

Index

- academic capitalism 306–7, 331
- academic commercialization in Sweden
 - study
 - conclusion and implications 242–5
 - empirical results and analysis 234–42
 - introduction 219–21
 - literature review 221–30
 - overview 8–9, 14–15, 338
 - research design 231–4
 - research questions 230
 - academic patenting in Europe study:
 - evidence on France, Italy and Sweden
 - academic patenting in Europe and USA 188–93
 - conclusions 212–14
 - introduction and terminology 187–8
 - KEINS database and research
 - methodology 193–6
 - overview 8, 14, 337–8
 - results
 - academic patents in USA and Europe: reassessment 211–12
 - academic scientists' patenting activity 196–201, 202
 - patent ownership 201–11
 - academic staff 51, 91, 93–4, 138
 - see also* faculty exchanges; individual eminence; joint staffing; professors; researchers
- actors 309, 311, 312, 315–16, 330–31
 - see also* individuals; industry; professors; research groups; researchers; staff; students
- administrative staff 93
- age, and individual research
 - productivity 93, 177, 241
 - see also* firm age; university age
- agency problems/conflict of interest 93, 179
- agriculture 163
- Alcan 259, 266–7
- alliances 21–2, 39, 41, 344–5, 346
 - see also* university alliances and cooperation structures study; university-industry interaction
- Anglo-Saxon university model 1, 2, 93, 94, 128–9, 348
- applied research 62, 130, 164–5, 170, 172, 228–9, 266–7, 283, 284, 285, 286–7
- Aquameth dataset 101–4, 105, 108, 120, 121
- Asia 2, 28, 31, 37
- Association of University Technology Managers (AUTM) 161, 178–9, 227
- attitudes to academic commercialization 227, 229, 230, 236–9, 240, 243, 244, 245
- augmentation strategies 254, 255
- Australia 1, 2, 4, 305, 306, 344, 345
- automatic control 232, 233, 235, 249–540
- autonomy 93–4, 96–8, 104, 121, 213, 304, 306, 307
- basic research
 - and academic commercialization 228, 229
 - and conceptualizing competition in universities 318
 - and elite universities and R&D subsidiaries of multinational enterprises study 269, 270–71
 - funding 166, 169, 207
 - and linear model of innovation 283–4, 285, 286, 339
 - in post-World War II Europe 130
 - and public goods 132
 - research council policy in Sweden 66
 - and universities as production units 91, 92

- and 'university of innovation' 280, 286
- and 'university of reflection' 287, 288–90, 292, 293
- Bayh-Dole Act (1980) (USA) 165–6, 167, 168, 173–4, 182, 189, 212, 223–4
- beamtime 70, 77, 81–2
- Bercovitz, J. 166, 168–9, 170, 172
- biological sciences 49–50, 198–200, 201
- biomedical research 167, 173, 189, 223
- biotechnology
 - and academic commercialization in Sweden study 232, 233, 235, 250
 - and academic patenting in Europe study 199, 200, 201, 202–3, 205, 206–7, 208, 209
 - and commercialization 133, 220
 - and university alliances and cooperation structures study 32, 37
- block funding 132, 191
- Bologna Process 3, 32, 301, 342, 348–9
- Bonaccorsi, Andrea 4, 100, 101, 306, 307, 343
- branding 38, 40, 41–2, 43, 262, 264, 265, 267
- budgets 96, 104, 306
- business and management education 25–6, 50, 342, 344–5, 346
- business logic/model 343–4, 346
- Cambridge-MIT Institute (CMI) 5, 26–7, 36, 40, 42
- Canada *see* University of Miami-McGill University strategic alliance
- CASE 268, 269
- Center for Global Research and Development 25, 36
- centres of excellence 120, 255, 347
- CERN 68, 72
- Chalmers University of Technology 131, 140, 143–4, 146, 147, 148, 150, 152, 213, 249, 250
 - see also* Royal Institute of Technology-Chalmers University of Technology strategic alliance
- change 42–3, 44
 - chemistry 198–200, 201, 202–3, 206–7, 209, 232, 233, 345, 249
 - Clark, B. 220
 - clinical trials 265–6, 271, 272
 - CNR (Italy) 191–2, 203, 205, 206, 212
 - CNRS (France) 191, 203, 205, 206, 212
 - Cohen, W.M. 133, 219
 - collaboration 51, 318, 319, 323, 335–6, 342
 - collegiate model 94, 95, 97
 - commercialization 11, 16, 133, 219–20, 279, 339, 342, 349
 - see also* academic commercialization in Sweden study; commercialization benefits; commercialization skills; commercialization strategies
 - commercialization benefits 26–9, 31, 34, 39, 40
 - commercialization skills 228, 229, 230, 238–9, 240, 241–2, 243–4, 245
 - commercialization strategies 2, 3, 227, 239–40, 244, 300
 - commitment 42–3, 44
 - common values 38, 44
 - communication 44, 52, 54
 - see also* collaboration; networks; university-industry interaction
 - community 50, 59, 181, 300
 - competencies 311–13, 343, 348–53, 354
 - 'competent buddies' 267–70, 271, 272
 - competition, concept 302–3, 310–11
 - see also* conceptualizing competition in universities; future directions for universities
 - competitive advantage 156, 157, 348, 352
 - competitive funding 130, 132, 133, 156, 157, 304–5
 - see also* external research funding
 - complementary knowledge 268
 - computer science 232, 233, 235, 249, 286–7, 288, 289–90
 - conceptualizing competition in universities
 - discussion 322–4
 - existence of competition 302–8
 - introduction 300–302
 - meaning of learning to compete 2–3, 308–16

