

- 
- AATCC guidelines 84–5  
absorption of light 9, 139  
accuracy  
  of colourant formulation 147–52  
  of digital colour printing 179–88  
  of instrumentation 47  
  observer accuracy 66, 106  
acid dyes 172, 174  
additive mixing 14–15, 26–7  
after-treatments 174–6, 222  
aftercare 222–3  
appearance of colour 19–20, 36–8  
appearance of samples 87  
application of colourants 221–2  
approval systems 123, 130–3  
artificial neural networks 147–52, 156–7  
ASP (application service provider)  
  model 198, 201  
ASTM D1729 guidelines 85–6  
attainable colours 167, 180–1  
automated dispensing systems 216
- benchmark instruments 49–50  
best practices 201–3  
binary continuous inkjets (CIJ) 166–7  
blackbody 8  
body colour calculation 110–11  
business and marketing model 189
- calibration database 140–2, 219  
cameras 51–2, 55, 219  
carpets 90  
choosing colours 194  
chromacity diagrams 37–8  
chromatic adaptation 18–19, 71–3  
CIE94 colour difference formulae 61–2  
CIE system 17, 19–20, 24–40  
  ASTM guidelines 86  
  colour difference formulae  
    (CIELAB) 58–60  
  colour matching functions 31–2  
  illuminants 30–1, 32, 34–5  
  light sources 30  
  primary colours 15, 27–8, 29–30  
  reflectance measurements 35, 36  
  standard observers 31–2, 35  
  tristimulus values 28, 29, 32–4, 36  
    and colour appearance 36–8  
  usefulness and limitations 38–40  
  viewing conditions 32, 35, 82–3, 211  
  *see also* description specification systems  
CIEDE2000 colour difference formulae  
  62–5, 73  
CIELAB colour difference formulae 58–60  
CMC colour difference formulae 60–1  
CMYK colour system 167, 180–1  
colour cathode-rays (CRTs) 98  
colour difference evaluation 58–65, 68, 73,  
  153  
colour display characterisation 98  
colour engines 207  
colour loss 176, 223, 224–5  
colour mapping  
  algorithm 100–2, 113–14  
  texture images 99–100  
colour matching functions 31–2  
colour simulation 97–115  
  body colour calculation 110–11  
  colour display characterisation 98  
  colour synthesis 108–13  
  dichromatic-based modelling 109–10  
  grey-scale comparison method 105  
  image synthesis 97  
  mapping algorithm 99–103, 113–14  
  texture effects 103–8  
colour sorting 153, 196  
colour synthesis 108–13  
colour vision 13–15  
  testing 81–2  
communication  
  choices 197–8  
  manual 121–4  
  technological 124–7  
computer formulation 136, 213–16

- concept colours 120–1
- cones in eyes 11, 12, 13–14
  - response equation 13
- constancy of colour 69–73, 217–18
  - chromatic adaptation 18–19, 71–3
  - and the human vision system 13, 18–19
  - inconstancy index 70, 71
  - metameric matches 70
  - spectral matches 70
- contrast 17–18
- corduroy 90
- cornea 10
- correlated colour temperature 8
- custom instruments 52
  
- daylight distribution 8
- DDP (Direct Digital Printing) 178
- description specification systems 22–42
  - additive mixing 14–15, 26–7
  - chromacity diagrams 37–8
  - Munsell system 25, 40–1
  - naming of colours 24–5
  - NCS (Natural Colour System) 41
  - ordering systems 40–1
  - specifier systems 41–2
  - subtractive mixing 26–7
  - see also* CIE system; measurement systems
- design of colours
  - and digital printing 176–8
  - see also* mind to market communication
- detergents 223–4
- dichromatic-based modelling 109–10
- difference evaluation 58–65, 68, 73, 153
- diffuse reflectance 9, 45
- diffuse transmittance 46
- DigiGrade system 225
- digital capture technology 177
- digital colour printing 160–90
  - accuracy and uniformity 179–88
  - attainable colours 167, 180–1
  - business and marketing model 189
  - colour loss 176
  - colour management system 181–3
  - design potentials and limitations 176–8
  - dither of colour 180
  - drop size 171
  - environment 174
  - fabric handling 169
  - fabric structure 172–3
  - fibre type 172
  - head height 170–1
  - ink placement 170
  - ink type and characteristics 171–2
  - multi (binary) continuous inkjets (CIJ) 166–7
  - paper-backing 173–4
  - photo-realistic printing 177
  - piezoelectric drop on demand (DOD) inkjet 165–6
  - post-treatment 174–6
  - pre-treatment 173–4, 179
  - print head movement 170
  - print pass 170
  - print speed 169–71
  - printing width 169
  - production printing 179
  - raster image processors (RIP) 183–8
  - repeat designs 177
  - resolution 171
    - for sample production 178–9
  - software 167, 178, 181–8
  - thermal drop on demand (DOD) inkjet 160–5
  - three-dimensional forms 177–8
  - washing printed fabrics 176
  - workflow issues 188
- Direct Digital Printing (DDP) 178
- disperse dyes 172, 174
- display characterisation 98
- distribution of daylight 8
- dither of colour 180
- drop size 171
- durability of colour 223–4
- Dvorine test 81
- dyes 172, 174
  
