm)	Acidity (pH)	Time of day	Sediment (grams/2ℓ)
1	3,0	7,8	14h30	0,43	3,0	7,8	14h30	0,00
2	3,0	7,8	12h30	0,38	3,0	7,8	12h30	0,00
3	3,0	7,6	11h00	0,36	3,0	7,6	11h00	0,01
4	3,0	7,8	14h30	0,25	3,0	7,8	14h30	0,00
5	3,0	7,8	13h00	0,25	3,0	7,8	13h00	0,00


Amount of the sediment at the start of backwash and 24 hours later
Sediment (grams/2ℓ)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.43
0.38
0.36
0.25
0.29
0
0
0.01
0
0
1
2
3
4
5
Week
Sediment (g/2ℓ) at start
Sediment (g/2ℓ) after 24 hours


Chlorine level at the start of backwash and 24 hours later
Clorine Level (ppm)
3.5
3
2.5
2
1.5
1
0.5
0
3
3
3
3
3
1
2
3
4
5
Week
Chlorine level at start
Clorine Level after 24 hours


Acidity level (pH) at the start of backwash and 24 hours later
Acidity (pH)
9
8
7
6
5
4
3
2
1
7.8
7.8
7.8
7.8
7.8

Data Analysis

The sediment content of the 2ℓ water sample at the start of the backwash compared to 24 hours later clearly shows that the process completely removes all the sediment from the water. The process in no way affects the Chlorine level or acidity of the water in the tank, as the values remained constant before and after the 24 hours. This means that the water will have no effect on the Acidity or Chlorine level in the pool, when it is put back.

Cost Analysis

Average Residential Cost of Water in Cape Town

To calculate the average cost of water for a household, I used the city of Cape Town's residential water pricing schedule. I then calculated the average water consumption of a household with a pool, which came to around 75kℓ or 75000ℓ. This figure was then used to create an average cost per ℓ of water. The average cost of 1l of water for this household is approximately R 0,017/ℓ

	kℓ Usage Tiers	ℓ Usage Tiers	R/kℓ	R/ℓ
	5,523	5523	Free	
	4,143	4143	R 7,60	R 0,0076
	8,745	8745	R 11,61	R 0,01161
	13,808	13808	R 17,20	R 0,0172
	13,808	13808	R 21,24	R 0,02124
	28,973	28973	R 28,02	R 0,02802
Average	**75**	**75000**	**R 17,134**	**R 0,017134**

Environmental and Financial Benefit

Using the R/ℓ figure, the monetary and environmental benefit of this system can be calculated based on the estimated number of pools.

From an environmental perspective this system saves a minimum of 500ℓ per week for a single household. The number of registered pools in South Africa is estimated to be approximately 1 million as provided by the ***National Pool and Spa Association*** with whom each pool is registered and recorded**.** Therefore the total estimated water saving could be up to 500 000 000ℓ per week if all households in South Africa implemented this system.

Naturally this also reduces the amount of pool water being flushed into the storm water drainage system by the same amount.

From a financial perspective, a household can save up to R400 per annum on water.

Environmental Saving			
No. Pools	**1**	**100 000**	**1 000 000**
Litres/week	500 ℓ	50 000 000 ℓ	500 000 000 ℓ
Litres/month	2 000 ℓ	200 000 000 ℓ	2 000 000 000 ℓ
Litres/annum	24 000 ℓ	2 400 000 000 ℓ	24 000 000 000 ℓ
Financial Saving			
No. Pools	**1**	**100 000**	**1 000 000**
Saving/week	R 9	R 856 700	R 8 567 000
Saving/month	R 34	R 3 426 800	R 34 268 000
Saving/annum	R 411	R 41 121 600	R 411 216 000

Installation Cost

The system is an extremely simple one with minimal parts which means that installation is quick and easy, as well as inexpensive. The total retail cost for a 500ℓ backwash system is R 1074.00. In assessing the cost versus benefits of the system, it is important to factor in both the capital cost and the environmental cost.

Based on the capital cost alone, a 500 ℓ system, the system would pay for itself over a period of approximately 2.6 years. With the support of government subsidies and volume discounts, this could be significantly reduced.

	Retail cost
Tank	R 900,00
Pipe (3m)	R 69,00
Elbow	R 6,00
T-piece	R 6,00
Coupling	R 7,00
Stop cock	R 85,00
	R 1 074,00

Interpretation

Outliers

There was one result where a small amount of sediment/particles (exactly 0.01g) were recorded leaving the tank. This result could be due to a slight weight difference in the filter paper. It also could be due to there being some particles in the water which did not sink to the bottom, but remained suspended. They then could have been collected in the 2ℓ sample and ended up having an effect of the weight.

Accuracy

The chlorine and pH tests relied on the standard household test kit which is based on a colour scale. While this may not be the most accurate, it does provide a sufficiently accurate measure for this project. We tried to limit the inconsistencies by using the same background colour (white paper) when analysing the tests. Also when calculating the price of water, we used an average household consumption of 75kℓ, but if this were less, this would affect the household's price/ℓ.

Trends

There is a gradual decrease is the mass of sediment in the samples taken at the start of backwashing. This could be due to lower rainfall amounts in those weeks, lowering the amounts of sediment collected in the pool. The experiment is purely a 'before and after' comparison so these variables should not have much of an affect.

Conclusion

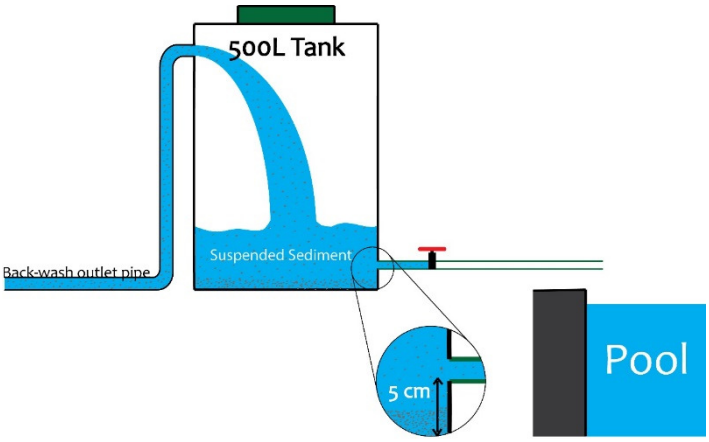
The system was extremely effective and was able to remove 98.22% of the sediment from a 500ℓ backwash to be put back into the pool, without the use of additional electricity or unsustainable filters, making it completely environmentally friendly. (The 2.88% was particles which had remained suspended in the water) The process also in no way affected the chlorine or pH levels of the water, thus allowing it to be put straight back into the pool without diluting the pool levels. Lastly there is a potentially huge environmental benefit with up to 500 000 000ℓ of water being saved weekly.

There is also a huge financial saving to be made due to the system only amounting to a total cost of R1047,00, which can be paid back in a period of just 2.6 years.

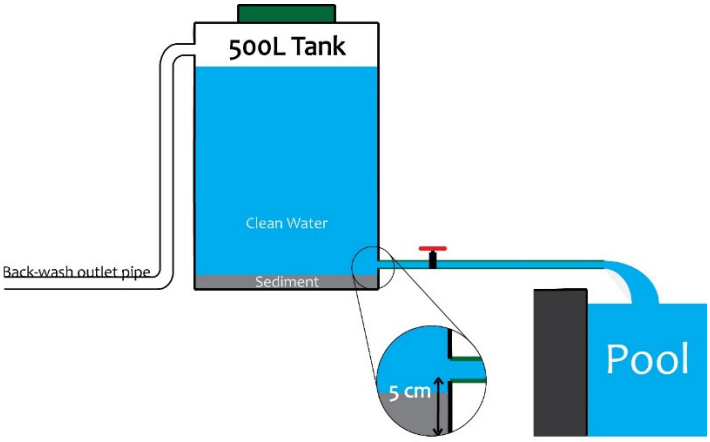
This cost is also minimal in comparison to the massive environmental saving.

Diagrams

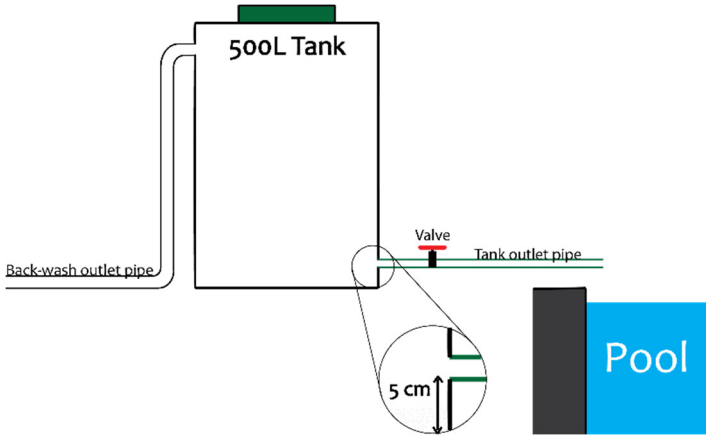
During Backwash



After 24 Hours

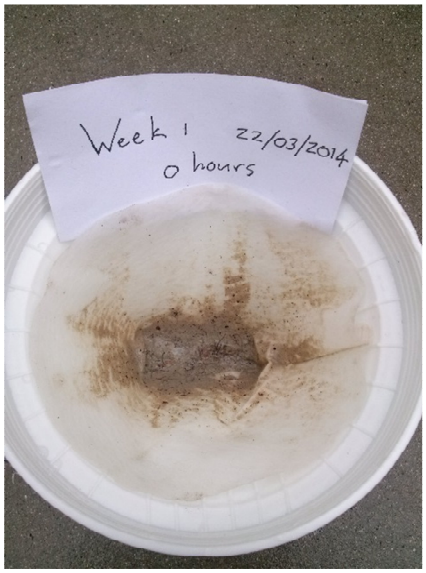


Installation Layout

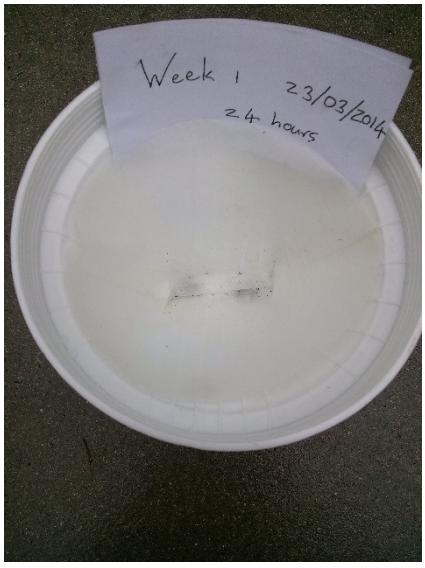


Pictures

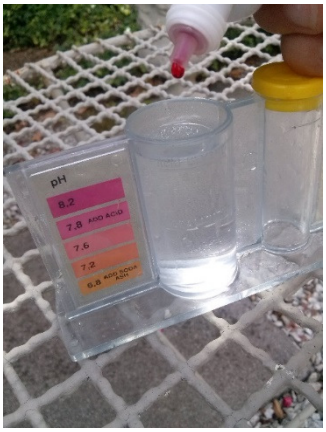
Samples from the tank during the backwash