- overview 10, 339–40
- selection mechanisms and metrics
 - 11, 316–22
- conflict of interest/agency problems 93, 179
- consortia 21, 22, 39, 41, 171
- consultancy 262, 263, 265, 266, 267, 285
- contracts 95–6, 137, 152, 213–14, 229, 266, 267
- cooperation 21–2, 39, 41, 42–3, 44, 52, 53, 54
 - see also* university alliances and cooperation structures study; university–industry interaction
- corporate strategies 272–3
- costs
 - and future directions for universities 352
 - large-scale research facilities 67–8, 71, 73, 75, 76, 79
 - and merger and 2015 agenda at the University of Manchester study 49–50, 52–3, 61
 - and strategy and differentiation in PhD education study 96, 103, 111
 - and university technology transfer in USA 171, 176, 178
- courses 25–6, 29, 30, 32, 33, 34, 43, 50, 320, 321
 - see also* business and management education; education; executive education; masters programmes; PhD education; strategy and differentiation in PhD education study
- Cowan, R. 283–4, 286, 287–8
- critical mass
 - and elite universities and R&D subsidiaries of multinational enterprises study 171
 - and future directions for universities 343
 - and merger and 2015 agenda at the University of Manchester study 50
 - and polarization of the Swedish university sector study 132, 139, 145, 154, 156, 157
 - and university alliances and cooperation structures study 33, 35, 43, 44
- crystallography 81–2
- culture 279, 280, 291
- cumulative advantage 155–6, 157
- customers
 - and conceptualizing competition 310, 311, 316, 317, 318–22, 323
 - and elite universities and R&D subsidiaries of multinational enterprises study 264, 265
 - and future directions for universities 345, 352–3
 - and ‘university of reflection’ 286
- Dalarna University College 141, 143, 145, 146, 147, 148, 150, 152
- Daraio, Cinzia 4, 100, 101, 306, 307, 343
- Darby, M.R. 133, 228, 229, 241
- database management systems (DBMSs) 288
- Davies, L.N. 252, 255, 256
- decentralization 66–7, 75–6, 79, 86, 307
- decision-making 93–4
- deficit, in merger and 2015 agenda at the University of Manchester study 61–2
- Denmark *see* Øresund University
- density in research subjects 136, 138–9, 145–8, 153–4
- department size 134
- departments 313, 314, 315–16
- deregulation 304, 324, 346, 347
- Di Gregorio, D. 178, 227, 228, 229
- differential calculus 293
- differentiation 38, 119–20, 321–2, 323, 324, 343, 347, 354
- ‘differentiation and specialization’ theme 6–8, 11, 13, 336–7
 - see also* differentiation; polarization of the Swedish university sector study; specialization; strategy and differentiation in PhD education study
- disadvantaged students 59
- disclosures, invention 171–3, 191, 204–5, 213

- disincentives 172–3, 191, 204–5, 224, 227
- distance measures of differentiation 105, 106, 121, 122
see also MSSD (mean sum of squared distances); SSD (sum of squared distances)
- diversity 154, 156, 331–2, 351
- division of labour 99, 156–7, 304
see also strategy and differentiation in PhD education study
- Doha 343
- Dosi, G. 11, 189, 339
- Duderstadt, James J. 344, 345
- Dunning, J.H. 252, 253
- dynamic processes 310–11, 312, 324, 331, 352
- dynamic steady state science 68, 85
- e-Bay 288–9
- e-learning 32, 58, 62
- economic growth 91, 131, 132–3, 155, 164–5, 181, 219, 224, 254–5, 302, 303
- economies of scale 26–8, 29, 30, 31, 33, 34, 35, 39, 40
see also critical mass; large-scale initiatives; MAX Lab within Lund University study
- education
 and conceptualizing competition in universities 316, 317, 318–19, 320–21, 323, 324
 excellence/quality 29–30, 32, 35, 50, 51, 58–9
 and future directions for universities 341–2, 348, 353–4
 as public good 132
 and scholarship 295
 and strategy and differentiation in PhD education study 90–91, 92, 95, 98, 100, 102–3
 as university's role 181
- education-research relative orientation 142–4, 153
- education universities 131
- efficiency
 and conceptualizing competition in universities 312, 316
 and merger and 2015 agenda at the University of Manchester study 50, 60, 62
 and strategy and differentiation in PhD education study 101, 103
 and university alliances and cooperation structures study 27–8, 29, 30, 33, 35, 39, 40, 43–4
- electrical and electronic engineering 198, 199, 200, 201, 202, 203, 205, 206–8, 209
- elite universities 3, 162, 345–6, 347, 354
see also elite universities and R&D subsidiaries of multinational enterprises study; Golden Triangle; Grandes Ecoles; Ivy League universities; ranking elite universities and R&D subsidiaries of multinational enterprises study attracting knowledge economy 271–3
 collaboration with elite universities 261–4
 ideal types of firm strategies 265–71
 introduction 251–2
 overview 9, 15, 338–9
 R&D localization and university-industry linkages 252–6
 research design and methodology 256–61
- 'emergent strategy' theme 5–6, 11, 12, 333–6, 348
see also MAX Lab within Lund University study; merger and 2015 agenda at the University of Manchester study; university alliances and cooperation structures study
- employment 58, 320, 321
- empowering collegiality 60
- engineering 26, 31, 32, 37, 49–50, 163, 164, 198–200, 201, 202, 256
- entrepreneurship 26, 119, 120, 133, 219, 221
see also academic commercialization in Sweden study; incubators; spin-out companies
- entropy 104–5, 122
- equity 176, 178
- Eriksson, Mikael 71, 75