- electromagnetic radiation 7
- electronic sample evaluation 132–3
- electronic tracking 134
- Encad 165
- engineered standards 127–30, 216–17
- enzymes 223–4
- eyes 7, 10–13
  
- fabric handling 169
- fabric structure 172–3
- FabriJet 169
- fast fashion concept 118–19
- fibre type 172
- finishing 222
- fitness for purpose 220–4
- flare 79
- flat woven textiles 89–90
- fluorescent colourants 147, 150–2
- fluorimeters 52–3
- formulation of colourants 136–57, 211–13
  - accuracy 147–52
  - artificial neural networks 147–52, 156–7
  - calibration database 140–2
  - colour difference evaluation 153
  - computer formulation 136, 213–16
  - fluorescent colourants 147, 150–2
  - historical shade libraries 211
  - Kubelka-Munk theory 137–9, 147, 156–7
  - pigmented systems 138
  - recipe correction 146–7
  - shade sorting 153

- spectrophotometric matching algorithms 142–6
- third-party development 212–13
- trial and error process 136
- frequency of purchase 119
- gain-offset-gamma (GOG) model 98
- ganglion cells 16
- geometries of measurement 44, 46
- Gild the Lily 178
- goniometric instruments 51
- grey-scale comparison method 105
- hand-held instruments 48–9
- head height 170–1
- Helmholtz reciprocity 45
- historical shade libraries 211
- human vision system 7, 10–17
  - colour vision 13–15
    - testing 81–2
  - constancy of colour 13, 18–19
  - eyes 7, 10–13
  - spatial vision 15–17
- humidity 81
- illuminants 30–1, 32, 34–5, 77–9
- image synthesis 97
- inconstancy index 70, 71
- industrial colour tolerance 65–8
- information requirements 197
- initial colour development 87–8
- ink jet technology
  - ink placement 170
  - ink type and characteristics 171–2
  - multi (binary) continuous inkjets (CIJ) 166–7
  - piezoelectric drop on demand (DOD) inkjet 165–6
  - thermal drop on demand (DOD) 160–5
  - see also* digital colour printing
- instrumentation 47–53
  - accuracy 47
  - and approval systems 131–3
  - benchtop instruments 49–50
  - calibration and maintenance 219
  - cameras 51–2, 55, 219
  - custom instruments 52
  - fluorimeters 52–3
  - goniometric instruments 51
  - hand-held instruments 48–9
  - inter-instrument agreement 53–4
  - light boxes 48
  - multiangle instruments 49
  - portable instruments 48–9
  - precision 47
  - scanning instruments 50–1
  - single-scale instruments 47–8
  - software for 54
  - specifications 47
  - spectrophotometers 9–10, 97, 133–4, 142–6
  - sphere-based 49
  - visual instruments 48
  - see also* measurement systems
- inter-instrument agreement 53–4
- Internet, online shopping 119
- iris 10–11
- Isihara test 81
- JPC79 colour difference formulae 60–1
- knitted textiles 89–90
- Kubelka-Munk theory 137–9, 147, 156–7
- lab-dips 195
- laboratory recipe correction 146
- lead times 203–4
- light 7–10
  - absorption 9, 139
  - correlated colour temperature 8
  - diffuse reflectance 9
  - distribution of daylight 8
  - measurement of coloured light 25
  - scattering 9
  - surface reflectance 8–9, 109–10
  - wavelengths 7–8, 29–30
- light boxes 48, 79
- light degradation 224
- light sources 30, 77–9, 82–3
  - AATCC guidelines 84–5
  - evaluation and quality 79
  - secondary sources 78–9
  - selection 78–9
  - standard illuminants 78
- liquid-crystal displays (LCDs) 98
- loose fibres 90
- maintenance of instruments 219
- management systems 181–3
  - see also* supply chain
- manual communication 121–4
- mapping algorithm 100–2, 113–14
- marketing model 189
- measurement systems 23–5, 44–55, 218–20
  - coloured light measurements 25
  - electronic sample evaluation 132–3
  - geometries of measurement 44, 46
  - instrumentation 47–53
  - inter-instrument agreement 53–4
  - physical sample evaluation 131–2
  - radiance factors 46
  - reflectance measurements 44–5
  - sample-induced effects 46–7
  - traceability 53–4
  - transmission factors 46
  - transmittance measurements 44, 45–6
  - see also* CIE system