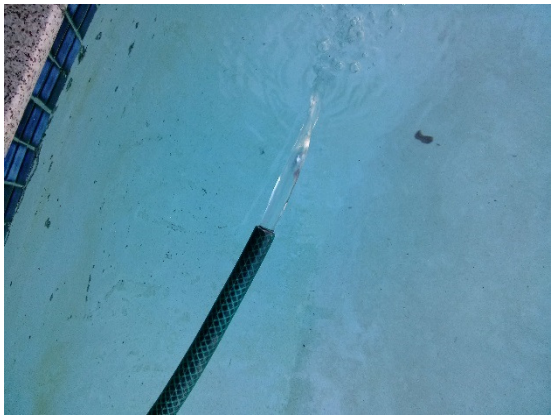
Samples from the tank after 24 Hours



Adding chemicals to water samples to calculate the pH



Running the clear water from the tank back into the pool

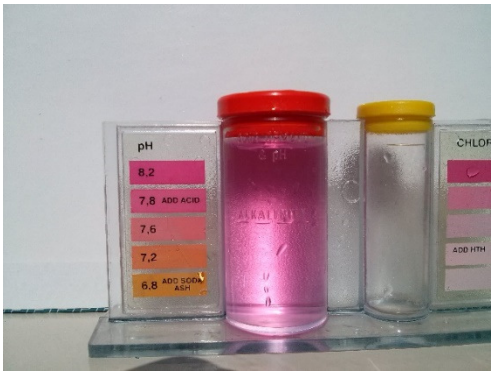


The tank where the water is left for the sediment to settle

Weighing the sediment which has been left to dry in the filter paper

Calculating the chlorine level of a water sample using a colour test and a constant background

Calculating the acidity of a sample of water using a colour test and a constant background



Background research

"Every backwash of two to three minutes will use between 200 and 900 litres of water"

An extract taken from: http://www.watersafe.co.za/2011/10/12/how-to-save-water-with-pool-backwashinghow-to-save-pool-water/

Definition: Backwash is the process of thoroughly cleaning your swimming pools' filter by a method of reversing the flow of water. Backwashing usually takes about two-to-three minutes. Continue to backwash until the water runs clear through the waste line.

An extract taken from:http://poolandpatio.about.com/od/poolglossaryal/g/DefinitionBackwash.htm

References

http://www.neltanks.co.za/

http://www.jojotanks.co.za/

http://www.health.nsw.gov.au/environment/factsheets/Pages/swimming-pool-backwash.aspx

http://www.capewatersolutions.co.za/2012/08/10/swimming-pool-water-saving/

Acknowledgements

A big thanks to:

JoJo and ***Nel Tanks*** for providing current tank pricing and size options

R James Plumbing for proving current system piping and connection prices

Pool Doctor for providing current Hyper Floc prices

The Nation Pool and Spa Institute for providing an approximate number of pools currently for South Africa

Research Plan

Title

"Recycling Pool Backwash Water"

Introduction

This project falls into the category of investigation, and sets out to test the effectiveness of a system to recycle the pool water used during a backwash, which ordinarily gets washed into the city's storm water drainage system. Without proper treatment this water is not suitable to be used on plants or lawns, due to its high chlorine content, and therefore the only alternative is to find a way to put it back into the pool.

The primary benefits of this investigation are:

3. Environmental: a significant saving in fresh treated water and a reduction of chlorinated water being flushed into the waste water system
4. Financial: a financial saving to pool owners with both their water bill and also in their pool maintenance products, such as chlorine.

Aim

It is possible to effectively recycle the water from a pool backwash by removing all of the sediment, without the use of expensive and harmful chemicals and/or filters by using the system described in this project?

Is the water of a suitable quality to be put back into the pool? (I.e. The chlorine content and pH level)

What is the effectiveness of the system described in this project?

What are the costs and environmental benefits of using this system?

Hypothesis

It is possible to remove the sediment from backwash water without the use of filters, but a flocculent will need to be added to aid the settling of the particles. In addition to this, no additional chemicals will need to be added to maintain the correct chlorine and pH levels.

Method/Procedure

Installation

- Install the tank in a flat area which is either level with, or above the pool.
- Connect the backwash outlet pipe to the tank about 5cm under the top lip
- Install the valve and pipe connection 5 cm from the base of the tank to allow for a layer of sediment.
- Connect a hose from the valve into the pool to drain the clear water from the tank back into the pool

Backwash process:

- Switch filer to backwash
- Start the pump and backwash the pool water into the tank
- Add between 2.5 ml and 5 mℓ of flocculent directly into the tank
- Stop the pump when water level reaches the top inlet pipe of the tank
- Collect an initial 2ℓ sample of the unsettled water directly from the tank
- Allow the water in the tank to stand for 24 hours to let the sediment settle
- After 24 hours take another 2ℓ sample from the top of the tank
- Once the water has been left for the correct period of time, the water is allowed to flow out of the tank into the pool, through an outlet valve positioned 10cm from the bottom of the tank so as not to catch any of the sediment and put it back in the pool.
- A second 2ℓ sample of the water flowing into the pool is also collected for testing and for comparison to the water flowing out of the pump
- Repeat the above process on a weekly basis to collect a sufficient number of samples

Data Analysis Procedure

Testing the water

- Test the chlorine and pH level of the pool at the time of backwashing, and note the results
- Immediately after collecting the initial 2ℓ sample, pour the sample through the filter paper and allow to stand
- A chlorine test is then used to calculate the chlorine content of each sample and they are compared.
- Next a pH test is conducted, and the two different samples compared.
- The water from the each respective sample is then run through filter paper to compare the amount of sediment in the water flowing into the tank versus the amount leaving the tank and entering the pool.
- Leave the filter paper samples dry completely

Calculating the sediment content

- Calculate the average weight of the filter paper by weighing 10 new pieces of filter paper and recording their individual weight, adding the results together and then dividing the combined weight by the number of samples. (In this case, 10)
- Weigh the individual filter samples taken from the tank immediately after backwashing and record their respective weights
- Weigh the individual filter samples taken from the tank after 24 hours and record their respective weights
- Calculate the weight of the sediment in each sample by subtracting the average weight of the empty filter paper.

Calculations

Average filter paper weight = $\frac{Total\ weights\ of\ the\ empty\ filter\ papers\ combined}{The\ number\ of\ samples\ taken}$

Sample weight = Dried filter paper weight **–** Average filter paper weight

= Sediment weight

Variables

Independent Variables

- The length of time the water is left to sit in the tank
- The size of each sample
- The number of samples collected
- The length of time between each backwash
- The amount of water put into the holding tank
- The ambient conditions around the pool
- Volume and type of chemicals added

Dependent Variables

- The mass of the sediment
- The chlorine level of the water
- The Acidity of the water

Bibliography

Anon., 2011. *Recycling pool backwash water.* [Online]
Available at: http://www.watersafe.co.za/2011/10/12/how-to-save-water-with-pool-backwashinghow-

to-save-pool-water/
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Available at:
http://www.betterhealth.vic.gov.au/bhcv2/bhcarticles.nsf/pages/Swimming_pools_water_quality
[Accessed 31 7 2014].

Anon., n.d. *Wikipedia.* [Online]
Available at: http://en.wikipedia.org/wiki/Flocculation
[Accessed 31 7 2014].

Background research

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Definition: Backwash is the process of thoroughly cleaning your swimming pools' filter by a method of reversing the flow of water. Backwashing usually takes about two-to-three minutes. Continue to backwash until the water runs clear through the waste line.

An extract taken from:http://poolandpatio.about.com/od/poolglossaryal/g/DefinitionBackwash.htm

Abstract

Category: Environmental Management (213)

Title of Project: Recycling Pool Backwash Water

Name: XXXXX

Grade: 10 **School:** XXXXXXX

Region: XXXXXXXX

Purpose of the project:

This project set out to test the effectiveness of a system to recycle the pool water used during a backwash, which ordinarily gets washed into the city's storm water drainage system. Without proper treatment this water is not suitable to be used on plants or lawns, and therefore the only alternative is to find a way to put it back into the pool. This will be done without the use of expensive and unsustainable chemicals and/or filters. As well as this, no additional resources will need to be added, making this system completely environmentally friendly.

