

# Systems Engineering Decision Making May Be More Emotional Than Rational!

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**Annotated Briefing**  
**Refer to Notes Pages**



# Abstract

## The Issue

### Introduction

- Abstract
  - Do systems engineers decide rationally or emotionally?
    - Survey result: **Most work-related decisions are made rationally but many, more emotionally than one might think.**
- Introduction
  - Descartes was wrong! (Antonio Demasio)
  - We operate on our subconscious; **make decisions emotionally**; and are happy through relationships. (David Brooks)
  - Hypothesis: **Systems engineers would say decisions are made rationally**; and because it was **politically correct**.
  - Most I spoke with acknowledged emotional content.
  - Were survey responses genuine? Some agonized!

# The Invitation

## Decision Making Survey Invitation

- Decision Making Survey Invitation(s)
  - 20 minutes to complete
  - Excel format
  - Voluntary
  - Partially, if uncomfortable
  - Treated confidentially; reported in aggregate
- 468 requests sent
  - 60 respondents
  - 14.5% response rate

# The Survey

## Questions (1/3)

- Q1) In your most recent project/program where systems engineering played a significant role, to what extent do you remember decisions being made based on reason vs. emotion, and how often was that?
  - Technology
  - Economics
  - Operations
  - Politics
  - Regulations
  - Programmatic Aspects
  - External Factors
  - Personal Factors
- For each part select one **(R, E) pair**
  - Primarily Rational: (R=100%, E=0%)
  - More Rational: (R=75%, E=25%)
  - About Equal: (R=50%, E=50%)
  - More Emotional: (R=25%, E=75%)
  - Primarily Emotional: (R=0%, E=100%)

## Questions (2/3)

- For each part select one **Frequency**
  - Almost Never: 1
  - Some Times: 2
  - Half Times: 3
  - Most Times: 4
  - Almost Always: 5
- Q2) In your personal life how would you characterize your own decision making?
  - Budgeting
  - Career
  - Entertainment
  - Family
  - Job
  - Recreation
  - Relationships
  - Shopping
- Q3) After having thought about and filled out this survey, characterize your planned overall future decision making.
  - Work Life
  - Personal Life

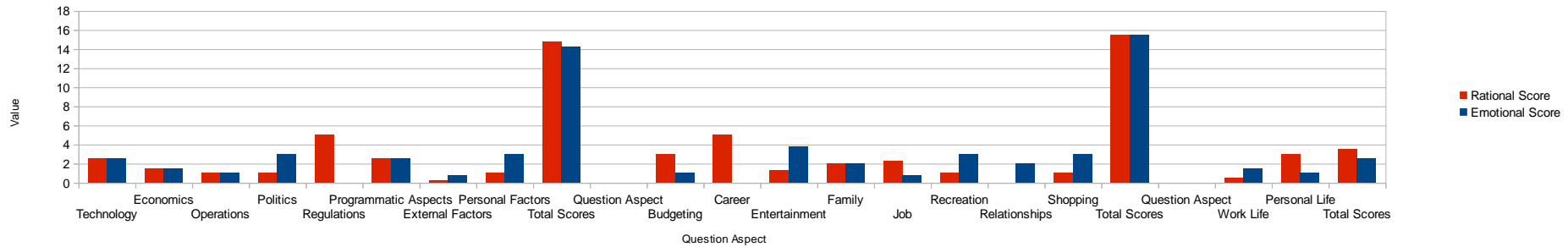
## Main Portion of Excel Spreadsheet Survey Showing Hypothetical Ratings (note Xs) (Figure 1)

Question			Trade-Off					Frequency				
	Question Aspect	Rate the Decision:	Primarily Rational*	More Rational*	About Equal	More Emotional**	Primarily Emotional**	Almost Never	Some Times	Half Times	Most Times	Almost Always
In your most recent project/program where systems engineering played a significant role, to what extent do you remember decisions being made based on reason vs. emotion, and how often was that?	Technology				X							X
Please read the "mouseover" Comments on all three basic questions and the Question Aspect of the above Question. Also, note the two footnotes under Rational and Emotional.	Economics				X					X		
	Operations				X				X			
	Politics					X					X	
	Regulations		X									X
	Programmatic Aspects				X							X
	External Factors					X		X				
	Personal Factors					X					X	
In your personal life how would you characterize your own decision making?	Budgeting			X							X	
	Career		X									X
	Entertainment					X						X
	Family				X						X	
	Job			X						X		
	Recreation					X					X	
	Relationships						X		X			
	Shopping					X					X	
After having thought about and filled out this survey, characterize your planned overall future decision making.	Work Life					X			X			
	Personal Life			X							X	

## Scoring (1/3)

- Each **(R, E) pair** was multiplied by **Frequency (weight)**.
- For example, More Rational and Most Times yields  
 $((R=75\%) \times 4, (E=25\%) \times 4) = (3, 1)$
- Larger R (E) score, more rational (emotional) decision
- R and E scores totalled for each **question**
- Array of any respondent's scores can be displayed in bar chart (next chart)
  
- All total scores for Row  $i$  were divided by number of respondents,  $N_i$  of Row  $i$ , to obtain average score