- ETH Zurich 258, 261, 266, 267, 268–70
see also elite universities and R&D subsidiaries of multinational enterprises study
- Etzkowitz, H. 163, 226, 241, 308, 318
- European Paradox 11, 16, 189–90, 339
- European Union 11, 189, 280
- excellence 29, 58–9, 120, 255, 304, 305, 343, 345–6, 347, 350–51
see also quality management; quality of education; quality of research; scientific excellence; ‘university of excellence’; world class research; individual eminence
- executive education 25, 62
- experimentation and discovery 343, 344, 345, 348
- exploitation strategies 254, 255
- external research funding
 and conceptualizing competition in universities 306–7, 324
 European universities 130–31
 and individual research eminence 133
 and merger and 2015 agenda at the University of Manchester study 53, 54, 57, 58, 60, 61
 and polarization of the Swedish university sector study 129, 132, 135, 136, 137, 149–52, 154–5, 156, 157
 and quality of research 133–4, 324
- faculty 2, 93, 300
- faculty exchanges 31, 34
- federations 22, 39, 41, 50, 51
- fee income 59, 60, 62, 96, 103, 107, 285, 301, 306
- Feldman, M. 170, 171, 172, 176, 181, 255
- financial constraints 94, 96
- Finland 109–10, 118, 119–20, 192
- firm age 134
- firm size 134
- firms, universities as 285, 307–8, 322, 330
see also industry; university-industry interaction
- flexibility 330–31, 344
- fluid mechanics 232, 233, 235, 249
- follow-on funding 28, 36
- foreign direct investment 35, 252, 253, 255, 272
- Forkman, Bengt 73, 74, 79, 84
- foundations
 Sweden 132, 137, 152, 155, 190, 213
 USA 164, 165, 166–7, 168, 169, 170, 181, 182, 212
- France 82, 107, 182, 191, 203–4, 205, 206, 212, 279, 282
see also academic patenting in Europe study: evidence on France, Italy and Sweden; Wharton-INSEAD Alliance
- funding
 and future directions for universities 352–3
 and strategy and differentiation in PhD education study 91, 92, 94, 95–6, 97, 98, 100, 103–4, 107, 110, 111, 113–15, 119–20
 and university alliances and cooperation structures study 26–9, 31, 32, 35, 36, 39, 40, 42, 43, 44
see also block funding; competitive funding; external research funding; fee income; follow-on funding; government funding; industry-funded research; performance-based funding; private funding; research funding; research infrastructure funding; revenues; seed capital; undergraduate education funding; venture capital
- Funding Council (UK) 53, 58–9
- future directions for universities
 conclusions 353–5
 learning to compete 2, 332–40
 new competitive regime 340–53
 creating change through strategy and competencies 2, 3, 347–53
 restructuring through opportunities and pressures 340–47
 overview 10
 propositions 330–32

- geographical contiguity 50, 55, 342
 geographical distance 42, 43
 Germany 31–3, 37, 40, 107, 163, 182, 229, 279, 300, 343, 346
 Gerybadze, A. 253, 254
 Geuna, Aldo 2, 4, 130, 131, 138, 139, 153, 155, 191, 192, 255, 318
 Gilbert, Alan 54
 Glasgow-Strathclyde Universities Strategic Alliance (Synergy) 33–4, 37, 40
 global university sectoral innovation system 313, 314–15, 348
 globalization
 and elite universities and R&D subsidiaries of multinational enterprises study 252, 253, 256
 and future directions for universities 2, 330–31, 343, 348
 and merger and 2015 agenda at the University of Manchester study 50
 of students, resources and faculty 2, 300
 and university alliances and cooperation structures study 25, 30, 32, 38, 43
 Golden Triangle 48, 51, 62–3
 see also Imperial College, London; University of Cambridge
 Goodhardt, C. 281, 295
 Gothenburg University 131, 140, 143, 146, 147, 148, 150, 152
 Gotland College 141, 142, 143, 144, 146, 147, 148, 150, 152
 governance 50, 94, 95, 97, 100
 government funding
 and conceptualizing competition in universities 304–5, 306, 324
 MAX Lab within Lund University 74
 and polarization of the Swedish university sector study 137, 152
 and public and private goods 278, 284–5, 301
 research in European universities 130–31, 191, 203–4, 207
 research in Swedish universities 131–2
 research in USA 164, 165, 166, 171, 182, 223
 and strategy and differentiation in PhD education study 95–6, 103, 104, 107, 114–15, 119–20
 and university alliances and cooperation structures study 27–8, 29
 government policies
 education, science and innovation 2, 300, 313, 314, 332, 340
 PhDs, in strategy and differentiation in PhD education study 110, 113, 114–15, 119
 research 65–9, 71–2, 73, 74, 79, 86, 130–32, 272–3
 see also intellectual property policies
 government regulation 213, 265, 266, 304
 government research laboratories 182, 191–2, 203–4, 205, 206–7, 212
 government-university relations 95–6, 318, 319, 320, 321, 324
 graduates
 and conceptualizing competition in universities 318, 319, 320, 321
 and ‘university of innovation’ 285, 286
 and ‘university of reflection’ 287, 288, 289, 290, 293–4, 295
 Grandes Ecoles 32, 279, 282
 Harman, K. 19–20, 21–2, 39, 41
 Harvard University 162, 173, 307, 323, 346
 Hegde, D. 256, 272
 Henrekson, M. 221, 224, 226
 Hicks, D. 226, 256, 272, 305
 Hitachi 259, 270
 Holmén, Magnus 222, 309, 313
 human capital 286, 295, 318, 319, 320, 321, 350–51
 IBM 268–9, 288
 IDEA League 31–3, 37, 40
 Imperial College, London 31–3, 37, 40, 347
 incentives
 and academic commercialization 226, 227, 239–40