Procedure/Method:

Backwash process

- Collect a 2ℓ sample of the water in the tank directly after the backwash
- Collect another 2ℓ sample from the tanks outlet pipe after 12 hours
- Repeat the above process on a weekly basis until a sufficient number of samples have been collected

Testing the water

- Test the Chlorine and pH level of the pool at the time of backwashing, and directly after 12 hours, and note the results
- Immediately after collecting the 2ℓ samples, pour them through the filter paper, allowing the sediment to collect.
- Leave the filter paper samples dry completely for weighing

Calculating the sediment content

Sample weight = Dried filter paper weight **–** Average filter paper weight

= Sediment weight

Data/Results:

The system was 98.22% effective in removing the sediment from the backwash water. The system also had no effect on the chlorine and pH levels of the water, as these remained exactly the same at the time of entering and leaving the tank

Conclusion: The system was extremely affective and was able to remove 98.22% of the sediment from a 500ℓ backwash to be put back into the pool, without the use of additional electricity or unsustainable filters, making it completely environmentally friendly. The process also in no way affected the chlorine or pH levels of the water, thus allowing it to be put straight back into the pool without diluting the pool levels. Lastly there is a huge environmental benefit with up to 500 000 000ℓ of water being saved weekly. This saving is also huge in comparison to the nominal cost of installing the system which amounts to a total of just R1074,00.

APPENDIX G - Example Project Report (Stealth Aircraft: Deflecting Radar)

This project report was presented at a Regional Science Expo and is used with their permission. The plagiarism Pledge was removed and minor format changes were made to save space.

Stealth Aircraft: Deflecting Radar

Using Cell Phone Technology
Prototype 2

Science Expo Project

Category 212

Report File

Information about Participants

Names: XXXXXXXX

Age: 16

School: XXXX

Grade: 10

Science Teacher within College: XXXXXXX

Region: XXXXXX

Email Addresses:

XXXXXXXXX

Source of Photo on Previous Page: http://theaviationist.com/2014/03/27/vega-31-shot-down/

Research Plan

Introduction and Research Summary

This stealth shapes expo project involves experimenting with stealth technology to see how military vehicles like planes can be made almost invisible to radar. Radar is a detection system that tracks the location, speed and direction of a vehicle or an object by transmitting short bursts of radio waves and then detecting the "echo" of the waves as they bounce off the vehicle and return. (Templeton, 2014) By measuring how long it takes for the "echo" to arrive back, and the extent of the frequency shift that may have occurred, one can track the distance to the vehicle and its velocity.

Increased stealth involves reducing a vehicle's radar cross-section, or radar signature. (Scott, 2004) This can be done using various methods, like coating the vehicle with a special radar-absorbing paint that has a matte finish or simplifying the propulsion system so that it contains no moving parts, but one of the most important techniques is changing the shape of the vehicle (although more advanced flight technology is necessary for this since a stealthy shape is often not very aerodynamic). Stealthy aircraft like the F117-Nighthawk have very flat surfaces and sharp edges, so that when the radar waves hit those surfaces and edges, they scatter away from the radar receiver. (ScienceBuddiesStaff, 2013)

In order to test this, instead of using radio waves, we will use a different kind of electromagnetic wave: light. By producing light with a LED flashlight and detecting how much is reflected off various shapes, we can replicate the radar effect accurately. (ScienceBuddiesStaff, 2013) In this project we will be testing how different shapes affect the radar cross-section, or light reflection. We will create three shapes: a flat rectangle which will be our control shape, a cylinder which will represent the curved edges more commonly found on a conventional passenger plane and a V-shape which will represent a few jagged, sharp edges between flat surfaces mostly found only on stealth aircraft.

On top of this, for each shape we will test with three materials: aluminium flashing, which represents the metal, shiny surfaces of an aircraft, typical cardboard normally found on packaging boxes (for the cylinder shape brown card will have to be used since it can bend smoothly), which represents the more matte finish of paint on an aircraft like a fighter jet, and black card, which represents a stealth paint finish – with the control shape we can confirm which material reflects the least light. We will also perform each test of the different shapes and materials 5 times and take an average of these tests to obtain the most accurate results possible. All these tests will be done using cell phone technology: we will make use of a lux meter app on an Apple iPhone to measure the light readings. This app makes use of the camera on the phone and thus with a timer it can be used effectively to carry out our project.

Project Report

Source: Lockheed Martin

Question

Which shape and material of the reflecting object will reflect the least amount of light and thus have the smallest radar cross section and be the stealthiest?

Engineering Goal

The V-shaped, black card object will reflect the least amount of light.

Independent Variable: The material and shape of the object reflecting light.

Dependent Variable: The amount of light reflected from the object.

Design Requirements

- No other light from outside sources must affect the experiment (i.e. the only light source is the LED torch)
- Each shape must be vertically upright during testing (using a protractor)
- The amount of light emitted is kept constant (i.e. always the same LED flashlight, turned off after each measurement to prevent the LED torch reaching thermal equilibrium (where the light output is reduced) from being left on too long, measurement taken immediately after torch is turned on)

- The position of all objects within the box is kept constant (including distance between torch and reflecting surface)
- Each material of a certain shape must be the same size as all others of that shape
- Each shape must be cut as precisely as possible

Materials and Equipment

- Box with completely black insides (could be made or could buy a black box)
- Black construction paper/black card (if you are making the black box)
- Packaging tape
- Scissors (glue could also be used)
- LED flashlight, with an on-off switch on the end of the handle
- Lux meter, also known as a light meter (we are using an iPhone app)
- 2x sheet of cardboard and 1x sheet of brown card, 3x sheet of black card, 3x sheet of aluminium flashing (not aluminium foil)
- Pencil
- Ruler
- Protractor

Procedures

Construction of Test Box

If you have bought a black box, skip straight to step 3.

1. Place the cardboard box upright with its opening at the top.

2. Cover all the inside surfaces of the box with black construction paper or black card. Use tape to stick the construction paper/black card to the inside of the box. Apply tape only to the back of the sheets of paper/card to avoid excessive visible tape inside the box, which could affect light scatter. Alternatively, glue it to the sides of the box.

3. Position the lux meter (we will be using an iPhone application) so that its base is resting on the bottom of the box and its back is resting on one end of the box, in the middle of that side. If the meter has a separate device showing the reading, keep this outside of the box with a small hole at the top of the box for the wire to go through.

4. Using the tips of the scissors, cut a hole just above the camera of the iPhone that is just big enough for the flashlight to fit through.

5. Insert the flashlight about halfway through the hole so that the light source is inside the box and the on-off switch is *outside* the box. With this arrangement, the lux meter and the light source should be in line with each other vertically.

6. Measure 15cm from the light source to the other side of the box, and make a mark there, since this is where you should place the front part of each shape.

Construction of Test Shapes

1. Take the brown card and create the cylinder shape by overlapping the short ends and taping/gluing them together. This cylinder should be able to stand upright in the box. Determine the height and diameter of the cylinder and keep this constant for all the shapes.
2. Take the first sheet of cardboard and create the flat shape by cutting a rectangular shape which is small enough to fit inside the box neatly. Use the same size rectangle for all the other materials. Once again keep the dimensions constant.
3. Take the second sheet of cardboard and create a V-shape by halving the piece of paper precisely and bending the sides inward. Keep the dimensions constant.
4. Follow the first three steps again, but this time using aluminium flashing and black card, supported by cardboard attached to the back for the V-shape and using a cylindrical object for support for the cylinder shape, like a drinks can or a tennis ball box.

Data Analysis

1. Using your choice of shape and material, take your first shape and place its front point on the pencil mark you made while constructing the box. If it is a V-shape then the tip of the V (the bottom of the "V") should be pointing towards the lux meter and the other two points should be parallel to the other end of the box (use a ruler to judge this). In the case of the flat shape, ensure that it is precisely at a 90º angle to the base of the box using a protractor.
2. This next part depends on what lux meter you use. If you are using an app on your phone (we use an app called LuxMeter), use the timer on the app to give you time to put the phone in the box, turn on the flashlight and then have it take the reading automatically for you. If you are using an actual lux meter device, simply put the light sensor in the box, turn on the flashlight and seal the box.
3. For the lux meter app, open the box and take the lux meter reading after the remaining time on the timer has elapsed. For the lux meter device, simply take the reading from the outside display device after the box has been fully sealed.
4. Repeat these first three steps for each different shape, and five times for each so that the readings are more accurate.
5. Now do the same with the other two materials.
6. Record your results in a table, and obtain an average for each shape and material, and put these averages in a separate column.

Acknowledgements

On top of all the references mentioned in the bibliography, we would also like to acknowledge several particular examples. Support and help from both of our parents provided considerable help, in particular with printing, obtaining the different materials and improvements to the project to achieve more accurate results. The Science Buddies website (mentioned in the bibliography) also formed a significant part of our project as it provided us with the idea to test radar signatures with light, and also provided us with valuable background information about radar in general. Finally, our science teacher, Mr Kruger, also provided some valuable insight into how we could improve our project and make it more accurate, as well as organising the arrangements so that we could compete in the expo.