Detailed Results of Hypothetical Response





- Blank rows **not** scored; would bias results
- R or E score **variance** about **balanced** score =  $(\text{avg. row score} - 1.5) \exp(2)$
- **Standard deviation** =  $\sqrt{\text{variance}}$
- Nominal (with **balanced** selections of About Equal (R=50%, E=50%) and Half Times, Weight=3) total scores over
  - 8 rows of **Questions 1 and 2** is  $(50\% \times 3, 50\% \times 3) \times 8 = (12, 12)$
  - 2 rows of **Question 3** is  $(1.5, 1.5) \times 2 = (3, 3)$

# Helpful Survey Feedback from Some Respondents

## Pilot Survey

- Despite detailed instructions, there was considerable **confusion**.
  - Trade-Off columns were changed to **precede** Frequency columns.
  - Some were confused by **hypothetical** example.
  - **Fundamental questions**
    - What was behind survey?
    - Could it be completed with integrity?
- One colleague had lots of problems which we discussed.
  - He helped me simplify instructions.
  - But **he never completed the form!**
- Another colleague responded but only after interchanges
  - She suggested another category, “**intuitive**” or “**spiritual**”.
  - She explained logical means of postulating criteria and options and then doing trade study; this was rational.
  - She described spiritual but that was emotional.
  - So I stuck to **rational** and **emotional**.

- Several had significant **philosophical** problems.
- One declined to complete Questions 2 and 3, saying **only Question 1 was “relevant”**.
- One omitted **Economics** row saying that “was intentional.—I couldn't give **honest** responses. ... it is sometimes difficult to choose the correct response, instead of the response that reflects your **image of yourself ...**”
- One thought survey was **too analytical** and **needed discussion**.
- Dozen respondents provided **pithy and telling** comments
  - “... an **irrational desire for a technology to be mature** may sway the decision.”
  - “**Showing the program on cost was more important than showing program progress. ...**”
  - “**Operations needs are unknowable unknowns ...**”

## Main Survey (2/3)

- “Rational politics is an oxymoron.”
- “... all decisions about what [system] should do and not do is based on the emotional ... feeling of the seniors.”
- “... Chief Engineer has to apply experience (gut feeling) as often as not in decision making to make it all work out.” “Program managers consistently tried to present decision makers information they thought the decision makers wanted to hear.”
- “... Classical SE ignores any concerns other than interfaces with externals and always all externals are considered static.” “... if the system doesn't do x, then the user will do y some other way.”
- “... most positions were filled on the gut hunches of the hiring authorities ...”
- Another showed angst
  - ... decisions are based on reason, but often on the wrong reason. E.g., promoting your career rather than what is best for the project, or, with an eye to the next election, considering only short-term effects rather than whole-of-life.  
... he specified Most Times for every Frequency

- Another (who chose not to complete the survey) showed more anxiety
  - I am **constitutionally unable to cope with surveys**. ... **rational decision making is not a reality**. Do you think you can get people to answer this survey in any way **honestly**?\* Maybe a few, but I **doubt the predominant replier is going to know, let alone share, the extent that emotion biases and dominates**—all with of course rational post-decisional trappings.
  - ... **all “stories/theories”** developed are based on **selective remembering** of the facts that support the desired world view. ... individual's response is always a mix of rational and **irrational**. [(Douglas 2011) suggests that if one has difficult choices to make, **a heavy dose of irrationality may be just what you need.**]\*\*
- Several addressees really **agonized, and could have spent far less time just in answering the questions**. This is typical. ... **Ask 10 systems engineers their opinion, and one receives 20-30 different answers!** 😊

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\* (Lawton 2012, pp. 30-31) is an interesting article ([added after submission of this paper](#)) that addresses our irrational nature in cheating a little while still feeling good about ourselves.

\*\* (Jones, 2012, pp. 32-39) is an interesting article ([added after submission of this paper](#)) that addresses our irrational nature in making decisions.