- and strategy and differentiation in
 - PhD education study 119–20
 - ‘university of innovation’ 279–80
 - and university production units 94
 - and university technology transfer in
 - USA 171, 173, 174, 176–7, 178, 213
- inclusivity 49, 59
- incubators 168, 180, 227, 228
- individual eminence 133, 155–6, 157, 228, 229, 241, 306
- individual research productivity 93, 177, 241
- individually-owned patents 192, 204, 205, 208, 209
- individuals 3, 228–30, 236–8, 244–5, 313, 314, 315–16, 317, 350–51
- industrial research 83–4, 91, 164, 166, 225
 - see also* elite universities and R&D subsidiaries of multinational enterprises study; industrial research laboratories; university-industry interaction
- industrial research laboratories 164, 281, 284
- industrial work experience 238–9, 242, 245
- industry 133, 163–4, 280, 281, 283, 287, 318–19, 320, 321
- industry-funded research
 - and merger and 2015 agenda at the University of Manchester study 58, 61
 - and polarization of the Swedish university sector study 135, 137, 152, 155
 - and quality of research 133–4
 - statistics 131
 - and ‘university of innovation’ 280
 - USA 165, 166, 169–71, 182
- industry-owned patents
 - academic patenting in Europe 191, 193, 203, 204, 205, 206–7, 208, 209–10, 211, 212, 213–14
 - USA 192, 203, 212
- informal agreements 77–8, 79, 82, 85, 86
- informal networks 267, 268, 270, 342
- information provision 44, 52, 54
- infrastructure 52–3, 91, 266, 269, 271
 - see also* large-scale research facilities; MAX Lab within Lund University study; research infrastructure funding; small-scale research facilities
- innovation
 - and future directions for universities 352
 - in late 20th century Europe 130
 - linear model 283–6, 339
 - and perfect competition 303
 - and university alliances and cooperation structures study 25, 26–7, 28, 33, 35, 36
 - and ‘university of innovation’ 279–81, 283–6, 290–91
 - and ‘university of reflection’ 285–90, 291–7
 - university’s role 181, 254–6
- inorganic chemistry 232, 233, 235, 249
- inputs 91, 92, 95, 99, 101, 107, 344
- INSEAD-Wharton Alliance 24–6, 35, 36, 40, 42, 346
- INSERM (National Institute of Health and Medical Research) (France) 191, 203, 205, 206, 212
- intellectual property policies
 - Europe 188–9, 190, 191, 192, 208–10, 212, 214
 - and merger and 2015 agenda at the University of Manchester study 58
 - Sweden 190, 204, 209–10, 212, 224, 225, 226, 244
- intellectual property rights
 - Europe 188–90, 191, 205, 207, 208–10, 212, 214
 - professor’s privilege 190, 191, 204, 212, 224, 244
 - USA 165–6, 167, 168, 169, 170–71, 173–4, 176, 177–8, 181, 182, 189, 212, 213, 223–4, 225
- inter-personal relationships 42, 256
- International Alliance of Research Universities 34–5, 37, 40
- international competition 2, 4, 97, 99, 108, 121, 323, 332

- international higher education ranking 3–4, 11, 56, 60, 61, 93, 258, 281, 282
- international image 25, 26–7, 34–5, 39, 40, 56, 60, 61, 108, 120
- international networks 262
- international research facilities 65, 82
see also CERN; MAX Lab within Lund University study
- international students
 and competition in universities 4, 300
 and future directions for universities 2, 345, 346
 and merger and 2015 agenda at the University of Manchester study 49, 59, 62
 and strategy and differentiation in PhD education study 107, 108, 112, 120, 121
 and university alliances and cooperation structures study 25, 30, 32, 37, 43
- invention disclosures 171–3, 191, 204–5, 213
- investment *see* foreign direct investment; funding; human capital; large-scale investment; venture capital
- IT systems 54, 269
- Italy 115–17, 118, 119, 191–2, 203–4, 205, 206, 212
see also academic patenting in Europe study: evidence on France, Italy and Sweden
- Ivy League universities 48, 62–3, 344
see also Harvard University
- job losses 53, 61
- joint courses 25–6, 29, 30, 31, 32, 33, 34, 37, 43
- joint grant schemes 27–8, 32
- joint marketing of research and teaching 31, 33, 34, 39, 40
- joint publications 25, 27, 36
- joint research 25–9, 30, 31, 32, 33, 34, 36, 43, 50, 262, 263
- joint staffing 262, 263, 270
- joint ventures 50, 262, 263
- Karjoth, Günter 268–9
- Karolinska Institute 31, 37, 131, 140, 142, 143, 146, 147, 148, 149, 150, 152, 205, 207, 258, 260, 265, 267, 270, 271
see also elite universities and R&D subsidiaries of multinational enterprises study
- KEINS database 193–6
- knowledge 229, 230, 239, 240, 245, 283, 300–301, 317, 318
see also complementary knowledge; experimentation and discovery; information provision; innovation; knowledge-based services; knowledge businesses; knowledge transfer; learning by universities; local knowledge; new knowledge; scarce knowledge; tacit knowledge
- knowledge-based services 3, 305–6, 315–16, 317–22, 323, 324, 346, 348, 350–51, 353–4
- knowledge businesses 3, 301, 309–10, 342–3, 345–6, 350
- knowledge transfer 57–8, 61, 133, 219, 252–3, 254, 255, 269, 272, 280, 317
- Krafft, J. 310, 311
- Kuemmerle, W. 252, 254
- Kuhn, T.S. 292–3
- land-grant educational institutions 162–3, 167, 182
- Lang, W.D. 21, 22, 39
- large-scale initiatives 65, 66, 306–7, 343, 346, 347, 350
- large-scale investment 52–3, 67–8, 71
see also MAX Lab within Lund University study
- large-scale research 4, 65, 66
- large-scale research facilities 65, 66, 67–8, 71, 72, 82, 347
see also MAX Lab within Lund University study
- Larger (and older) Research and Teaching Intensive universities 143–4, 145, 146, 147, 148–9, 151, 153, 154, 155, 156
- lawsuits 174, 175