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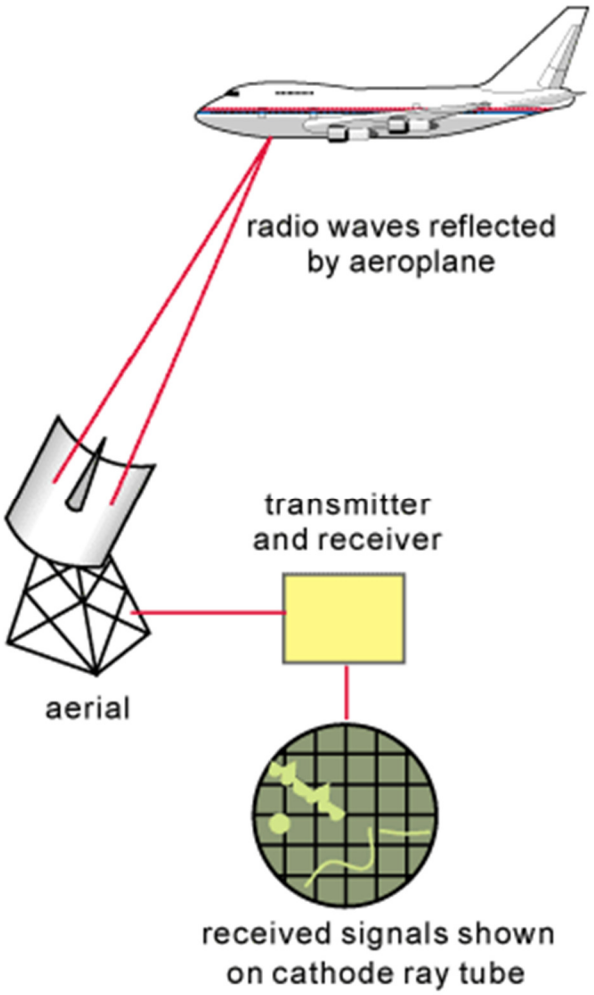


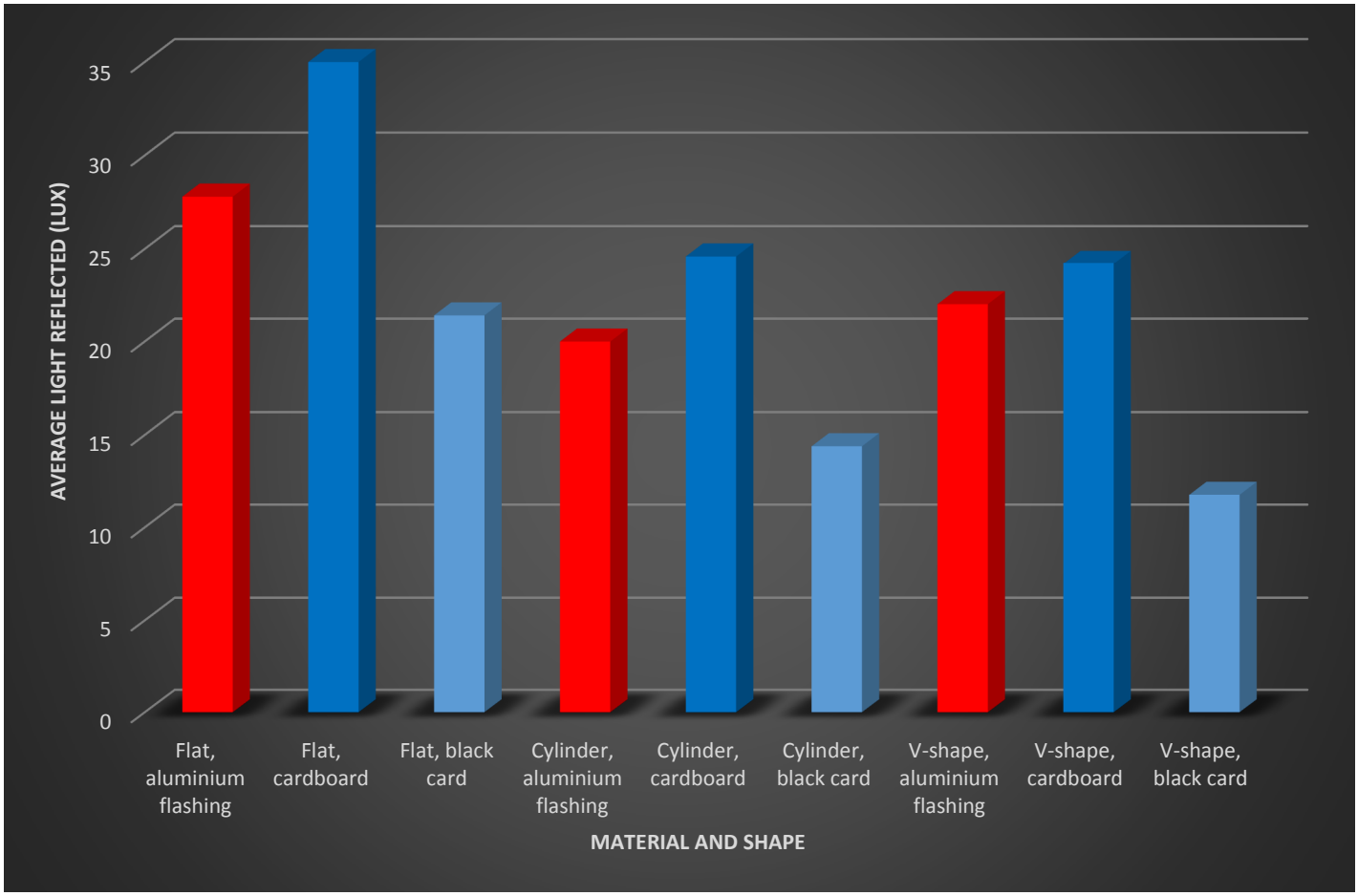
Source: http://www.hk-phy.org/iq/stealth/stealth_e.html

Results and Analysis

Table representing 5 Results and the Average Result for the Amount of Light Reflected off Various Materials and Shapes (measured by a Lux Meter) when shone at with an LED Flashlight

Material and Shape	Lux Meter Readings (lux)	Average Lux Meter Reading (lux)
Flat, aluminium flashing	28,28,27,27,29	27.8
Flat, cardboard	38,35,35,35,32	35.0
Flat, black card	22,22,20,22,21	21.4
Cylinder, aluminium flashing	19,21,20,20,20	20.0
Cylinder, cardboard	26,20,26,25,26	24.6
Cylinder, black card	16,13,14,15,14	14.4
V-shape, aluminium flashing	18,23,22,24,23	22.0
V-shape, cardboard	24,24,24,25,24	24.2
V-shape, black card	14,11,10,12,12	11.8

Graph representing the Average Amount of Light Reflected off Various Materials and Shapes (measured by a Lux Meter) when shone at with an LED Flashlight



Patterns

In terms of materials, it is definitely clear that cardboard reflects the most light, followed by aluminium foil and then black card. In terms of shapes, it is evident that the flat shape reflects the most amount of light, the cylinder shape reflects the second most amount of light and the V-shape reflects the least amount of light. It therefore makes sense that the F117 Nighthawk (a stealth bomber) and other stealth aircraft have a black, matte finish and have sharp, jagged edges, since this, as shown in the experiment, will reflected the least radar waves and scatter/absorb them more, reducing the aircraft's radar signature.

Evaluation

Although our hypothesis turned out to be correct, we experienced several unexpected results with the aluminium flashing. According to our research, the material with the most dull, matte texture would reflect the least light. Thus the aluminium flashing, being shiny and, at first appearance, more reflective than the likes of cardboard and black card, should reflect the most light. However, our results do not show this. Although black card reflected less light than both other materials, aluminium flashing, according to the averages, reflected less than cardboard. This was a confusing result at first as we identified cardboard as being more matte than aluminium flashing. After some examination and thinking, we realised that, due

to all the scratches and slightly crumpled areas of the aluminium foil, the uneven surface was, besides being shiny and not at all matte, reflecting less light because it scattered the light rays from the LED flashlight in many other directions. This was the major error in our experiment; had we used a shinier surface which was smoother and straighter, we are confident that our results would have been different. In our first prototype we used aluminium foil; now in this experiment (prototype 2) we tried using aluminium flashing, but to little avail – the surface was too matte and uneven to prove our theory right. Therefore, we experimented briefly outside of our actual project and proved our theory to be true (see below). Besides from that issue, we found that we definitely should have put more time into producing neater, more precise shapes so that we could obtain more accurate results.

Abstract

Purpose of Project

Using light instead of radar waves, to test whether a more angular shape (V-shape) which is black (similar to a stealth aircraft) will reflect less light than a curved shape (cylinder) which is shiny and silver (similar to a conventional aircraft), and will therefore have a smaller radar cross section and be more stealthy.

Procedure

Using a black box in which to test (so that no outside light can interfere), we shone light from an LED torch on one side of the box onto various shapes and materials on the other side of the box and detected how much was reflected using an iPhone app. A V-shape (sharp, angular edges), cylinder (smooth, curved sides) and flat surface (control shape to confirm which material is most stealthy) were made for 3 different materials: aluminium flashing (conventional aircraft), cardboard (fighter jet) and black card (stealth aircraft).

Results

In terms of shapes, the V-shape reflected the least light, followed by the cylinder and then the flat shape. In the case of materials, the black card reflected the least light, the aluminium flashing reflected the second least light and the cardboard reflected the most light. Thus the combination that reflected the least light was the V-shaped black card.

Conclusion

Overall, our hypothesis proved to be correct and the V-shaped black card reflected the least light; we met our engineering goal and achieved the stealthiest shape and material since this combination would have the smallest radar signature and thus be the stealthiest.

APPENDIX H – Video transcript

A GUIDE TO

JUDGING SCIENCE PROJECTS

Video Transcript

CHAPTER ONE - INTRODUCTION

Narrator

Every year for more than 30 years young South Africans have entered their projects in the Eskom expo for young scientists. Thousands of judges from around the country have had the opportunity to judge these projects. Their insight, comments, motivation, encouragement, criticism and praise have inspired those young scientists to perform every better on a regional and national level. Your contribution as a young is invalu able in the development of young scientists.

Participant 1

The judging makes me very nervous sometimes but after the second judge I kind of start feeling more relaxed and it helps me to see flaws in my projects sometimes and to better it for the future.

Participant 2

And they helped to give us advice on how to improve our projects.

Participant 3

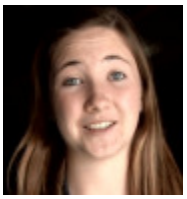
The good thing about the judging was that the really don't intermediate. They have a friendly tone that enhances the stress, I mean reduces the stress levels that are there. That makes the participants that are there really comfortable and be able to project the projects well.

Participant 4

They were able to help me with improvements on my project and also give me ideas of where I can go further with it.

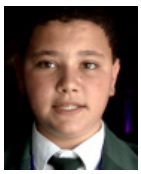
Participant 5

IT has also been really good because the judges have been helping us to think out of the box with their questions.



