



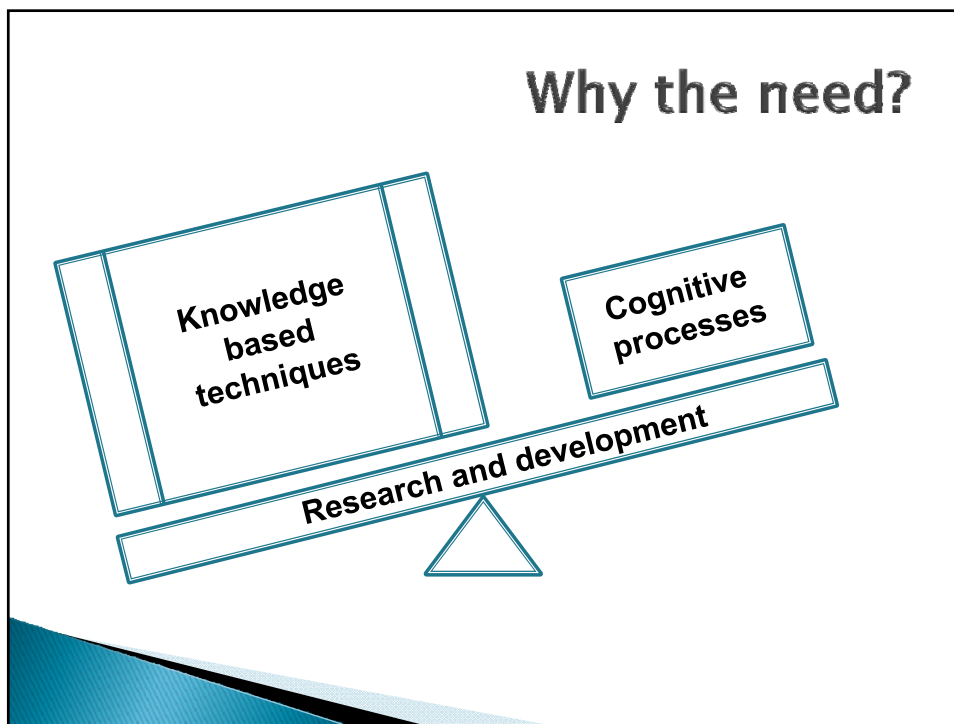
Personality and performance in software engineering personnel

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Overview

- ▶ The need
- ▶ Psychology and cost estimation
- ▶ Previous work
- ▶ NESMA responses



"...project cost underestimation and overrun is a global problem which has not diminished in the last 50 years..."

...no learning seems to take place"

Flyvbjerg et al. (2008)

Psychology and cost estimation

- ▶ Cognitive processes
- ▶ Individual differences
- ▶ Personality measures



Personality measures

- ▶ Type measures
 - e.g. MBTI
 - Individuals naturally *prefer* one overall combination of type differences, even if they can become more proficient in other types
 - Preferences are polar opposites
- ▶ Trait measures
 - e.g. Big 5 (Costa & McCrae, 1992)
 - Dimensions of personality

Trait measure: Big 5 Factors

- ▶ Openness
 - Strong curiosity and preference for novelty and variety
- ▶ Conscientiousness
 - Disciplined, organized, and achievement-oriented
- ▶ Extraversion
 - Degree of sociability, assertiveness, and talkativeness
- ▶ Agreeableness
 - Being helpful, cooperative, and sympathetic
- ▶ Neuroticism
 - Degree of emotional stability, impulse control, anxiety

Why trait rather than type?

Trait: Big 5	Type: MBTI
Continuous dimension	Distinct categories
Genetically or biologically based	Can be developed
Reflect durable personality patterns; types	Tend to be a product of context (place, time, and culture)
More detailed statistical analysis possible	Independent categories restrict analysis

Personality and cost estimation

- ▶ Expert + CBR tool outperforms either technique alone (Myrtveit and Stensrud, 1998)
- ▶ Expert + computerised cost models (Rush and Roy 2000)

- ▶ Inconclusive evidence from 15 studies (Jørgensen 2004)
 - 5 formal models best
 - 5 expert judgement best
 - 5 differentiate best

Problem solving using CBR tools

- ▶ History repeats itself but not exactly...
- ▶ CBR tools, e.g. archANGEL, work with continuous and categorical case features
- ▶ Retrieve similar cases (analogies) using various algorithms to find better feature subsets
- ▶ Highly configurable
- ▶ Some times has good accuracy
- ▶ ...but other times doesn't!