- leadership 39, 40
see also top-down management
- learning by universities 2–3, 342, 343, 344, 352
- LeBas, C. 254, 264
- legal framework/legislation
 intellectual property rights in
 Europe 188–90, 191, 205, 208
 intellectual property rights in USA
 165–6, 167, 168, 173–4, 182,
 189, 212, 223–4
- land-grant educational institutions
 in USA 162–3, 182
- and strategy and differentiation
 in PhD education study 96,
 100
- Leslie, Larry L. 2, 161, 306–7, 308
- licensing
 and academic commercialization in
 Sweden study 235
 USA 166, 167, 168, 170–71, 172,
 173, 175–7, 178, 181, 183, 214,
 223, 227
- licensing revenues 175–6
- life cycle models 93, 177
- Link, A. 177
- Linköping University 131, 140, 143,
 144, 146, 147, 148, 150, 152, 249,
 250
- Lissoni, F. 193–4, 235
- literature 291
- local economic development 163, 181,
 183
- local education and research 2, 348
- local government 163, 165
- local knowledge 267, 268, 272
- localization of R&D 252–6, 267–70,
 271, 272, 273
- Lockett, A. 227, 238, 243, 244
- long timescales 280, 281, 282, 283, 284,
 286, 287, 295–6, 331
- Luleå University of Technology 140,
 143, 144, 146, 147, 148, 149, 150,
 152, 249, 250
- Lund University 131, 140, 142, 143,
 145, 146, 147, 148, 150, 152, 249,
 250
see also MAX Lab within Lund
 University study
- LUSY 72–3
- Malmö University 140, 142, 143, 144,
 146, 147, 148, 150, 152
- management 44–5, 50, 60, 70–71, 93–4,
 343, 344, 350, 352, 353
see also business and management
 education; database
 management systems (DBMS);
 decentralization; leadership;
 quality management; top-down
 management
- Manchester Federal School of
 Business and Management 50
- Mansfield, E. 133–4, 226, 255, 318
- market capitalization 28, 36
- market size 99, 342–3
- marketing 31, 33, 34, 39, 40, 264, 284
- markets
 and conceptualizing competition
 310, 311
 and conceptualizing competition in
 universities 11, 305–6, 322, 323
 and elite universities and R&D
 subsidiaries of multinational
 enterprises study 252–3, 254,
 256, 264, 265, 267, 268
 and future directions for universities
 342, 348–9
 and polarization of the Swedish
 university sector study 156–7
 and strategy and differentiation in
 PhD education study 91, 92, 97,
 99
 ‘university of reflection’ versus
 ‘university of innovation’ 291–4
- Martin, B.R. 133, 219, 255, 318
- mass education 3, 343, 345–6, 354
- masters programmes 25, 26, 31, 32, 37,
 43, 342, 346
- materials sciences 32, 50
- Matthew effect 130, 155–6, 157
- MAX Lab within Lund University study
 conclusions 86–7
 development of MAX Lab 69–78
 expansion and growth 78–80
 introduction: large-scale research
 facilities and Swedish research
 policy 65–9
 outlook 84–5
 overview 6, 12, 334–5
 user involvement 80–84, 85, 86

- MBA's 25, 26, 342, 346
- McGill University-University of Miami strategic alliance 31, 36, 40
- McKelvey, Maureen 263, 309
- medical schools 167
- medical sciences and technologies 29, 37, 198, 199, 202
- Meek, V.L. 19–20, 21
- merger and 2015 agenda at the University of Manchester study 2015 agenda 55–63
introduction 48
overview 5–6, 12, 334, 335
process of change 52–5
rationale for merger 49–52
- mergers 21, 22, 39, 41, 304, 335–6, 344
- Merton, Robert K. 155, 157, 300
- metrics 101, 305, 319–22, 323, 341–2, 350
see also ranking
- Meyer, K.E. 252, 255, 256
- Meyer-Krahmer, F. 229, 255, 271
- military research 164, 182
- MIT 167, 171, 173, 181, 189, 221, 243, 245, 344
- Mitt University 140, 142, 143, 144, 146, 147, 148, 150
- Morrill Acts (1862 and 1890) (USA) 162–3, 182
- Mowery, D.C. 166, 167, 172, 173, 174, 175, 189, 201, 202, 211, 212, 213, 223, 255, 257
- MSSD (mean sum of squared distances) 105, 106, 108, 118, 119–20
- multinational enterprises *see* elite universities and R&D subsidiaries of multinational enterprises study
- national innovation system 222, 223–5
- National Institutes of Health (NIH) 164, 169, 212
- national policies *see* government policies
- National Science Foundation 164, 165, 169, 170, 182, 212
- Nelson, R.R. 181, 225, 271, 283
- Netherlands 31–3, 37, 40, 110–11, 118, 119, 120
- networks
and conceptualizing competition in universities 318
and elite universities and R&D subsidiaries of multinational enterprises study 252, 262, 264, 267, 268, 270–71, 272, 273
and future directions for universities 342, 345, 349
- new knowledge 301, 303, 317, 318, 319, 320
- new products and services 303
- niche education and research areas 11, 156, 157, 344–5, 346, 354
- Nobel Prizes 30, 37, 56, 60, 80, 84, 281
- non-disclosure, invention 172–3, 205
- non-industrial contract research 137, 152
- normal scientific research 292–3, 294, 295, 354
- NU-database (National Agency for Higher Education) 135, 136, 137, 138
- nuclear technologies 205, 207
- objectivity 281, 282, 283
- opportunities 41, 43–4, 263, 264, 311, 312–13, 319, 341–7, 350
- Örebro University 140, 143, 146, 147, 148, 149, 150, 152
- Øresund University 29–30, 37, 40, 42
- O'Shea, R.P. 241, 243, 244–5
- outputs 90–91, 92, 95, 98–9, 100, 107, 344
- outsourcing 76–8, 252, 335–6, 344–5
- Park, D. 302, 310, 311
- participation 44, 45, 52, 76–8, 85, 86
- particle accelerators 68, 69, 72–3, 74–5, 82
see also MAX Lab within Lund University study
- patents
academic patenting in Europe versus USA 188–93, 201, 202, 211–12
citations 225, 226, 229
and elite universities and R&D subsidiaries of multinational enterprises study 263
legislation in Europe 188–90, 205