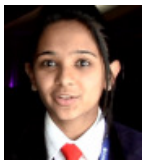
Participant 6

At first I was very, very, very nervous but as soon as the first judge came my nerves disintegrated and I was confident. The judges, they are actually friendly. I really enjoyed it.



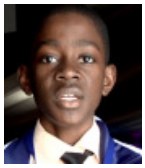
Participant 7

They also helped me widen my knowledge about my project but were also as interested in my project as I was and there was no communication difficulties.



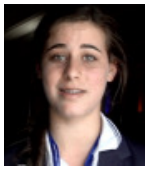
Participant 8

The judging is very nice. The judges are very friendly. They are kind. It is not like they rudely ask you or hardly ask you. They are really soft, polite, and we really love it because once the judges are soft to us we reply softly and even our hearts are calm and we reply calmly to them. What they require, the questions they ask are really direct. It is really nice to see such kind judges. So it is really motivative as well.



Participant 9

Being my first time coming to South Africa I've experienced a lot, I've learnt new things, I've made new friends, and just become exposed to collecting scientific methods and ideas as young scientists.



Participant 10

This has been an incredible experience and I truly am blessed to be here with people from all over the world, learning about their cultures and sharing a passion that we all love, science.

Narrator

This DVD is a guide to uniform standard for expert judging in South Africa and the African continent.

CHAPTER TWO PROFILE OF A JUDGE

Narrator

Profile of a judge. What qualifies you to be a judge?

Lali Dangazele

Some judges have degrees, diplomas and impressive academic qualifications. Others have none. The one quality all of them share is a passion for science.

Narrator

They all have a passion for science. But is that all you need to qualify as a judge? Judge Lalitha does not make the grade. Why?

EXAMPLE OF POOR JUDGE INTERVIEW

Lalitha

Hello

Palesa

Hello ma'am.

Lalitha

How are you?

Palesa

I'm good and you.

Lalitha

So nice my darling. Wena Palesa.

Palesa

Yes.

Lalitha

I'm Lalitha.

Palesa

Okay.

Lalitha

Is this your project, this one?

Palesa

Yes it is.

Lalitha

It's very nice. Very, very nice. It's the perfect ethanol concentration. It's very, very nice. What is ethanol?

Palesa

Well, ethanol is alcohol.

Lalitha

[Laughs]. You drink alcohol yourself, Palesa?

Palesa

No, no I don't drink it. I used it as my project as an alternative source of energy.

Lalitha

Oh, to give you energy yourself?

Palesa

No. as an alternative source of energy for cooking and lighting purposes.

Lalitha

Hmm, you're too clever. You're so clever.

[Phone rings, talks on phone]. No, I'm at an expo. Eskom. Eskom Electricity.

Excuse me, baby. So, hypothesis.

Mrs Priscilla Moodley (SA International Science Fair Director)

These young scientists are probably more nervous than you are. For them this is a serious matter. We want them to communicate with us. We expect them to be in control of the language, be eloquent and confident. Our attitude and approach is going to be instrumental

Brian Cox

It's really, really important that the learners experience a positive judging activity because the learners need to understand what happens in science outside of the school curriculum. And for many of them this is the first opportunity that they have to experience that. So a judging experience that is fair, that is friendly, that is decent gives them a positive experience. And then they go out of that and they have a more enthused outlook in terms of science. It may promote them to go into a science career. That is really important in South Africa where we have a serious lack of skills.

Ms Olga Peel

It's best to sit down when you're interviewing a child or two children that have done the project. That gives you a space in which you, the children and the project are together. If there are people close by please stop the interview and ask them to move away. It's especially distracting if any parents are around as they do tend to force the child to behave differently. You want that child to open up to you, and that's a very good thing because they have the opportunity to tell you what they've done. If there is a problem with language – and this does happen – even though expo is supposed to be done in English we do advise that interpreters are around to help if a child does not understand what you're saying. This also helps them relax because they will be tense if they don't' understand you or you don't understand them.

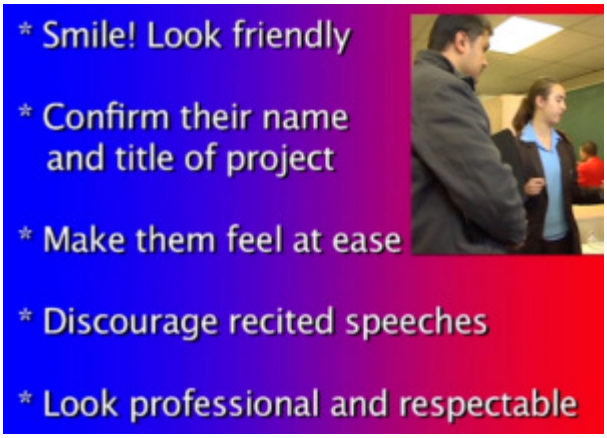
EXAMPLE OF A GOOD JUDGE INTERVIEW

Lalitha

Hi Palesa. My name is Lalitha and I'm here to chat with you about your project. Is that okay?

Palesa

Yes ma'am it's okay.



Lalitha

Fantastic. So the title of your project is "The perfect ethanol concentration". What do you mean by perfect?

Palesa

You know as a little girl when I was growing up I used to visit my grandmother in the rural areas and we would go to the kraals to collect firewood.

Lalitha

Hold on there, little Palesa, just to be a bit more specific. With regard to, for example, your hypothesis, "ethanol is the most cost-effective alternative energy source and will replace other fossil fuels such as paraffin and coal when used to heat food". Can you tell me how you tested this hypothesis?

Palesa

Oh yes. What I basically did was I did three experiments using samples of ethanol, paraffin and coal. I wanted to test which one would be more cost-effective, would burn longer and would have a bigger flame.

Lalitha

Lovely. So it was a very clear hypothesis and a reason for why you did the project. So tell me, if you could improve this project how would you basically improve? What would you do differently?

Palesa

I would improve my project by using more samples, namely solar power, hydro power and fire wood.

Lalitha

Ah, so you would increase your sample. I see. Thank you very much, Palesa, for chatting to me abut your project. It's really a lovely project.

Ms Olga Peel

If you want to judge for expo you need to be somebody who has a science background. Not necessarily a BSc but certainly have passion for science. And also you need to be able to interact with children. Expo is about the project, not about the child. So your interaction is between you, the child and the child talking about their work.

Christine Popich (Participant)

I think it's important for a judge to have respect for the work you've done in your project and the hard work and effort you've put into your project, because if a judge doesn't respect that then you won't have any confidence and they must give you a chance to explain what you've done in your project.

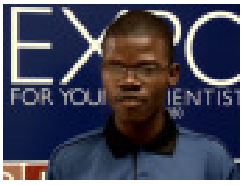
Danielle Mallabone

And I think it's important for judges to understand that we don't know as much as they do. So they need to teach us, and I think it's really important that they do teach us and engage with us.

Jayde Bromwich

The judges help me profusely. From the districts to regionals they encourage me to further my research, to change my research and to improve myself, to improve my standards. As soon as a judge showed interest in project it made me want to live up to what standards they thought that I could live up to.

Retse Monyake



Most of the judges there are certain things that they saw in my project that I could not see. And so by talking to them and actually seeing, after explaining to them they would tell you that, okay, we see this, and this and this. How about you do this, and this and this? And it actually gives you a wider perspective and it helps you to actually learn more on the project and actually improve it.

Ulrik de Meulenaere

I think the role of the judges is very important. It's good when they give you suggestions on how you can improve your project. But it is also important that they do that in a constructive manner, in a positive manner.

CHAPTER THREE JUDGING CRITERIA

Narrator

Judging Criteria. Evaluating an expo project.

Mrs Priscilla Moodley

It's important to identify the type of project you're going to judge, simply because not all projects can be judged in the same way. Different criteria need to be applied to three different types of projects, A, B and C. A, the pure science project. This type of project deals with basic knowledge and fundamental and basic truths.

Lali Dangazele

Pure scientists, however, apply the scientific method to conduct experiments or studies that test hypotheses and develop theories. Little or no regard is given to applying this knowledge to practical applications. An important aspect of this experimentation involves variables, and where possible, controlling them.

Narrator

Pure scientists like Albert Einstein with his Theory of Relativity and in our age Stephen Hawking on the creation of the universe rely heavily on mathematics and logic to formulate new theories.

Lali Dangazele

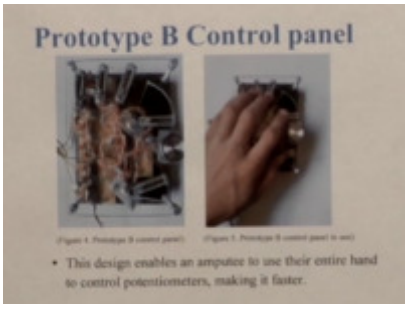
The next type of project is B, applied science project. In this type of project learners evaluate and develop innovative devices in technology, engineering or computers. Scientific laws and relationships are applied to human needs.

Narrator

Innovative ideas and inventions will sometimes be found in this type of project. The applied sciences category also includes biological and human sciences.

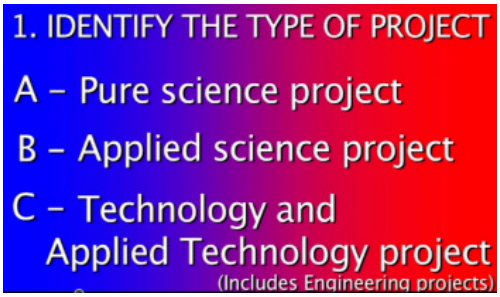
Mrs Priscilla Moodley

The third type is C, technology and applied technology like engineering. Technology and applied technology is the application of pure and applied science knowledge to meet a specific user need, like this one that demonstrates the development of a useful technology using a systematic design build and test process. In this project engineering aims and goals are clearly set out.



Narrator

It is important to identify the type of project. Is it A, pure science, B, applies science, or C, technology and applied technology like engineering. After we have identified the type of project we look at originality.