Interaction cognitive processes and personality

- ▶ CBR based on cognitive process of analogical reasoning
- ▶ ...but not biologically plausible

- ▶ Humans use a range of problem solving skills and comprise a range of individual differences which may affect performance independently and in combination

Previously...

- ▶ Mair, Shepperd & Martincova (2009)
- ▶ 5 PMs
- ▶ Dataset of 18 comparable, recent, UK enhancement projects (2003 – 2008)
- ▶ Reduced actual effort from 15258 to 5086 person-hours in one project
- ▶ Participants were asked to:
 1. use a think-aloud protocol
 2. agree or disagree with the 'estimate' using the data set of projects and archANGEL
 3. provide a preferred estimate

What the data tell us...

Variable	Description	Min	Mean	Max
UFP	Unadjusted FPs	90	658	1719
AFP	Adjusted FPs	90	701	1822
LOC	Lines of code	2676	29940	64031
Duration	In days	192	393	544
Effort	In person hours	6174	18200	50886
MaxFTE	Max full-time equivalent staff	5.8	15.7	30
PeakStaff	Max number of personnel	8	25.2	52

Results: accuracy (time)

- P1: no prediction
 - (42 minutes)
- P2: overestimate
 - (32 minutes)
- P3: most accurate**
 - (24 minutes)
- P4: fastest, but underestimate
 - (19 minutes)
- P5: underestimate
 - (20 minutes)

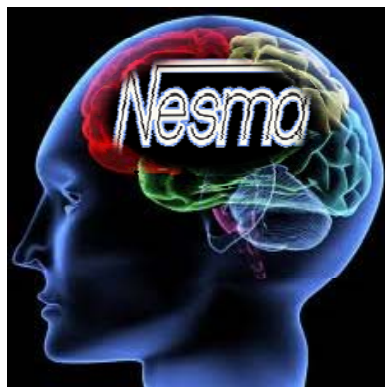
Participant	Time (min)	Predicted	Range
P1	42	-	-
P2	32	20000	16000 -20000
P3	24	15000	11000 -19458
P4	19	12000	11000 -13000
P5	20	10000	9500 -10500

Big 5 results

Participant	Open-ness	Conscientiousness	Extraversion	Agreeable-ness	Neurotic-ism
P1	Med 23/50	High 45/45	Low 11/40	High 31/45	Med 18/40
P2	High 44/50	High 41/45	High 34/40	High 32/45	Med 17/40
P3	High 43/50	High 43/45	High 28/40	High 33/45	Med 22/40
P4	High 34/50	High 37/45	High 40/40	High 36/45	Med 21/40
P5	Med 26/50	High 32/45	Med 15/40	High 40/45	Med 29/40

Scores on each dimension are weighted independently (i.e., low, med and high bands are not equal across dimensions).

NESMA results



NESMA demographics

- ▶ Sex 12m; 1f
- ▶ Modal age: 41–50
- ▶ Job title: range
- ▶ Modal time in job: 5–7 years
- ▶ 50% shared responsibility for estimation

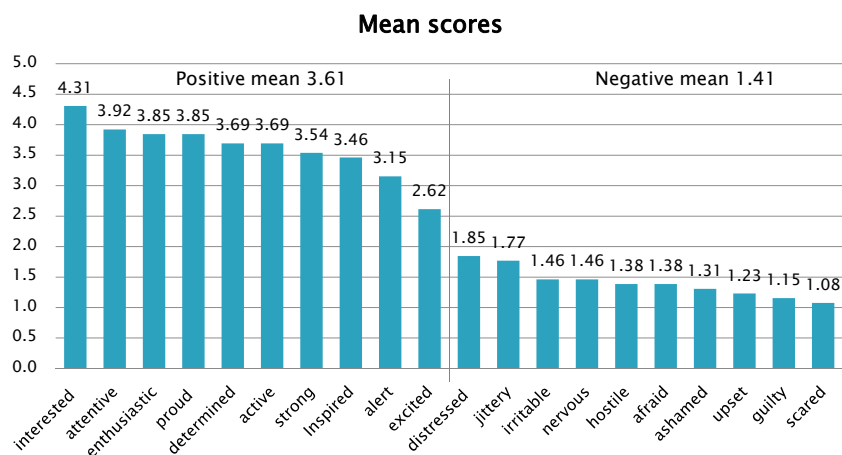
NESMA questionnaires

1. Positive Affect and Negative Affect scale
2. Grit Inventory
3. Big Five Inventory
4. Metacognitive Awareness Inventory
5. Personal Problem Solving Inventory
6. Emotional Intelligence Inventory