- metamerism 68–9, 70, 79
  - ASTM guidelines 86
- mind to market communication 117–35
  - approval systems 123, 130–3
  - concept colours 120–1
  - electronic tracking 134
  - engineered standards 127–30, 216–17
  - fast fashion concept 118–19
  - manual communication 121–4
  - palette development 120–1, 125–7
  - reporting packages 134
  - shopping habits 118–19
  - supplier accreditation 133
  - target colour distribution 121–2, 129–30
  - technological communication 124–7
    - see also* supply chain
- mixing colours 14–15, 26–7
- MLP (multi-layer perception) 148, 150
- multi (binary) continuous inkjets (CIJ) 166–7
- multi-spectral imaging 205–6
- multiangle instruments 49
- Munsell system 25, 40–1
  
- naming of colours 24–5
- nature of colour 7–8
- NCS (Natural Colour System) 41
- neural networks 147–52, 156–7
  
- observers
  - accuracy 66, 106
  - metamerism 68–9
  - repeatability 66
  - standard observers 31–2, 35, 81
  - training 86
  - uncertainty 67–8
  - viewing environment 32, 35, 82–3, 211
    - see also* visual evaluation
- online shopping 119
- opaque materials 9
- opponent processing 14–15
- opsin 11
- ordering systems 40–1
  
- palette development 120–1, 125–7
- paper-backing 173–4
- perception of colour 7–20, 77–83
  - appearance 19–20, 36–8
  - contrast 17–18
  - human vision system 7, 10–17
  - light sources 77–9, 82–3
  - nature of colour 7–8
  - physical basis of colour 8–10
  - texture effects 103–8
  - three-dimensional nature 17, 25
    - see also* constancy of colour
- photo-realistic printing 177
- photopigments 11–13
- physical basis of colour 8–10
- physical sample evaluation 131–2
- piezoelectric drop on demand (DOD) inkjet 165–6
- pigmented formulation systems 138
- pigmented inks 171
- pile textiles 90
- portable instruments 48–9
- post-treatments in digital printing 174–6, 222
- pre-treatments in digital printing 173–4, 179
- precision of instruments 47
- predictive systems 214–15
- primary colours 15, 27–8, 29–30
- primary data 215–16
- principle of univariance 13
- print head movement 170
- print pass 170
- print speed 169–71
- printing width 169
- production printing 179, 195–6
  - quality control 88–9, 195–6
  - recipe correction 146–7
- pupil 11
- purchase frequency 119
  
- quality evaluation 57–73, 210–26
  - after-treatments 222
  - aftercare 222–3
  - application of colourants 221–2
  - colour difference formulae 58–65, 68, 73
  - colour loss 223, 224–5
  - constancy of colour 69–73, 217–18
  - durability of colour 223–4
  - finishing 222
  - fitness for purpose 220–4
  - industrial colour tolerance 65–8
  - light degradation 224
  - metamerism 68–9, 70, 79
  - observer accuracy 66, 106
  - observer repeatability 66
  - observer uncertainty 67–8
  - predictive systems 214–15
  - primary data 215–16
  - production quality control 88–9
  - raw materials 221
  - reproduction forecasting 210–13
  - target measurement 213–14
  - testing methodology 224–5
  - variation evaluation 216–20
  - washing and cleaning effects 223–4
  - wear and tear 222–3
  - wrong decision measures 66–7
    - see also* working standards
  
- radiance factors 46
- raster image processors (RIP) 183–8
- raw materials 221
- re-standardisation 218
- reactive dyes 172, 174