# Survey Results

## Pilot Group (1/5)

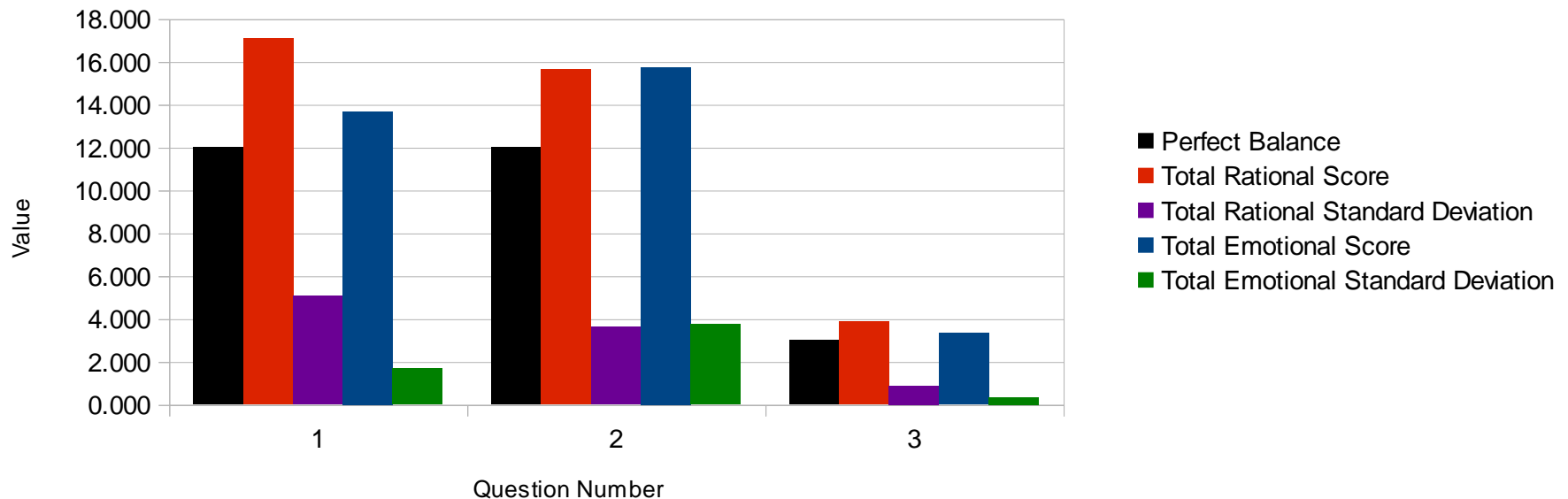
- Table 1 (next chart) assesses scores of 15 respondents.
  - Questions 1 and 3 total scores favored Rational, and Question 2 yielded slight edge to Emotional.
  - Relatively large standard deviations emphasize departures from perfect balance for Questions 1 and 2.
- Question 1
  - Rational prevails over Emotional for Regulations, Programmatic Aspects, Technology, Economics, Operations, and External Factors.
  - Emotional dominates for Politics and Personal Factors.
  - Degrees to which Emotion plays role is notable.
    - Politics and Personal Factors loom largest.
    - Programmatic Aspects is next followed by Technology and External Factors.
    - These first two suggest that emotion plays significant role in programmatic decisions and technology selection.
    - Because one is not in control of External Factors that leads to some emotional decisions.
    - Finally, Operations, Economics, and Regulations (scoring below 1.5) show an increasing bias towards Rational.

# Numerical Data for Pilot Group (Table 1)

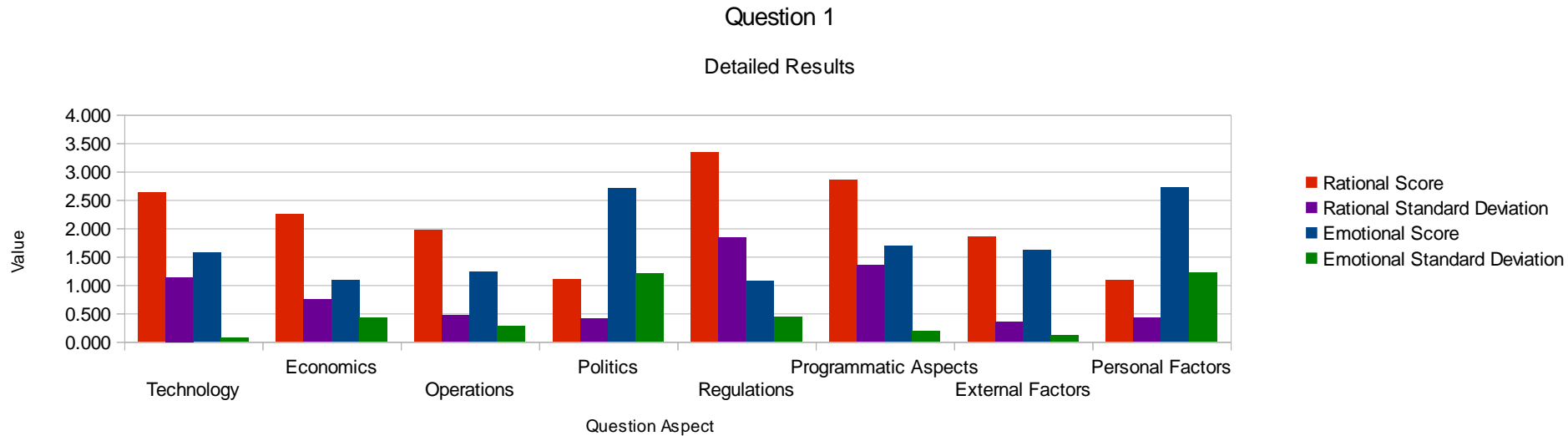
## Overall Results for Pilot Group (Figure 3)

Question	Perfect Balance	Total Rational Score	Total Rational Standard Deviation	Total Emotional Score	Emotional Standard Deviation
1	12	17.067	5.067	13.667	1.667
2	12	15.625	3.625	15.732	3.732
3	3	3.875	0.875	3.339	0.339