1 Positive and Negative Affect Scale (PANAS)

- ▶ Watson, Clark & Tellegen, (1988)
- ▶ 20 words (10 positive and 10 negative)
- ▶ Describe feelings and emotions
- ▶ Rated on 5-point scale

PANAS results from NESMA



NESMA questionnaires

1. Positive and Negative Affect
2. Grit
3. Big Five
4. Metacognitive Awareness
5. Personal Problem Solving
6. Emotional Intelligence

Non-cognitive individual differences

- ▶ “Intellectual talent is important for achievement ...but other factors also matter”
- ▶ E.g. Positive, non-cognitive trait, Grit
 - passion + motivation
 - promotes overcoming challenges
 - serves as driving force in achievement

Grit

- ▶ Duckworth, Peterson, Matthews & Kelly (2007) *J. Personality and Social Psychology*, 92, 1087
- ▶ Predicts success beyond IQ and conscientiousness measures

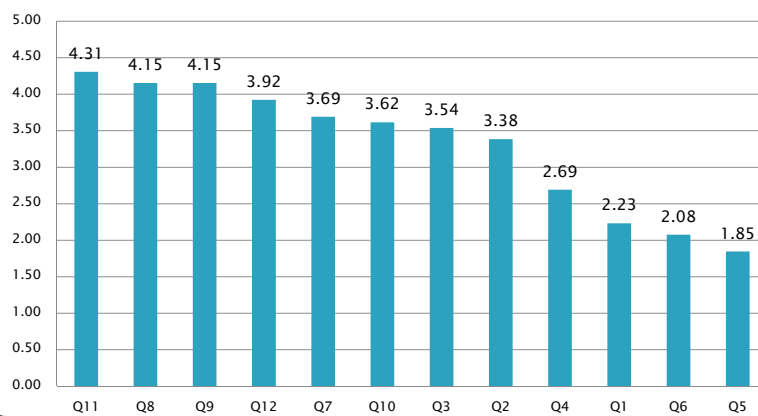


Grit measure (mean NESMA score)

- ▶ I am a hard worker (4.31)
- ▶ I have overcome setbacks to conquer an important challenge (4.15)
- ▶ I finish whatever I begin (4.15)
- ▶ I am diligent (3.92)
- ▶ I have achieved a goal that took years of work (3.69)
- ▶ Setbacks don't discourage me (3.62)
- ▶ I become interested in new pursuits every few months (3.54)
- ▶ New ideas and new projects sometimes distract me from previous ones (3.38)
- ▶ My interests change from year to year (2.69)
- ▶ I often set a goal but later choose to pursue a different one (2.23)
- ▶ I have difficulty maintaining my focus on projects that take more than a few months to complete (2.08)
- ▶ I have been obsessed with a certain idea or project for a short time but later lost interest (1.85)

Grit results from NESMA

Mean score/item
Overall mean 3.3

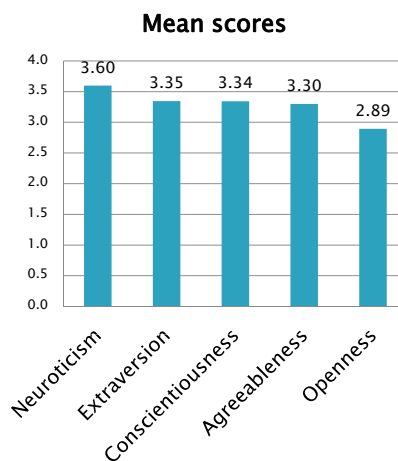


NESMA questionnaires

1. Positive and Negative Affect
2. Grit
3. **Big Five**
4. Metacognitive Awareness
5. Personal Problem Solving
6. Emotional Intelligence