- recipe correction 146–7
- recipe formulation *see* formulation of colourants
- reflectance measurements 35, 36, 44–5
- regular reflectance 45
- regular transmittance 45
- repeat designs 177
- reporting packages 134
- reproduction forecasting 210–13
- resolution in digital colour printing 171
- retina 10, 11, 13–14, 15
- rhodopsin 11
- RIP (raster image processors) 183–8
- rods in eyes 11, 12
- roll grouping 196
  
- samples
  - appearance 87
  - conditioning 81
  - electronic evaluation 132–3
  - physical characteristics 80
  - physical condition 211
  - physical evaluation 131–2
  - preparation 80–1, 83, 85
  - production 178–9
  - sample-induced effects 46–7
  - testing 89
  - viewing conditions 32, 35, 82–3, 211
- scanning instruments 50–1
- scattering 9
- SCOPE system 153–6
- scotopic vision 13
- secondary component matching 195
- secondary light sources 78–9
- shade libraries 211
- shade sorting 153
- shopping habits 118–19
- simulation *see* colour simulation
- single-scale instruments 47–8
- software 206–8
  - colour engines 207
  - for digital colour printing 167, 178, 181–8
  - for instruments 54
  - raster image processors (RIP) 183–8
- sorting 153, 196
- spatial vision 15–17
- specifier systems 41–2
- spectral matches 70
- spectrophotometers 9–10, 97, 133–4, 142–6
- sphere-based instruments 49
- standard observers 31–2, 35, 81
- standardisation 205
- standards *see* working standards
- steaming 174
- subcontracting 193, 212–13
- subtractive mixing 26–7
- supplier accreditation 133
  
- supply chain 117–18, 191–209
  - ASP (application service provider) model 198, 201
  - best practices 201–3
  - choosing colours 194
  - colour sorting 196
  - communication choices 197–8
  - information requirements 197
  - lab-dips 195
  - lead times 203–4
  - multi-spectral imaging 205–6
  - production checks 195–6
  - recent changes to 193–4
  - roll grouping 196
  - secondary component matching 195
  - standardisation 205
  - subcontracting 193
  - workflow 192, 204
  - see also* mind to market communication
- surface reflectance 8–9, 109–10
  
- target colour distribution 121–2, 129–30
- target measurement 213–14
- technological communication 124–7
- temperature 81
  - correlated colour temperature 8
- testing colour vision 81–2
- testing methodologies 224–5
- texture 99–100, 103–8
- thermal drop on demand (DOD)
  - inkjet 160–5
- third-party colour formulation 212–13
- threads and yarns 90
- three-dimensional forms 108–13, 177–8
- three-dimensional nature of colour 17, 25
- traceability 53–4
- translucency 9
- transmission factors 46
- transmittance measurements 44, 45–6
- transparency 9
- trial and error colour formulation 136
- trichromacy 14–15, 17
- tristimulus values 28, 29, 32–4, 36
  - and colour appearance 36–8
  
- uniformity of colour 23
- univariance principle 13
  
- variation evaluation 216–20
- velour 90
- viewing environment 32, 35, 82–3, 211
- visual evaluation 76–92
  - AATCC evaluation procedure 84–5
  - appearance of samples 87
  - ASTM D1729 guidelines 85–6
  - colour vision testing 81–2
  - of flat woven textiles 89–90
  - and humidity 81
  - industrial guidelines 83–6

- initial colour development 87–8
- of knitted textiles 89–90
- light sources 77–9, 82–3
- of loose fibres 90
- object being observed 80–1, 83
- observer accuracy 66, 106
- observer environment 83
- observer training 86
- physical and psychological influences 82
- of pile textiles 90
- production quality control 88–9
- sample preparation 80–1, 83, 85
- sample testing 89
- standard observers 81
- and temperature 81
- viewing environment 32, 35, 82–3, 211
- of yarns and threads 90
  - see also* human vision system; perception
  - of colour
- visual instruments 48
- washing and cleaning effects 176, 223–4
- wavelengths 7–8, 29–30
- wear and tear 222–3
- wool 140
- workflow
  - in digital colour printing 188
  - in the supply chain 192, 204
- working standards 80–1, 123, 216–17
  - engineered standards 127–30
  - re-standardisation 218
- wrong decision measures 66–7
- yarns and threads 90