Overall Results



# Detailed Question 1 Results for Pilot Group (Figure 4)

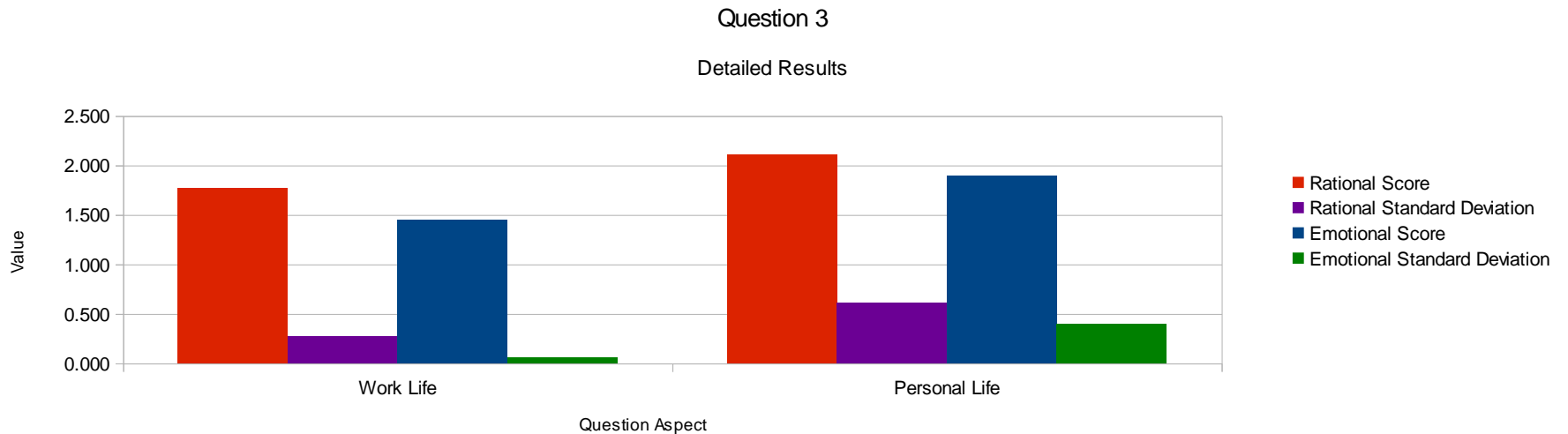
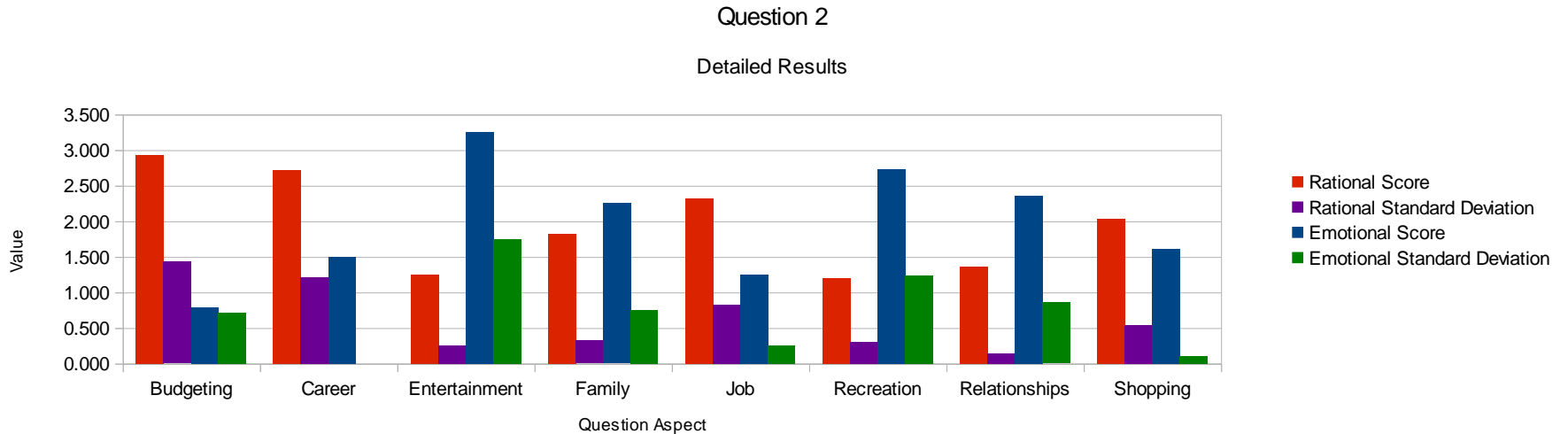




- Question 2
  - Entertainment decisions have greatest Emotional content with Recreation second.
  - Next come Relationships and Family.
  - Budgeting, Career (Emotion was perfectly balanced at 1.5), and Job are quite Rational.
  - Shopping could have been even more Emotional.
- Question 3
  - Both future Work Life and Personal Life would be somewhat more Rational than Emotional.
  - Work Life is closer to being perfectly balanced.
  - Both future Work Life and Personal Life decisions would have roughly equal Emotional and Rational contents.

# Detailed Question 2 Results for Pilot Group (Figure 5)

## Detailed Question 3 Results for Pilot Group (Figure 6)



- Table 2 (next chart) assessed total scores of 21 respondents.
- All three scores favor Rational over Emotional, particularly for Question 1. But there are significant Emotional components.
- Question 1
  - Personal Factors and Politics have largest Emotional scores.
  - External Factors shows more emotion than Programmatic Aspects.
  - Economics, and Operations come next.
  - Technology and Regulations are quite Rational.