- and university-industry interaction 255
- and 'university of innovation' 280, 284
- and university technology transfer in USA 166, 167, 168, 172, 173–5, 178, 221, 223–4, 225
- see also* academic commercialization in Sweden study; academic patenting in Europe study; evidence on France, Italy and Sweden
- perfect competition 302–3
- performance-based funding 110, 115, 304, 305, 306, 341
- personal interaction 42, 256
- personalized learning 59, 62
- pharmaceuticals
 - and academic patenting in Europe study 199, 200, 201, 202–3, 205, 206–7, 208, 209
 - collaboration, mergers and outsourcing 335
 - and elite universities and R&D subsidiaries of multinational enterprises study 265–6, 271, 272
 - government regulation 265, 266, 304
- PhD education 94, 95, 97, 107–8, 122
 - see also* strategy and differentiation in PhD education study
- PhD intensity, in strategy and differentiation in PhD education study 103, 105, 106, 107, 108, 109–10, 111–12, 113, 114–15, 116–17, 118
- PhD students 92, 138, 140–41, 320, 321
- philosophy 291
- physical sciences 49–50, 198–200
- physics 78–9, 80–81, 82–3, 84
- polarization of the Swedish university sector study
 - descriptive characteristics of Swedish universities 129, 139–49
 - discussion and conclusion 153–7
 - external research funding 129, 132, 135, 136, 137, 149–52, 154–5, 156, 157
 - introduction 128–30
 - overview 7–8, 13, 336
 - research design 135–9
 - theoretical overview 130–35
- policies *see* government policies
- positioning 11, 95, 99, 100, 121, 156, 323, 324, 342
- postgraduate research student completions 57
- presidential model 94, 95, 97
- price competition 303, 305–6, 310
- private funding 26, 28, 35, 44, 103, 104
 - see also* external research funding; industry-funded research
- private goods 284–5, 301
- private universities 162, 213
- problem-solving research
 - and academic commercialization 229
 - and conceptualizing competition in universities 318–19
 - and elite universities and R&D subsidiaries of multinational enterprises study 263, 265, 266–7, 271, 272, 273
 - and external funding 134
 - and 'university of reflection' 286–7, 288, 289–90
- product development 266–70, 283
- production units 90–94, 95, 98–9, 100, 107
- productivity 26, 62
 - see also* research productivity; individual research productivity
- products 291, 310, 311
 - see also* knowledge-based services; private goods; product development; public goods
- professors
 - and academic patenting in Europe study 190, 191, 196–201, 202, 204–5, 212
 - and polarization of the Swedish university sector study 138, 140–41, 142–9, 153, 154
- professor's privilege 190, 191, 204, 212, 224, 244
- profiling 35, 38, 40, 43
- projective geometry 289, 290
- PRTs (Participating Research Teams) (MAX Lab) 77, 85

- public goods
 - graduates 285
 - and justification of government funding 278, 285, 301
 - scholarship 290–94, 295, 296–7
 - societal benefits 132–3
 - technology transfer 163, 182
 - ‘university of culture’ 279, 291
 - ‘university of excellence’ 281–3
 - ‘university of innovation’ 279–81, 283–6, 290–91
 - ‘university of reflection’ 285–90, 291–6
- public research foundations 132, 137, 152
- public research organizations 182, 191–2, 203–4, 205, 206–7, 212
- public universities 162–3, 213
- publication
 - and academic commercialization 240–41
 - and conceptualizing competition in universities 306
 - and linear model of innovation 284
 - and merger and 2015 agenda at the University of Manchester study 57, 60, 61
 - and patent citations 225, 226, 229
 - and universities as production units 91, 92
 - and ‘university of innovation’ 280, 285
 - and university technology transfer in USA 172
 - see also* quality of research; research productivity
- quality management 33
- quality of education 29–30, 32, 35, 50, 51, 58–9
- quality of research
 - and academic commercialization 228, 229–30
 - and external funding 133–4, 324
 - and Matthew effect 155–6, 157
 - and performance-based funding 304, 305, 341
 - Swedish universities 132
 - and university-industry interaction 226
- see also* excellence; research productivity; star scientists; world class research; individual eminence
- Rahm, Diane 163, 164, 166
- ranking 3, 56, 60, 61, 93, 258, 281–3, 320, 321, 341, 342
- RCA (revealed comparative advantage), in polarization of the Swedish university sector study 151–2
- R&D subsidiaries *see* elite universities and R&D subsidiaries of multinational enterprises study
- Readings, B. 279, 283
- recruitment
 - and elite universities and R&D subsidiaries of multinational enterprises study 262, 268, 269, 270
 - and merger and 2015 agenda at the University of Manchester study 49
 - and university alliances and cooperation structures study 29, 30, 32, 37, 39, 40, 43
- reflection 285–90, 291–6
- ‘reflections’ theme 9–10, 16, 339–40
 - see also* conceptualizing competition in universities; future directions for universities; running the marathon
- Reger, G. 253, 254, 255
- regional economic growth 155, 254–5
- regional universities 131–2, 155
 - see also* Smaller (and younger) Education Dependent HEIs
- renewal 25–8, 29, 30–31, 32, 33, 35, 39, 40, 43
- reputation 282–3, 288–9, 295–6, 320, 321–2
 - see also* elite universities; international image; metrics; ranking; individual research eminence
- research
 - commercialization 133, 220
 - and conceptualizing competition in universities 3, 316, 317, 318, 319, 320, 323, 324