Big 5 results from NESMA

- ▶ 42 items, 5-point Likert scale
- ▶ Continuous dimensions
- ▶ Genetically or biologically based durable personality patterns



Big 5 results from NESMA

Item	Mean	Highest
13	4.62	Is a reliable worker
42	4.54	Likes to cooperate with others
24	4.54	Is emotionally stable, not easily upset
7	4.46	Is helpful and unselfish with others
10	4.38	Is curious about many different things
Item	Mean	Lowest
23	2.08	Tends to be lazy
37	1.92	Is sometimes rude to others
39	1.77	Gets nervous easily
12	1.54	Starts quarrels with others
4	1.38	Is depressed, blue

NESMA questionnaires

1. Positive and Negative Affect
2. Grit
3. Big Five
4. **Metacognitive Awareness**
5. Personal Problem Solving
6. Emotional Intelligence

Metacognition

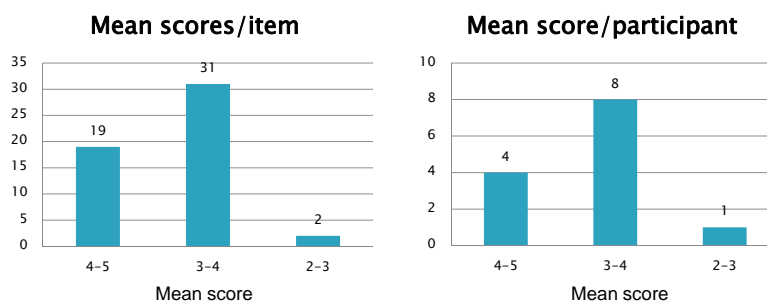
- ▶ Thinking about thinking (Flavell, 1979)
 - planning, appropriate problem solving skills and strategies, estimating performance, calibrating extent of learning
- ▶ 2 major components
 - knowledge and skills

Components of metacognition

Metacognitive knowledge	Metacognitive skills
Knowledge of interactions among self, task and strategy characteristics	Knowledge for self-regulating problem solving and learning activities
Knowledge of cognitive skills and strategies that are perceived to work best and how and when to use them	Knowledge of activities that control one's thinking and learning (planning, reflection and evaluation)
Rigid and resistant to change	Dynamic and flexible, can be developed
Single loop learning	Double loop learning

MAI (Schraw & Dennison, 1994)

- ▶ 52 items scored on 5-point Likert scale
- ▶ NESMA overall mean score 3.81 (SD 0.4)



MAI highest scored items

Item	MAI item	Mean
46	I learn more when I am interested in the topic	4.77
13	I consciously focus my attention on important information	4.38
25	I ask others for help when I don't understand something	4.38
41	I use the organizational structure of the text to help me learn	4.38
12	I am good at organizing information	4.31
26	I can motivate myself to learn when I need to	4.31
37	I draw pictures or diagrams to help me understand while learning	4.31
52	I stop and reread when I get confused	4.31

MAI lowest scored items

Item	MAI item	Mean
17	I am good at remembering information	3.38
20	I have control over how well I learn	3.38
49	I ask myself questions about how well I am doing while I am learning something new	3.38
1	I ask myself periodically if I am meeting my goals	3.23
14	I have a specific purpose for each strategy I use	3.23
21	I periodically review to help me understand important relationships	3.23
4	I pace myself while learning in order to have enough time	2.85
50	I ask myself if I learned as much as I could have once I finished a task	2.77

NESMA questionnaires

1. Positive and Negative Affect
2. Grit
3. Big Five
4. Metacognitive Awareness
5. **Personal Problem Solving**
6. Emotional Intelligence

Personal problem solving inventory (Heppner & Peterson (1982))

- ▶ 13 items 5-point Likert scale (NESMA mean 3.72)

Item	Highest scoring PPSI item	Mean
13	When I become aware of a problem, I try to find out exactly what the problem is	4.69
10	I trust my ability to solve new and difficult problems	4.46
1	I am usually able to think up creative and effective alternatives to solve a problem	4.38
8	Given enough time and effort, I believe I can solve most problems that confront me	4.31
2	I have the ability to solve most problems even though initially no solution is immediately apparent	4.23
9	When faced with a novel situation I have confidence that I can handle problems that may arise	4.23