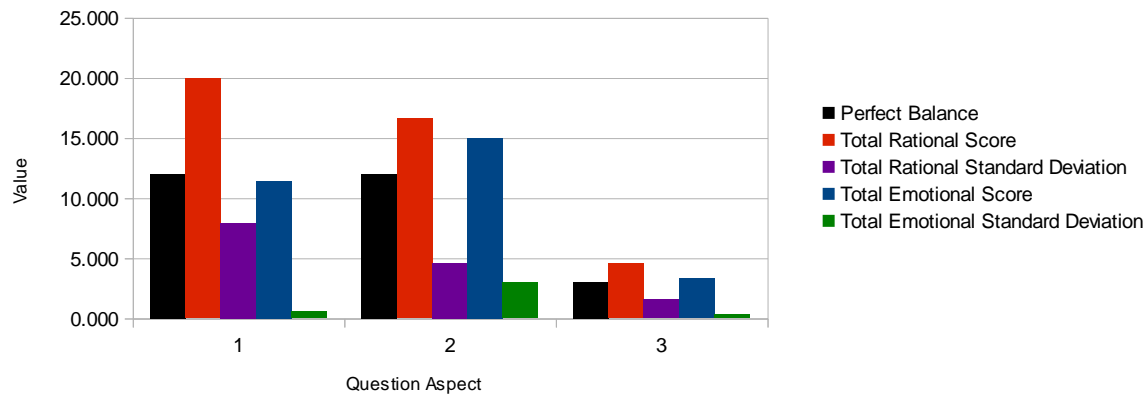
# Numerical Data for 2<sup>nd</sup> Group (Table 2)

## Overall Results for 2<sup>nd</sup> Group (Figure 7)

### Detailed Question 1 Results for 2<sup>nd</sup> Group (Figure 8)

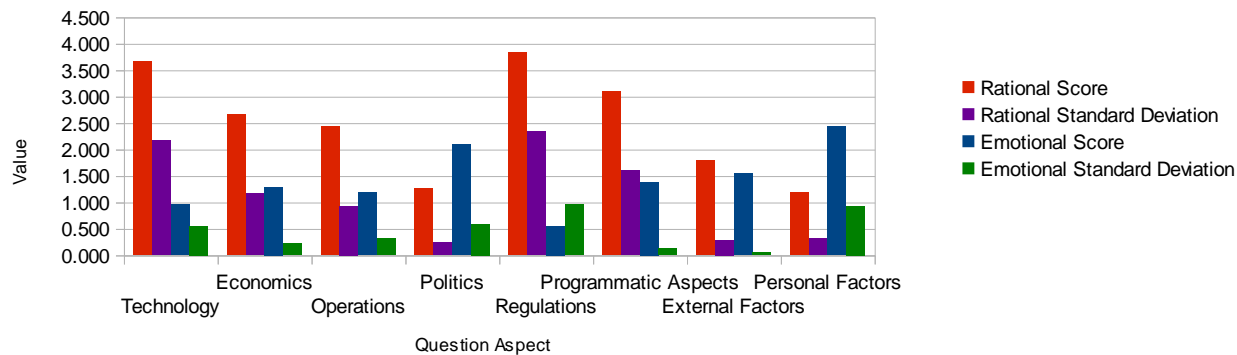
Question	Perfect Balance	Total Rational Score	Total Rational Standard Deviation	Total Emotional Score	Total Emotional Standard Deviation
1	12	19.925	7.925	11.423	0.577
2	12	16.595	4.595	14.976	2.976
3	3	4.560	1.560	3.298	0.298

Overall Results



Question 1

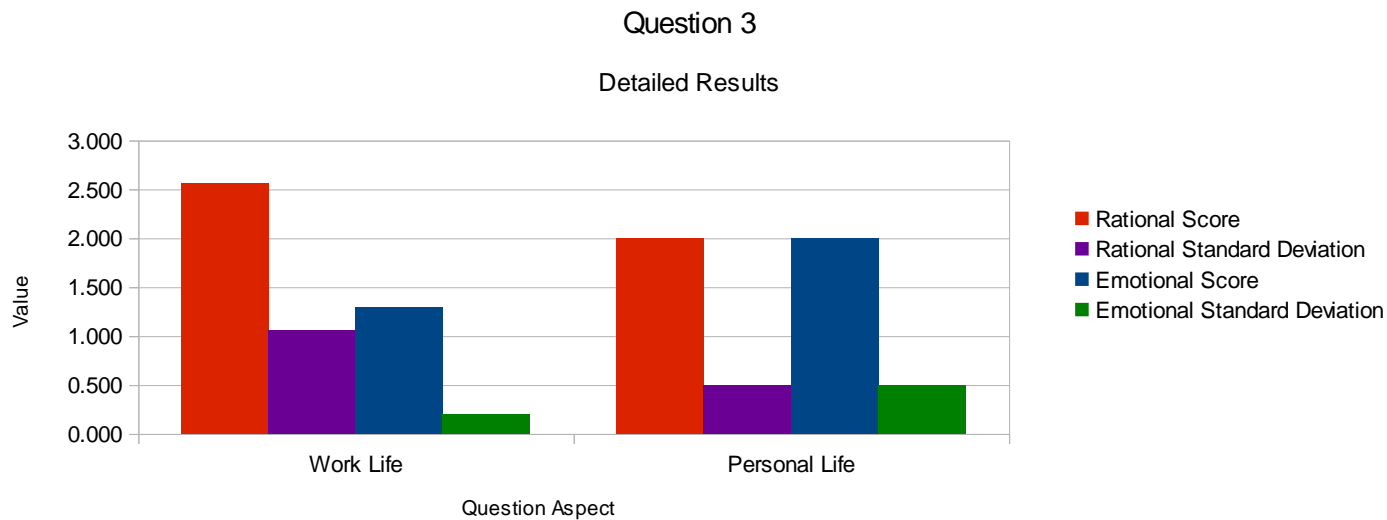
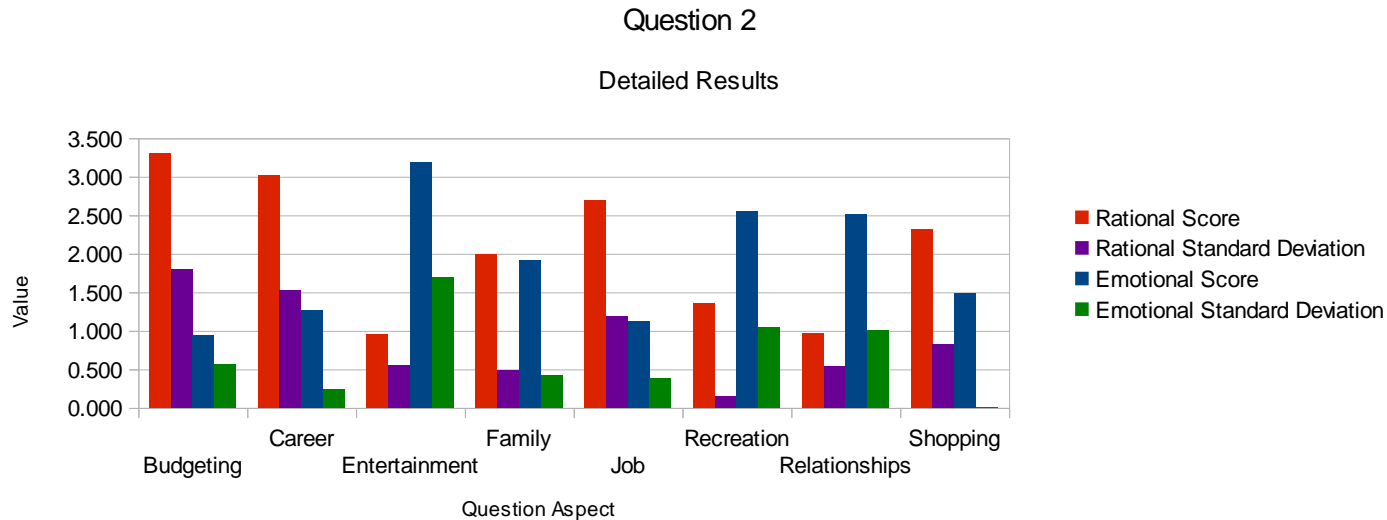
Detailed Results