- and economic growth 132, 133
- and future directions for universities 341–2, 348, 353–4
- industry impacts 133
- and knowledge transfer 133, 219
- and merger and 2015 agenda at the University of Manchester study 49, 50, 54
- and strategy and differentiation in PhD education study 90–91, 92, 93, 95, 99, 100, 103
- research areas 67
- Research Assessment Exercise (RAE) (UK) 49, 56–7, 59, 114–15, 305, 341, 348
- research councils 66, 67, 70, 73, 74, 75, 76–7, 78–9, 85, 110, 137, 152
- research-education relative orientation 142–4, 153
- research expenditure 57, 60–61, 140–41
- research funding
 - European universities 130–31, 191, 203–4, 207
 - and Matthew effect 155–6, 157
 - and merger and 2015 agenda at the University of Manchester study 50, 53, 58
 - and polarization of the Swedish university sector study 137, 152
 - and strategy and differentiation in PhD education study 110, 113–14
 - Swedish universities 66–7, 131–2
 - USA 164, 165, 166, 169–71, 178, 182, 189
- research groups 228–30, 236–7, 313, 314, 315–16, 321, 350–51, 354
- research infrastructure 108, 266, 269, 271
 - see also* large-scale research facilities; MAX Lab within Lund University study; research infrastructure funding; small-scale research facilities
- research infrastructure funding 67, 72, 73, 74, 75–7, 79
- research intensity 103, 132, 134, 135, 136, 139, 153
- research orientation 228–9, 230
 - see also* applied research; basic research; research-education relative orientation; subject disciplines
- research policies, government 65–9, 71–2, 73, 74, 79, 86, 130–32, 272–3
- research problem complexity 50
- research productivity
 - and academic commercialization 228, 240–41
 - of individuals 93, 177, 241
 - and Matthew effect 155–6, 157
 - and polarization of the Swedish university sector study 132, 135, 136, 139, 148–9, 154, 155, 156–7
- research universities 131, 300
- researchers 138–9, 140–141, 142–9, 153–4, 318
- resources
 - and competition in universities 300
 - and conceptualizing competition in universities 312
 - and future directions for universities 2, 330–31, 340, 352–3
 - and Matthew effect 155–6, 157
 - and merger and 2015 agenda at the University of Manchester study 50, 59–60
 - and university alliances 19–20, 38, 43
- restructuring 50, 53–4, 340–47
- ‘rethinking university-industry relations’ theme 8–9, 11, 14–16, 337–9
 - see also* academic commercialization in Sweden study; academic patenting in Europe study; evidence on France, Italy and Sweden; elite universities and R&D subsidiaries of multinational enterprises study; university technology transfer in USA study
- revenues 59–60, 140–41, 175–6, 181, 224, 244
 - see also* fee income; funding
- revolutionary science 292, 293, 295
- risks 41–3
- rivalry 310–11

- Rosenberg, N. 221, 224
- Royal Institute of Technology 131, 140, 143, 146, 147, 148, 150, 152, 249, 250
- Royal Institute of Technology-Chalmers University of Technology strategic alliance 23, 30–31, 37, 40
- royalties 171, 176–7, 178, 213, 214, 227
- ‘running clinical trials’ 265–6, 271, 272
- running the marathon
introduction 278–83
overview 9–10, 339
scholarship as a public good 290–94
universities competing naturally 294–6
‘university of innovation’ 283–5
‘university of reflection’ 285–90
- Salter, A.J. 133, 219, 255, 318
- Sampat, B.N. 166, 173, 174, 189, 201, 202, 211, 212, 213, 255, 257
- satisfaction 58–9, 60, 94
- Saviotti, P.P. 310, 311
- scarce knowledge 317, 319
- scholarship 290–94, 295
- Schumpeterian perspective 303, 304, 310–13, 343
- science
and academic commercialization 228, 229, 230
dynamic steady state concept 68, 85
and economic growth 133
and elite universities and R&D subsidiaries of multinational enterprises study 256
and industry in USA 163–4
as public good 132
and university alliances and cooperation structures study 27, 28, 37
and university-industry interaction 134
and ‘university of innovation’ 279–80
- science parks 168, 180, 227
- scientific and control instruments 200, 201, 202–3, 209
- scientific excellence 70, 71, 78, 155–6, 157
- ‘seamless networks’ 270–71, 272
- selection, recruitment and promotion 93–4, 96, 97, 98
- selection environment 311–12, 341–2, 348, 354–5
- selection mechanisms 316–22, 323
- SETsquared Partnership - Universities: Bath, Bristol, Southampton, Surrey 27–8, 36, 40
- Shane, S. 178, 227, 228, 229, 313
- Shanghai Jiao Tong Academic Ranking of World Universities 3, 56, 60, 281, 282
- short timescales 280, 281, 283, 284, 286, 287, 301, 331
- Siegbahn, Kai 80, 84
- Siegel, D. 177, 244, 256
- Sierra, C. 254, 264
- Silent Aircraft Initiative 26–7
- size *see* department size; firm size; university size
- Slaughter, Sheila 2, 161, 306–7, 308
- small-scale research 65
see also MAX Lab within Lund University study
- small-scale research facilities 71, 74–5, 78, 79, 80
- Smaller (and younger) Education Dependent HEIs 144, 145, 146, 147–9, 151, 153–4, 155, 156–7
- Smith, Adam 99, 156
- Smith-Lever Act (1914) (USA) 163, 182
- social cohesion 11, 280
- social problem solutions 91, 132, 318, 319, 320, 321
- society 11, 316, 317, 324, 331, 353
- software development 286–7
- ‘solution demanders’ 266–7, 271, 272, 273
- Spain 115, 116, 118, 119
- specialization
and conceptualizing competition in universities 321, 323, 324
and future directions for universities 332, 342–3, 344–5, 346, 347, 354
and merger and 2015 agenda at the University of Manchester study 49