Lali Dangazele

The project you are judging should be original. It should be the participant's own idea and not somebody else's.

Mrs Priscilla Moodley

Ask the question, does the learner refer to background reading? Is the learner's approach original? What about the use of resources and depth of planning? Did the learner conduct a proper investigation with repeated testing?

Lali Dangazele

To repeat an experiment from the school syllabus or to choose a problem to which people already know the answer is not original and therefore not acceptable as an Eskom Expo project.

Mrs Priscilla Moodley

Other projects that are not acceptable are those that could be dangerous to the learner or others.

Lali Dangazele

Here's an example of one.

Scientist

Let's connect this one. Enter. Hato potato!

Narrator

That obviously was a staged experiment to demonstrate the possible dangers of experimenting. So do not choose a project that could be dangerous to yourself or others. And do not choose a project that involves any experiments on insects, live animals or humans or a project that involves collecting plants or animals that are protected by nature conversation laws.

Lali Dangazele

Any project on insects, live animals and humans must be done under the supervision of a qualified scientist. The same applies for projects that involve collecting plants or animals that are protected by nature conservation laws.

Prof Ian Jandrell

Because the Eskom Expo for Young Scientists is targeted at young learners at school and because members of the public including young children can view these projects we steer clear of projects that deal with illegal activities. So again if you see a project which deals with an illegal activity which we haven't

picked up, please do draw that to the attention of the ethics committee.

Narrator

Now let' evaluate the scientific method.

Mrs Priscilla Moodley

Most Eskom Expo projects are A type science projects and need to be executed with the scientific method in place. Is there a clear statement of the problem? Is there enough data to support any conclusion? Is there a value scientific method through which the problem was pursued?

Lali Dangazele

In applied science projects like engineering projects different steps are followed that refer to engineering goals, the development process and the evaluation of the improvement.

Mrs Priscilla Moodley

Then there are mathematics projects that focus on proofs, solving equations, explaining existing phenomena or proving new concepts and ideas.

Lali Dangazele

Whatever the category that the project is listed under it needs to be executed through a method that proves the validity of the results.

Narrator

Written Communication.

Lali Dangazele

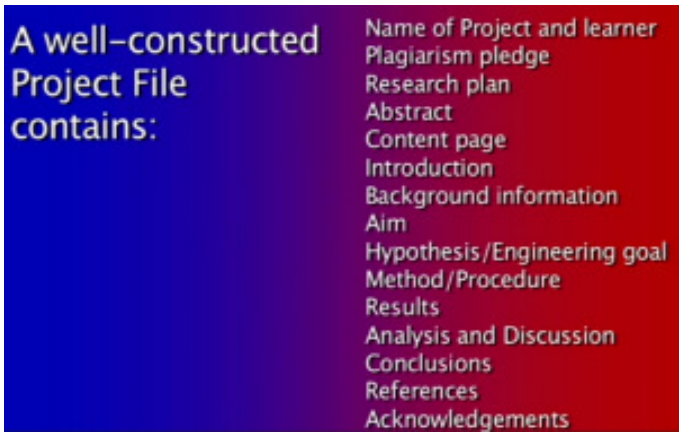
The written work is what we see in the files and of course on the posters.It consists of a project data file that contains the rough work, showing what was done when, where and how. A report file also known as a project file, such as this one, is a neatly laid-out file with information laid out on the content in neatly labelled sections. And the poster, which is the show piece of the project, has to make an impression and capture the attention.

Narrator

What are we looking for in the project data file or journal?

Mrs Priscilla Moodley

In the project data file or journal the learner has to record all the work that has been done from day one to the end. Hand-written notes, emails, discussions, interviews, designs and plans, copies of articles or web pages, and a record of all survey questionnaires.



Lali Dangazele

It's a bit like a notebook and a diary combined. And as it goes, notebooks and diaries are not always tidy.

Mrs Priscilla Moodley

The information in the data file will give you a clear indication of the effort the learner has put into the project. It is the single most important document of the project because it is from the data collected in this file that the report file can be created.

Narrator

What are we looking for in the report or project file?

Mrs Priscilla Moodley

At the front of the report or project file you need to find a research plan and a standardised plagiarism form issued by Eskom, Expo for Young Scientists which has to be signed by the learner.

Prof Ian Jandrell

Now, your research plan is a very important document because it shows that you've thought about what you're going to do. Therefore your research plan must be written in the future tense and the plan must be included as part of your project file.

Narrator

Well, if you use another person's words or ideas and pretend that they are your ideas that is plagiarism. It is also stealing or borrowing another person's work or paying another person to write your assignment. And if you copy directly from a source

without referencing the original source that is fraudulent. So is presenting false data.

Mrs Priscilla Moodley

When the plagiarism form is in place and signed the learner has committed to an honest piece of work.

Lali Dangazele

Then there is the abstract

Prof Ian Jandrell

The abstract is probably the first part of the project that you as a judge will read and it is probably the last part of the project that the learner wrote. The abstract is a very short, concise summary of the work. It will explain why the project was done, how the project was done, what the final discovery or conclusions drawn were and it may even mention what extension to the work can take place. But the key thing about an abstract for me is did the abstract entice you as a judge to actually read the rest of the project? Did the abstract convince you that the work you are going to read about was in fact valuable?

Mrs Priscilla Moodley

There has to be a content page. It has to be there to make it easy for the reader to navigate through the report file.

Lali Dangazele

The introduction will tell you why the work has been done and give you some background research on the topic. You're looking for evidence of background research that is summarised in the report with articles in the appendix. In the introduction the learner focuses on the question or problem and has included supporting evidence.

Mrs Priscilla Moodley

The aim. What does the learner want to achieve in this project?

Lali Dangazele

This is followed by the all-important hypothesis.

Mrs Priscilla Moodley

Or in the case of the engineering project, the engineering goals.

Lali Dangazele

Of course. The learner has to make a statement on what is going to be tested. What question needs to be answered? It obviously goes hand in hand with the aim, correct?

Mrs Priscilla Moodley

It does.

Lali Dangazele

It does. I think so.

Mrs Priscilla Moodley

The method deals with how the experimentation is to be done. It includes the independent, dependant and fixed variables. It must be written in the third person. The scientific method used should be so clear that anyone anywhere could carry out the experiment or innovation by following the learner's method and come to the same conclusion. Remember good science is repeatable.

Lali Dangazele

You can repeat that, Priscilla. The next section is results. The result of the investigation over here is the overview of the data that has been collected. Data is put in order and clearly displayed in tables and graphs.

Mrs Priscilla Moodley

The results need to be analysed. The learner must describe observations and findings.

Lali Dangazele

The next section is discussions, error and modifications. In this section learners discuss the patterns and the trends and why they may have happened. The learner should report what went wrong, what errors were made if any, and why it went wrong and what could be done to improve the project.

Mrs Priscilla Moodley

That brings us to the conclusion. They are the outcome of the project and the answer to the question that was posed at the beginning. Conclusions refer directly to the aim and hypothesis. Results will be included to support the conclusions.

Lali Dangazele

And right at the back we have references and acknowledgments. The project needs to contain a detailed list of books, magazines,

web pages and publications that were consulted and it must be properly set out.

Mrs Priscilla Moodley

And finally the learner has to acknowledge the people consulted and who helped with the project. The learner has to indicate the extent and nature of help received.

Lali Dangazele

And that concludes the content of the report or project file.

Narrator

A well constructed project file contains name of the project and the learner, plagiarism pledge, the research plan and abstract, a content page, introduction, background information, aim, hypothesis or the engineering goal, method or procedure, results, analysis and discussion, conclusions, references and acknowledgements.

Lali Dangazele

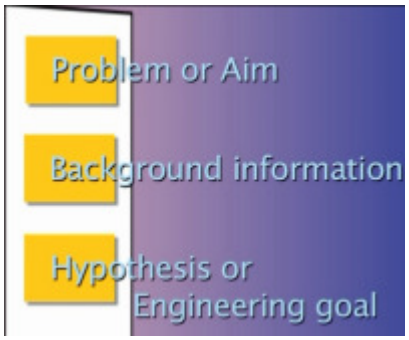
Next up is the poster and display.

Narrator

And what are we looking for in the poster and the display?

Lali Dangazele

This is a typical display set-up which you will find at the international science fair or the ISF of the Eskom Expo. The standard display boards provided at the ISF are one metre high



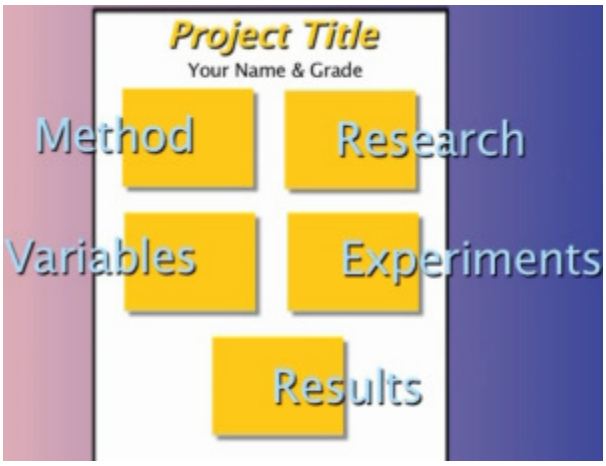
with a middle panel of 1.5 metres wide and the left and the right panel are 50 centimetres each. So if the learner uses all three sides of the display board there will be plenty of space. A typical layout for the display board would be on the left panel the problem, the introduction as well as the aim of the project and the hypothesis.

Mrs Priscilla Moodley

When it is an engineering project that would be the engineering goal. Also on the left panel could be background information.

Lali Dangazele

On the middle panel, the title of the project and the name of the learner or learners, the method or procedure including the variables, dependant, independent and fixed variables. The results must be illustrated with colourful tables, diagrams or graphs as this learner has done. Photos and drawings can be added as well, as we can see.