- Question 2
  - Entertainment, Recreation, and Relationships decisions have greatest Emotional content.
  - Relationships rated higher emotionally than for Pilot Group.
  - Family, Shopping, Career, and Job are lower.
  - Budgeting is higher.
  
- Question 3
  - Work Life is much more Rational than for Pilot Group.
  - Personal Life is equally Rational and Emotional.

# Detailed Question 2 Results for 2<sup>nd</sup> Group (Figure 9)

## Detailed Question 3 Results for 2<sup>nd</sup> Group (Figure 10)



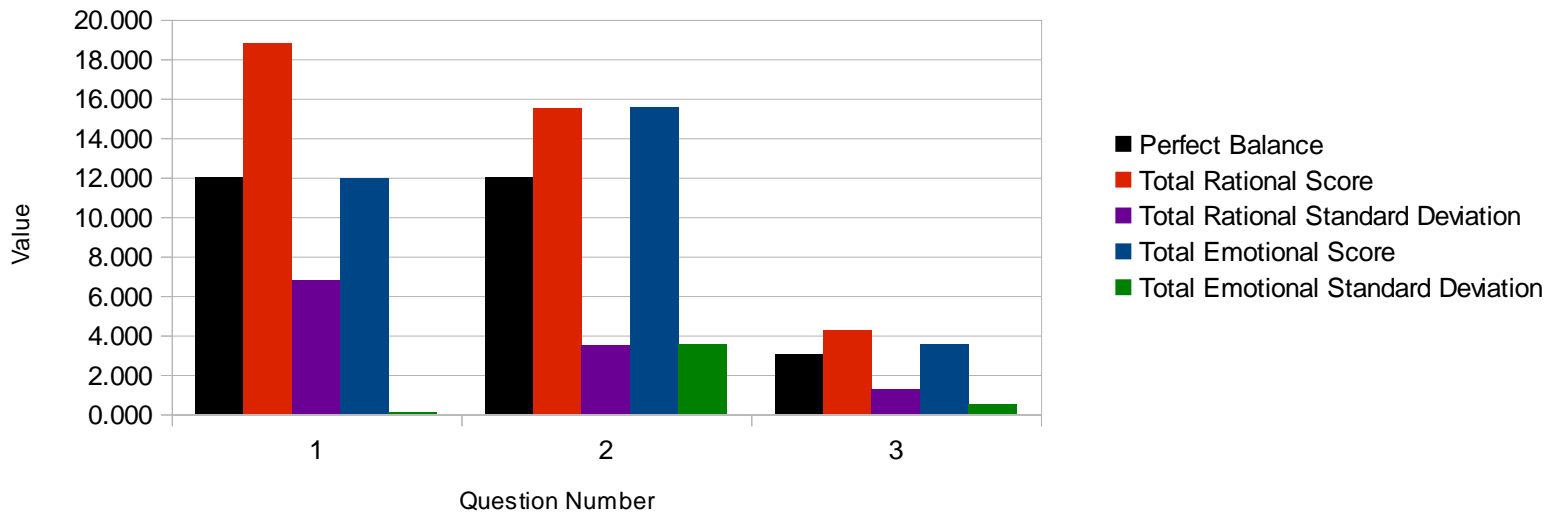
- Pilot Group consisted of **close friends** and/or **colleagues**.
- 2<sup>nd</sup> Group were colleagues **known personally** and/or **they know me**.
- **Response rate** of Pilot Group was significantly higher (**60%**).
- **Lower response rate (18.6%)** of 2<sup>nd</sup> Group but
  - Most everyone is busy
  - May not care for surveys
  - May not want to bother
  - Even though some asked for help, they failed to follow through.
- Table 3 (next chart) assessed total scores of **all groups**.
  - **Rational is prevalent in Question 1** with **Emotional** in perfect balance.
  - **Emotional edges Rational in Question 2** and both above perfect balance
  - Rational wins over Emotion in Question 3** but not by very much.