Personal problem solving inventory (Heppner & Peterson (1982))

Item	Lowest scoring PPSI item	Mean
4	I make decisions and am happy with them later	4.15
6	I try to predict the overall result of carrying out a particular course of action	4.15
5	When I make plans to solve a problem, I am almost certain that I can make them work	4.08
11	After making a decision, the outcome I expected usually matches the actual outcome	3.85
7	When I try to think up possible solutions to a problem, I do not come up with many different alternatives	2.23
12	When confronted with a new problem, I am unsure of whether I can handle the situation	1.92
3	Many problems I face are too complex for me to solve	1.62

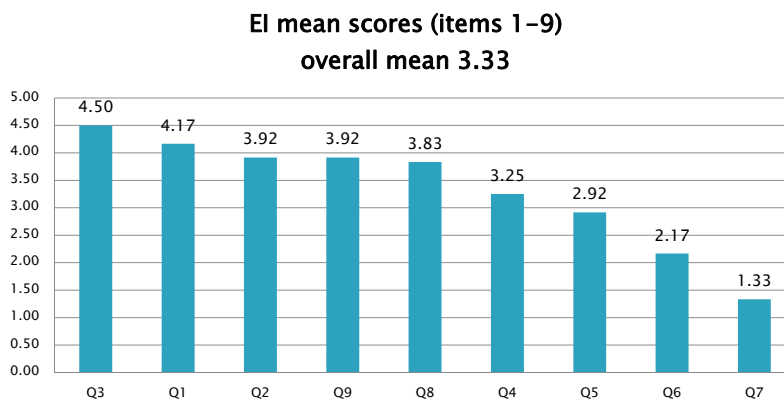
NESMA questionnaires

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Emotional Intelligence

- ▶ Skill or ability to identify, assess and control one's and others' emotions
- ▶ Perceiving, using, understanding and managing emotions
- ▶ Mayer, DiPaolo & Salovey (1990)
 - 1–9 scored on 5 point Likert-scale
 - 10–16 multiple choice
- Removed 1 participant who answered only 1 item

Emotional Intelligence Inventory



Emotional Intelligence Inventory items 1–9

Item	EII item	Mean
3	I generally like who I am	4.50
1	I am generally aware of how each person feels about the other people in our social circle	4.17
2	When I am upset, I can usually pinpoint exactly why I am distressed	3.92
9	I would describe myself as a good judge of character	3.92
8	I feel confident about my own skills, talents, and abilities	3.83
4	I feel uncomfortable in emotionally charged situations	3.25
5	I tend to avoid confrontations. When I am involved in a confrontation, I become extremely anxious	2.92
6	I am generally aloof and detached until I really get to know a person	2.17
7	I tend to overreact to minor problems	1.33

Emotional intelligence items 10–13

10. When I am facing an unpleasant task, I tend to:

Make a plan and work on it a little each day (6)

11. During a heated argument, I am more likely to:

Stop the fight and agree to a short break before resuming the discussion (8)

12. When making an important decision, I tend to:

Follow my instincts (9)

13. Which of the following statements best describes you?

I have an easy time making friends and getting to know new people (9)

Emotional intelligence items 14–16

14. You have invested a lot of time and energy into a project. While you feel confident about your work, the manager is unhappy about it. How do you deal with this situation?

Decide the manager is stupid and stop putting forth your best efforts (7)

15. One of your co-workers has a habit that annoys you. The problem seems to be getting worse each day. How do you respond?

Tell your co-worker what is bothering you (11)

16. You've been feeling stressed at work and haven't finished projects as quickly as you should. When your boss suddenly assigns you another large project, how do you feel?

Anxious about getting all the work done (10)

Summary NESMA results

PANAS		Grit	Big 5		MAI	PPSI	EII
PA	3.61	3.30	Neuroticism	3.60	3.81	3.72	3.30
NA	1.41		Extraversion	3.35			
			Conscientiousness	3.34			
			Agreeableness	3.30			
			Openness	2.89			

NESMA people are...

- Highly metacognitively aware and good problem solvers
- positive, co-operative, determined conscientious and resilient
- fairly extraverted, but are controlled and don't like taking risks preferring the known to the unknown!

▶ Questions please!