Mrs Priscilla Moodley

But take note, if photographs of people are used written permission to display the photos has to be obtained. On the right panel analysis and discussions of results and interpretation, followed by conclusions and acknowledgements.

Lali Dangazele

The learner has to use their imagination and creativity to make the display board visually exciting, as long as the information on it is clear and laid out in a logical order. On the table apparatus and items used in the investigation can be exhibited to enhance the display.

Mrs Priscilla Moodley

The report or project file and the poster boa rd must be represented in a scientific language. It has to be typed without spelling mistakes. The information has to be presented with clear and suitable headings.

Lali Dangazele

The information in the report file has to be presented in a logical order. Is there a clear statement of the problem? Is there a clear experimental progression? What data analysis was performed and was it effective? Is there enough data to support any of the conclusions and is there a valid scientific method through which the problem was pursued? The poster summarises the project in an exciting visual way to capture the attention. Colour, contrast as well as composition are useful tools to enhance the presentation.

Mrs Priscilla Moodley

The poster layout shows a logical flow progressing from left to right. It includes the title and the participant's name, the problem, background information, the aim and hypothesis. It also includes the method and displays important results through graphs and diagrams. It contains a short discussion of the results and highlights the conclusion. And finally it acknowledges people and institutions that have assisted in the creation of the project. This visual presentation can be enhances with photographs, illustrations and relevant items.

Lali Dangazele

Through the display you will recognise the creativity of the participant. But keep in mind, a beautiful, expensive display does not automatically imply a good scientific project.

Narrator

Oral communication

Mrs Priscilla Moodley

It is your positive and encouraging attitude as judge that is going to be a factor in the ability of the learner to communicate freely. The interview is aimed at establishing the participant's understanding of the topic, the originality and thoroughness of the scientific method and experimentation.

Lali Dangazele

The participant is confident and the presentation is exciting and stimulating. The participant is enthusiastic about the project and explains it in a logical and well organised way.

Mrs Priscilla Moodley

Is the participant aware of any limitations? Is the learner fully aware of the possibilities for expanding the project? Is the participant knowledgeable about the scientific method being used? Does the learner have sufficient background information on the topic? These are the questions you need answers for.

Lali Dangazele

The participant speaks coherently about the work done and is verbally fluent. The participants should be able to listen to your questions and respond clearly and intelligently. The delivery is totally audible with varying intonation. And the learner uses appropriate scientific language and vocabulary in the oral presentation.

Mrs Priscilla Moodley

Tell me, how did you come about your hypothesis?

Learner

Well, the pelargonium zonale is the progenitor of most pelargoniums throughout South Africa and the world, and more than ten species of pelargoniums are on the list of endangered plant species. Then I would like to find out if the pelargonium zonale progenitor would also become an endangered specie.

Mrs Priscilla Moodley

Okay. What have you learnt from this project?

Learner

I learnt much more about the indigenous plants of South Africa. And the vertical down force of the pelargonium seed has also never been measured, so I did something that has never been done.

Lali Dangazele

The learner looks good, is in control and has a positive attitude while presenting the project and when answering questions. There is little nervousness visible. The learner has good manners and is respectful.

CHAPTER FOUR ETHICS AND SAFETY

Narrator

Ethics and safety.

Lali Dangazele

Although ethics is not part of your judging mandate, it is an all-important part of the project display and presentation. Members of the ethics committee will do the ethics check.

However, there are a few dos and don't that we have to pay attention to. Professor.

Prof Ian Jandrell

The Eskom Expo for Young Scientists takes ethics in research extremely seriously. And therefore at all of the science fairs there is an ethics committee whose responsibility it is to in fact confirm that the learners have complied with the ethics of the Eskom Expo for Young Scientists. As part of the process each learn would have been asked to complete an ethics checklist. And this checklist deals with a number of things including, for example, whether living organisms such as animals, plants, fungi or bacteria have been used in the project. Agar plates or other growth mediums, human or other animal parts, dangerous chemicals and so on. However in some cases they may miss something. And as a judger we would ask that if you see any part of a project, any element of a project or any part of a display that you believe could be an ethics violation that you immediately draw that to the attention of the ethics committee. The Eskom Expo for Young Scientists also takes the safety of the project very seriously. There are many reasons for this, but one of the reasons is that the learners and the public are exposed to these displays, and of course many of the members of the public are very young kids who may touch and fiddle with things. And although a safety check would have been done, we would ask that as a judge if you see any project which you think is unsafe or poses a hazard to please draw that to the attention of the ethics committee.

CHAPTER FIVE JUDGING TOOLS

Narrator

Judging tools.

Lali Dangazele

Before the judges go on the floor they attend a workshop where judging processes are clearly explained in great detail. Projects are divided up according to your area of specialisation, and where necessary new judges can be paired off with experienced ones.

Brian Cox

In the workshops we train the judges to interact with the learners in a friendly and respectful manner to respect the effort

the learners have gone through to produce their project and also to make them feel comfortable. And we also train them to be absolutely fair and unbiased in every aspect of the judging, which includes looking at the written work, it includes looking at the scientific ability and the scientific method and the creativity that the learner has applied while doing their project. The judges are required to follow a very strict series of steps in terms of their judging process and that is confined by the judging sheet. The reason for that is in order to ensure fairness and in order to ensure that each learner is judged in the same way with the same set of standards regardless of the project that they've entered, because over 25 different categories of science there is a remarkable variety in what the learner could be doing. And the only way to control the fairness is to obey those rules.

Mrs Priscilla Moodley

Following the guidelines on the assessment sheet will make your life much easier and will ultimately result in a uniform judging standard.

Lali Dangazele

So how does it work?

Mrs Priscilla Moodley

There are three main sections to the scoring sheet. Section one, value of project. Section two, written communication. Section three, oral communication. Section one, value of project, gets a mark out of 50. Section two, written communication, gets a mark out of 30. Section three, oral communication, gets a mark out of 20. This will give you an initial total out of 100.

Lali Dangazele

That sounds exciting. I definitely want to be a judge. So can I start? I'm ready for section one.

Mrs Priscilla Moodley

Good show. It says here, to assess value of project start with the vertical axis and move over the horizontal axis. First of all you have to know what kind of project you are dealing with. Is it A, pure science?

Lali Dangazele

Pure science has to do with the basic knowledge and fundamental principles, correct?

Mrs Priscilla Moodley

You know your science. Yes, pure science focuses on learning more about the world we live in by improving our knowledge at a fundamental and basic level. B, is it an applied science project?

Lali Dangazele

That's the development of innovative ideas and inventions.

Mrs Priscilla Moodley

Spot on. Or C, it could be a technology and applied technology project.

Lali Dangazele

That has to do with the development of a useful technology using a systematic design, build and test process. That then also includes engineering projects.

Mrs Priscilla Moodley

Yes. And it states here the criteria below refers to specific kinds of projects as listed above.

Lali Dangazele

That means that each one of these three types, A, B and C, has its own specific judging criteria.

Mrs Priscilla Moodley

Yes.

Lali Dangazele

That is why it is so important to first identify the type of project you are going to judge.

Mrs Priscilla Moodley

Keep in mind the project you are looking at could be a combination of A, B and C. Let's get back to the assessment sheet, Lali. In the vertical axis it says scientific method.

Lali Dangazele

So what am I looking for?

Mrs Priscilla Moodley

Okay. Application of scientific method, range of investigation, results, analysis and conclusions.

Lali Dangazele

I see. And still on the vertical axis we have the different levels to rate the scientific method of the project. So for example level one would rate the project as poor, level two is fair, level three is good and level four is excellent. And then each one of these levels refers to an A, B or C type project.

Mrs Priscilla Moodley

You got it.

Lali Dangazele

Fantastic. So let's say I'm judging a type B project which is the applied science one. I noted that there is a new solution to the problem after prototyping and testing, and there is an analysis of the observations and investigation and quite good use of graphs and statistics. That means that I rate the science project as a level three, which is good. From level three I move horizontally under the heading originality.

Mrs Priscilla Moodley

Correct. Under the heading originality you have to decide the learner is able to think and act independently. This refers to background reading. The learner has an original approach and makes good use of resources. The learner shows depth of planning and execution of the investigation. Your judgement will rank him in column rank one, rank two, rank three, rank four.

Lali Dangazele

I think I understand, Priscilla. So let's say I find a project that shows a novel approach, which shows resourcefulness and creativity throughout the project. That would fit the rank four column, excellent. So where the level three row and the rank four column meet is the single block that gives me a choice of six marks.

Mrs Priscilla Moodley

The mark you choose goes straight into section one at the top of your scoring sheet.

Lali Dangazele

That's easy enough. I really want to do it. I think this project is work 41.

Mrs Priscilla Moodley

That's it. You have done with section one, value of project.

Lali Dangazele

Next up is section two, written communication.

Mrs Priscilla Moodley

There are three important documents to consider. The report or project file, the poster and the data file or journal.

Lali Dangazele

This is the file with all the information about the project. It needs to be very neat and logically organised. Let's see, is there a research plan? Yes. And the plagiarism sheet is in place? That is there as well. This is important because it tells us that the participant has done an honest piece of work.

Mrs Priscilla Moodley

Equally important is the abstract. That is basically a summary of the project.

Lali Dangazele

Yes, here it is, two paragraphs.

Mrs Priscilla Moodley

As long as it does not exceed 250 word. Is there evidence of background research in the file?

Lali Dangazele

Yes, there is. It gives us an indication of how much reading up on the subject the learner has does. The introduction includes the question, problem statement with supporting evidence. That's how it should be done.

Mrs Priscilla Moodley

Apart from being neatly laid out the information should be legible and presented in scientific language with suitable headings and no spelling mistakes.