# Numerical Data for All Groups (Table 3)

## Overall Results for All Groups (Figure 11)

Question	Perfect Balance	Total Rational Score	Total Rational Standard Deviation	Total Emotional Score	Total Emotional Standard Deviation
1	12	18.754	6.754	11.936	0.064
2	12	15.462	3.462	15.538	3.538
3	3	4.230	1.230	3.499	0.499

Total Cumulative Overall Results

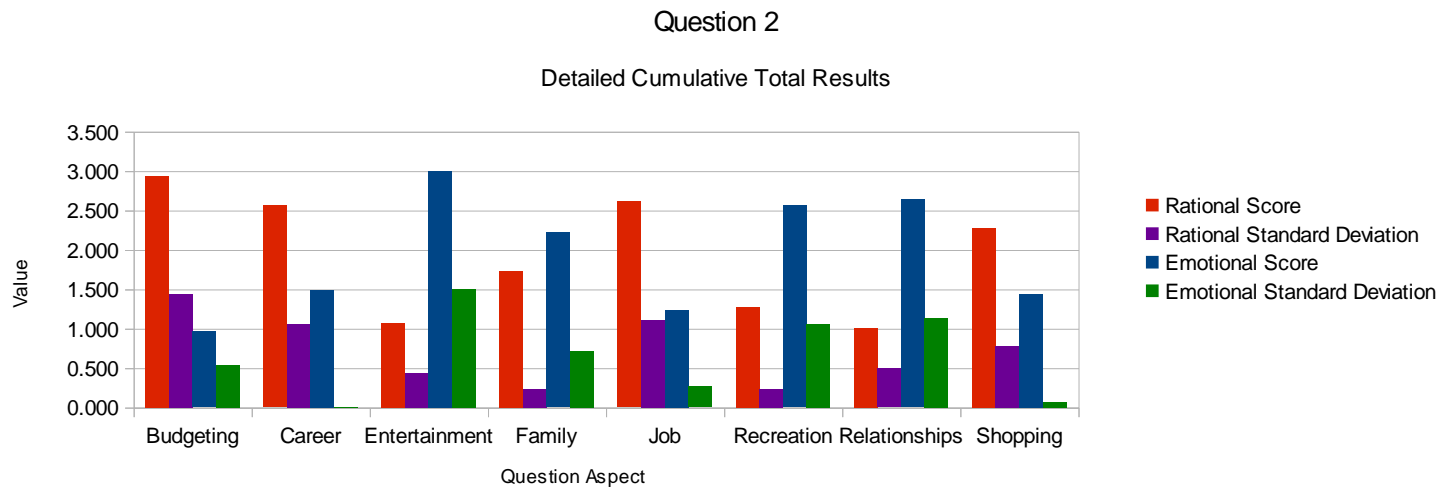
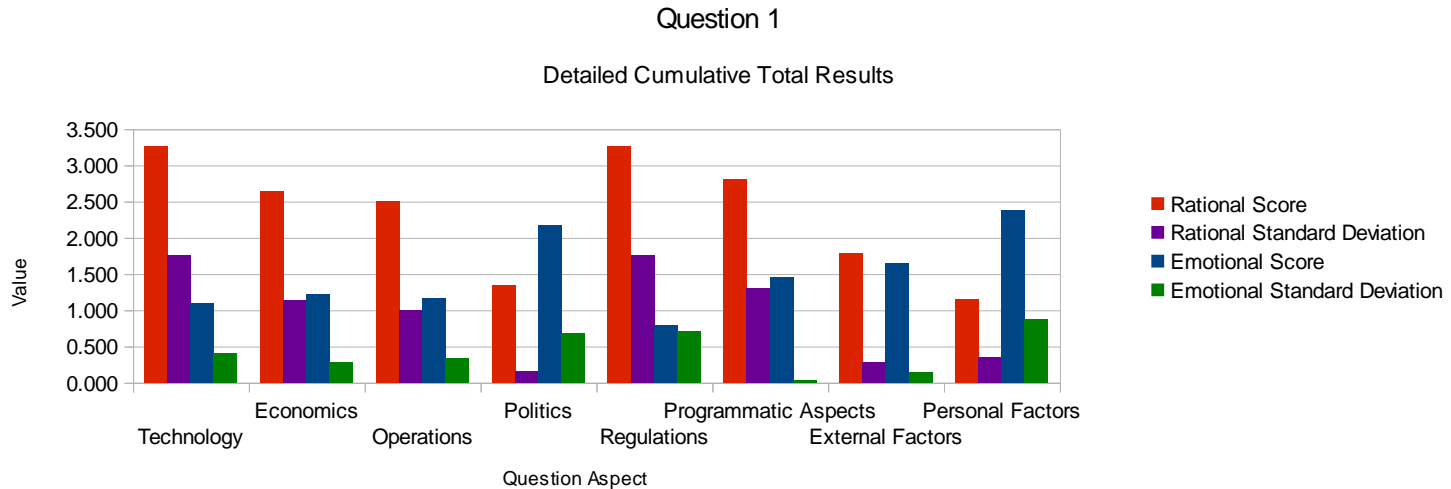




