# Table of Contents

Chapter 1: Introduction to the research ................................................................. 1  
Focus of the research ......................................................................................... 2  
Contextualisation of this PhD ........................................................................ 4  
Research Question ............................................................................................ 6  
Research Aim .................................................................................................... 6  
Research objectives ......................................................................................... 6  
My Background ................................................................................................. 7  
Research methodology ..................................................................................... 8  
Introduction ...................................................................................................... 8  
A definition of action research ....................................................................... 9  
The four phase research methodology ............................................................ 11  
Research in art and design ............................................................................ 12  
Materials rationale ........................................................................................... 14  
Soda .................................................................................................................. 14  
Lime .................................................................................................................. 14  
Silica .................................................................................................................. 14  
List of materials ............................................................................................... 16  
List of Equipment ............................................................................................. 16  
Particle sizes .................................................................................................... 17  
Summary ........................................................................................................... 18  

Chapter 2: Egyptian faience contextual review .................................................. 19  
Section 1: Historical context ........................................................................... 20  
What is Egyptian faience? ............................................................................ 20  
Terminology ...................................................................................................... 20  
Egyptian faience uses .................................................................................... 21  
Egyptian faience development ...................................................................... 27
What was it made of? ............................................................................................................. 28
Physical properties of faience paste ....................................................................................... 29
Forming methods ...................................................................................................................... 31
Organic binders .......................................................................................................................... 31
How was it glazed? ...................................................................................................................... 32
Colour palette ............................................................................................................................. 36
Why was faience significant? .................................................................................................... 36

Section 2: Faience in current contexts ..................................................................................... 38
Ceramic stains ........................................................................................................................... 38
What is appealing about Egyptian paste? ................................................................................. 38
What are the limitations of faience? ........................................................................................ 41

Section 3: Visual assessment .................................................................................................... 43
Faience workshop ....................................................................................................................... 44
Contemporary artwork: Zahed Tajeddin: Nu Shabtis .............................................................. 55
Egyptian faience Vessel .............................................................................................................. 60
Summary ..................................................................................................................................... 64

Chapter 3: 3D printing introduction and contextual review ..................................................... 65
Section 1: 3D printing introduction .......................................................................................... 66
Process description: Powder binder printing ............................................................................. 71
Section 2: Contextual review: 3D printing material/process development for creative
applications in art and design .................................................................................................... 80
Paste extrusion ........................................................................................................................... 80
Powder binder printing ............................................................................................................ 84
Recent innovations and technological developments in the field of ceramic 3D
printing .......................................................................................................................................... 86
Summary ..................................................................................................................................... 87

Chapter 4: Practical experiments into the development of an efflorescence paste for 3D
extrusion ....................................................................................................................................... 85
Chapter 5: Practical experiments into ceramic powder binder printing and cementation glazing

Introduction .............................................................................................................. 106

Section one: Cementation glazing and its suitability for powder binder 3D printing .... 107

Rationale for the development of a cementation 3D printing process ......................... 107

Introduction to the cementation glazing technique ................................................. 110

The glazing mechanisms ......................................................................................... 110

Summary .................................................................................................................. 113

Section two: Cementation 3D printing trials ......................................................... 114

Equipment and material preparation ........................................................................ 115

Group 1 .................................................................................................................. 119

Trial 1: Initial glaze and body composition test ...................................................... 119

Trial 2: Sodium chloride trial ................................................................................. 123

Trial 3: Substitution of calcium carbonate for calcium hydroxide .......................... 126

Group 2 .................................................................................................................. 129

Process outline ........................................................................................................ 129

Trial 4: 3D printing cementation body and glaze trial ............................................ 131

Trial 5: Sodium carbonate reduction ...................................................................... 135

Group 3 .................................................................................................................. 141
Presentations, public demonstrations and press features ................................................................. 202

Appendix 2: Practitioner example – The Fishpig ............................................................................ 204

Appendix 3: Practical examples of 3D printed, cementation glazed ceramics ............................ 208

Appendix 4: Practical experiments into 3D printable ceramic bodies that self-glaze through efflorescence ................................................................................................................. 211

Introduction ........................................................................................................................................ 211

Section One: Efflorescence body development for powder binder 3D printing. ....................... 212

Introduction ........................................................................................................................................ 212

Trial 1: 3DP efflorescence body 1a (EB1a) ...................................................................................... 217

Trial 2: 3DP efflorescence body 1b (EB1b) ...................................................................................... 220

Trial 3: Gradient kiln trial ................................................................................................................. 224

Trial 4: Object development ............................................................................................................. 230

Trial 5: Broad collar necklace ........................................................................................................... 235

Advantages and disadvantages of this process compared to current ceramic 3D printing techniques ........................................................................................................................................ 240

Section Two: Application glazing for 3D printed ceramics ............................................................ 242

Introduction ........................................................................................................................................ 242

Efflorescence slip ............................................................................................................................... 244

Appendix 5: Particle size analysis ...................................................................................................... 249