Lali Dangazele

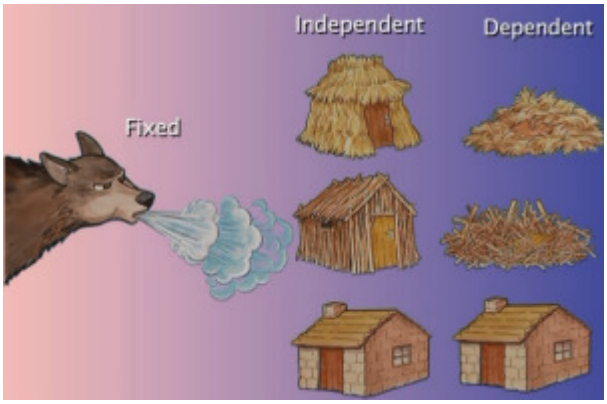
Is the aim and hypothesis and/or engineering goal of the project reflected in the report and on the poster?

Mrs Priscilla Moodley

Variables. Fixed, dependant and independent variables need to be identified in the report and on the poster.

Narrator

Here follows a simplified example that explains dependant, independent and fixed variables. Piggy one is independent. He



has built a house of straw. That's the independent variable. The wolf comes along and blows. The result is the straw house is destroyed. That's the dependent variable. Piggy two builds a house of sticks. That again is the independent variable. The wolf with the same strength of breath blows. The result is the stick house collapses. That's the dependant variable. The third part of the experiment is piggy three who builds a brick house. That's the independent variable again. The wolf with the same strength of breath blows. The result is that the house stays intact. That is the dependant variable. So in our experiment the different houses are the independent variables. What happens to them are the dependant variables. And the constant or fixed variable is the wolf's breath because that stays the same throughout the experiment.

Lali Dangazele

And when it comes to results we want to see full observations in the report file with findings presented in tabular form and in graphs. On the poster these can be summarised, but always scientifically and mathematically correct.

Mrs Priscilla Moodley

The analysis of the result is very important. Findings and graphs need to be explained in words more extensively in the report than on the poster.

Lali Dangazele

And to take the research a step further, a discussion of the results should be included. Patterns and trends are noted and explained, anomalies and limitations noted and clarified, to demonstrate that the participant is serious about the project and has included future possibilities of research in the report.

Mrs Priscilla Moodley

Both the report and the poster reflect the conclusions. They need to be valid based on the results and findings and linked to the aim and hypothesis or engineering goals.

Lali Dangazele

References are only entered in the report. Reference of books, magazines, internet addresses, articles and so forth, all given in the correct format. So what is the correct format, Priscilla?

Mrs Priscilla Moodley

For books the author's surname and initials, year of publication, title of the book – that needs to be underlined – where it was published and by whom it was published.

Lali Dangazele

So that's different from magazines and the internet. It also needs to show the author's name and initials and the year of publication. Then we need to have the title of the article, the title of the journal underlined, the volume and the pages from where the learner found the information.

Mrs Priscilla Moodley

Finally, it is important to find the depth of adult assistance that has been received and how this assistance has been used. That information we should find in the acknowledgement.

Lali Dangazele

Why is that so important?

Mrs Priscilla Moodley

Assistance from parents, teachers and specialists is acceptable. They can act as mentors to the learner, but must not display their own scientific knowledge and skills. The participant should have done the practical work themselves.

Lali Dangazele

As mentioned earlier, the poster board summarises the project. It has to make an impact and capture the attention. It is the difference between walking past and being drawn to it. This is neat and well laid out, I would say. The participant has made use of colour coding to enhance the display. There is a clear, logical flow in the presentation and it is all there, the problem, the background, the hypothesis, background information, a clear method is displayed with important results captured in graphs as well as the discussion of the results and the conclusion. I would give this a good mark.

Mrs Priscilla Moodley

The last item to mark is the project data file. It contains the rough work with original data sheets, handwritten notes, emails, discussions, interviews, designs and plans, copies of articles or web pages, and a record of all survey questionnaires.

Lali Dangazele

All the criteria we have mentioned is set out on the scoring sheet right here. Has it been done or not? Has the student met the criteria? And how do you rate the learner's performance. Again it has been made quite easy for you. For each of the criteria on the rubric you give a mark between zero and two. Zero is for not done or not present. 0.5 is poor. 1.5 is good and 2 excellent. I give a mark for each of the criteria, and when I add them all up I get 23.5. That result can go straight to section two at the top of the scoring sheet.

Now on to section three, which is oral communication skills. The criteria on the rubric are marked with the same system from zero to two. The first criteria is capture of interest. Is the learner's presentation exciting and stimulating or is the participant just trying to get it over and done with? Enthusiasm and effort is the second one. Here what we want to know is was there lots of enthusiasm in the presentation? Did the learner make a worthwhile effort to explain things about their project?

Mrs Priscilla Moodley

It often happens that the learner explains just as far as what has been learnt off by heart. That would not deserve a good mark. The next one we come to is voice and tone. Very important. To communicate and make contact the learner has to speak up, be audible and clear.

Lali Dangazele

May I chip in here Priscilla? So to be able to do this you have to put salt and mix it with water...

Mrs Priscilla Moodley

Thank you, Lali. That gives you a mark of 0.5 on my sheet. The next thing is I'm seeing you have a lot of self confidence. So we are coming to self confidence and body language. Is the

participant confident about the project or battling to keep their nerves under control?

Lali Dangazele

The next section is scientific language. Now, it is a science project executed according to a scientific method, and therefore the learner has to use appropriate scientific language and vocabulary and be verbally fluent.

Mrs Priscilla Moodley

The next one we come to is response to questions. Your questions need to be answered. Too often learners simply ramble on without listening to the questions. They need to respond clearly and intelligently.

Lali Dangazele

And this is done through the presentation of the project. The learner takes the initiative when presenting the project to you as the judge. It need to be done in a logical manner and well organised way without reciting or reading of notes and things like that.

Mrs Priscilla Moodley

Although the participants all want their project to be just perfect, the learner needs to be fully aware of the limitations and can explain the reason for it. Following that the learner would have suggestions for expanding and improving the project.

Lali Dangazele

And lastly, authenticity. The learner takes complete ownership of the project and integrates assistance received in their answers to questions, can demonstrate all the methods and techniques used. It is important to find out the amount of adult assistance received, how this assistance has been used and to ask questions.

Mrs Priscilla Moodley

A mark between zero and two for each criteria is entered in the right-hand column. The sum of these marks, let's make it 13, is entered in section three at the top of the scoring sheet.

Lali Dangazele

So if we add up these three scores from section one, two and three we enter the result in the block that says initial total. So it would be 41 plus 23.5 plus the 13 which gives us 77.5. But then we can just round that off to 78.

Mrs Priscilla Moodley

That's a good mark. The block next to your initial total is marked final total.

Lali Dangazele

But why would my initial total change?

Mrs Priscilla Moodley

Let's have a look at how the judging process works.

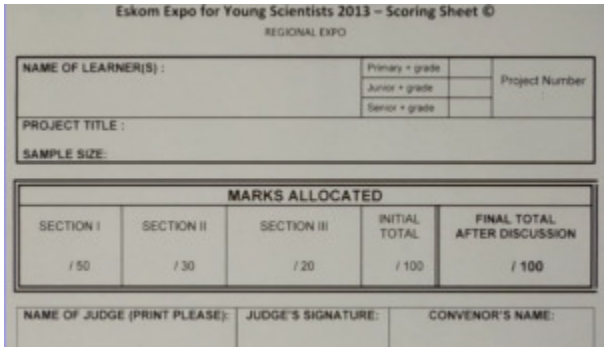
CHAPTER SIX JUDGING PROCESS

Narrator

Judging process.

Olga Peel

When you judge at Expo you aren't ever judging on your own. You always judge as part of a panel in charge of a category or several categories. There are at least two judges for every project. And to ensure that we've got a good standard we judge separately for the pre-judging and for the interview. Once the Expo is over or after the judging is over then the judges get together, discuss the results and finalise


Eskom Expo for Young Scientists 2013 – Scoring Sheet ©

REGIONAL EXPO

NAME OF LEARNER(S) :

Primary + grade

Junior + grade

Senior + grade

Project Number

PROJECT TITLE :

SAMPLE SIZE:

MARKS ALLOCATED

SECTION I	SECTION II	SECTION III	INITIAL TOTAL	FINAL TOTAL AFTER DISCUSSION
/ 50	/ 30	/ 20	/ 100	/ 100

NAME OF JUDGE (PRINT PLEASE): | JUDGE'S SIGNATURE: | CONVENOR'S NAME:

them. If you look on the judging sheet you will actually see there is an initial total and the final total. The final total is after discussion. The judging panel can be led by conveners or a judges committee, and they are the people who will manage the whole process of deciding on the awards. Once that discussion is over the decisions are finalised. Expo says this: the chief judge's

decision is final. This means you cannot go back afterwards and query the decisions, because all judges had a chance to give input on the final results.

Brian Cox

The convener's role is one of team leadership and in a sense a management function. They are there to ensure that all the judges are allocated specific projects and also as an interface between the judges and the committee. They are all very experienced judges themselves and they have the ability to perform the admin tasks that are required. They are the ones that the judges will turn to if there are any concerns that need to be raised.

Olga Peel

If you have a problem while pre-judging call your convener. His or her job is to sort out things like a project in the wrong category, mistakes, plagiarism and any other ethical issues. And that's exactly what they will do. They will wander around looking at the projects, chatting to you, and help you make sure that you are judging confidently. At the end of the judging process you will take your judging sheets and sit in a panel with the convener and the other judges from the category and finalise the results. This is the time when you fill in the judging sheet, you finalise everything, and then your judging experience is over. The convener then has to hand the results in, making sure that they are all completed with all of the judging sheets. So their management experience carries on after the judging process. Just remember that you need to interact with your convener rather than with other judges or the judging committee until your job is finished.

Brian Cox

As you can see there is a vast amount of support for the judges from the new judge workshops, through to the meeting before the actual event, meeting with your conveners, the assistance the conveners provide and of course with us on the committee standing by looking out for any concerns. Judging is a great experience and we really encourage everybody to participate.

END OF TRANSCRIPT