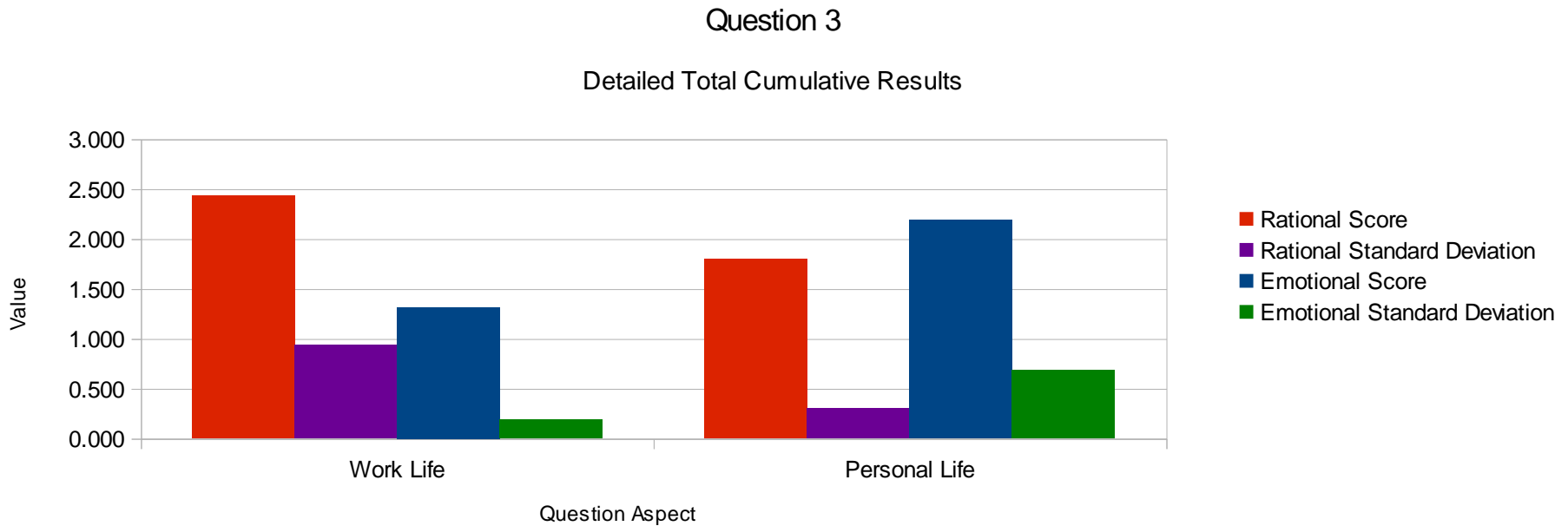
- Question 1
  - Personal Factors and Politics are largest in Emotional content.
  - External Factors and Programmatic Aspects come next.
  - Regulations and Technology have strongest Rational content.
  - Economics and Operations follow Programmatic Aspects in Rational content.
- Question 2
  - Entertainment, Relationships, and Recreation decisions have greatest Emotional content.
  - Followed by Family
  - Budgeting, Job, and Career have largest Rational content.
  - Followed by Shopping
- Question 3
  - Work Life promises to be significantly more Rational.
  - Personal Life is more Emotional.

# Detailed Question 1 Results for All Groups (Figure 12)

## Detailed Question 2 Results for All Groups (Figure 13)



# Detailed Question 3 Results for All Groups (Figure 14)



- Total results for all survey groups
  - Question 1 (Work Place)
    - Significant Emotional content in Personal Factors, Politics, Programmatic Aspects (just under perfect balance), and External Factors.
    - Rational dominates in Regulations, Technology, Programmatic Aspects, Economics, and Operations.
  - Question 2 (Personal Life)
    - Emotion dominates in Entertainment, Relationships, Recreation, and Family.
    - Career and Shopping are nearly perfectly balanced in Emotional content.
    - Budgeting, Job, Career, and Shopping have most Rational content.
  - Question 3 (Future)
    - Work Life is much more Rational
    - Personal Life is more Emotional
- Several correspondents questioned response authenticity and suggested Emotional component might be stronger in actual practice. I agree! 😊

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# Biography

Brian E. White received Ph.D. and M.S. degrees in Computer Sciences from the University of Wisconsin, and S.M. and S.B. degrees in Electrical Engineering from M.I.T. He served in the U. S. Air Force, and for 8 years was at M.I.T. Lincoln Laboratory. For 5 years Dr. White was a principal engineering manager at Signatron, Inc. In his 28 years at The MITRE Corporation, he held a variety of senior professional staff and project/resource management positions. He was Director of MITRE's Systems Engineering Process Office, 2003-2009. Dr. White left MITRE in July, 2010, to offer a consulting service, CAU←SES (“Complexity Are Us” ← Systems Engineering Strategies).