- Swedish universities 131, 138–9, 144, 154, 156–7
 and university alliances and cooperation structures study 28, 35, 44
see also ‘differentiation and specialization’ theme
- spin-out companies
 and conceptualizing competition in universities 318, 319
 and economic growth 224
 effectiveness 221–2
 and merger and 2015 agenda at the University of Manchester study 58, 61
 and quality of research 228
 and university alliances and cooperation structures study 27, 28, 36
 University of Cambridge 180, 182
 and university technology transfer in USA 176, 177–9, 180, 181, 183, 189, 227
see also academic commercialization in Sweden study
- SSD (sum of squared distances) 105–6, 108, 109, 110, 111, 112–13, 114, 115–16, 117
- staff 60, 91, 93–4
see also academic staff; individual eminence; professors; researchers; staff cooperation; staff costs; staff involvement
- staff cooperation 42–3, 44, 52, 53, 54
 staff costs 61, 96
 staff involvement 44, 52
- Stanford University 181, 189, 223, 346
- star scientists 133, 228, 229
- start up companies *see* spin-out companies
- state universities 162–3
- Stockholm School of Economics (HHS) 131, 141, 143, 144, 146, 147, 148, 149, 150, 152, 213
- Stockholm University 131, 140, 143, 146, 147, 148, 149, 150, 152, 249
- strategy
 concept 94–5, 99
 and conceptualizing competition in universities 307–8, 309, 321–2, 323, 324
 and future directions for universities 2, 3, 331, 347–53
see also augmentation strategies; Bologna process; commercialization strategies; corporate strategies; ‘emergent strategy’ theme; exploitation strategies; strategy and differentiation in PhD education study; technology-seeking strategies
- strategy and differentiation in PhD education study
 conclusions 120–21
 defining differentiation of universities 100–104
 introduction 90
 measuring differentiation 104–6
 national patterns of differentiation in PhD education 107–17
 overview 6–7, 13, 336
 quantitative comparative analysis of differentiation in PhD education 117–20
 strategy, differentiation and positioning of universities in the European context 94–9
 university as a production unit 90–94
- Strathclyde-Glasgow Universities Strategic Alliance (Synergy) 33–4, 37, 40
- student cooperation 42–3, 44, 52, 54
 student exchanges 25, 26, 27, 31, 34
 student fee income 59, 60, 62, 96, 103, 107, 285, 301, 306
 student involvement 44, 52
- students
 and conceptualizing competition in universities 316, 317, 318, 319, 320–21
 and merger and 2015 agenda at the University of Manchester study 49, 50, 52, 54, 58–9
 and polarization of the Swedish university sector study 140–41, 142–4, 153

- see also* international students; PhD students; student cooperation; student exchanges; student fee income; student involvement
- subject disciplines
and academic commercialization 228–9, 230, 235
and academic patenting in Europe study 198–203, 205, 207–9
and elite universities and R&D subsidiaries of multinational enterprises study 271–2
and university alliances and cooperation structures study 26
see also research areas; individual subject disciplines
- subjectivity 283
- support structures *see* university support structures
- Sweden
foundations 132, 137, 152, 155, 190, 213
government research policy 65–9, 71–2, 73, 74, 79, 86, 131–2
research councils 66, 67, 70, 73, 74, 75, 76–7, 78–9, 85, 137
see also academic patenting in Europe study; evidence on France, Italy and Sweden; elite universities and R&D subsidiaries of multinational enterprises study; MAX Lab within Lund University study; Øresund University; polarization of the Swedish university sector study; Royal Institute of Technology-Chalmers University of Technology strategic alliance; Uppsala University
- Swedish Research Council 66, 67, 70, 73, 74, 75, 76–7, 79, 85
- Swedish University of Agricultural Studies 140, 142, 143, 144, 146, 147, 148, 150, 152, 249
- Switzerland 111–12, 113, 118, 119, 120
see also elite universities and R&D subsidiaries of multinational enterprises study; IDEA League
- synchrotron radiation and synchrotron radiation laboratories 69–70, 73–4, 80, 81, 82, 86
see also CERN; LUSY; MAX Lab within Lund University study
- synergies 25–31, 33, 34–5, 38, 40, 43, 353–4
- tacit knowledge 229, 230, 245, 256
- teaching *see* courses; education; students; teaching load
- teaching load 100–101, 102, 103
- technology 26–7, 28, 36, 37, 200–203, 205, 207–9, 228–9, 230
- technology-seeking strategies 254
- technology transfer offices 166–9, 171–2, 173, 181, 224, 227, 228
see also university technology transfer; university technology transfer in USA study
- telecommunications 201, 202–3, 206–8
- Texas A&M 343
- third mission 95, 99, 100, 103–4, 317, 319, 320, 321, 323
- Thursby, J.G. 170, 172, 177, 192, 204, 205, 211, 212–13, 223–4, 257
- Thursby, M.C. 170, 172, 177, 180, 223–4, 257
- timescales 237–8, 239, 286, 287–8, 293–4, 295–6, 331
see also long timescales; short timescales
- top-down management 3, 307–8, 343, 350, 351, 352, 353
- traditions 41–2, 43
- training 228, 238, 240, 241–2, 243, 245
- transformation 309–10
- triple helix university-local government-industry relations 163
- truth 291–2
- UK 3, 4, 48, 50–51, 112–15, 118, 119, 120, 227, 347
see also Cambridge-MIT Institute (CMD); elite universities and R&D subsidiaries of multinational enterprises study; Glasgow-Strathclyde Universities Strategic Alliance (Synergy); IDEA League;

- Imperial College, London;
merger and 2015 agenda at the
University of Manchester
study; Research Assessment
Exercise (RAE) (UK);
SETsquared Partnership –
Universities: Bath, Bristol,
Southampton, Surrey;
University of Cambridge;
University of Nottingham;
White Rose University
Consortium
- Umeå University 140, 143, 144, 146,
147, 148, 150, 152
- UMIST *see* merger and 2015 agenda at
the University of Manchester
study
- uncertainty 92, 312, 343–4, 351
- undergraduate education funding 149,
150, 151, 152, 153
- university alliances and cooperation
structures study
alliances considered 24–35, 36–7
discussion: terminology,
opportunities and risks 39,
41–5
introduction: terminology 19–21
methods of analysis 23–4
overview 5, 12, 333–4, 335
research background and
terminology 21–2
synthesis of motives 35–9, 40
- universities
contracts with governments 95–6
as firms 285, 307–8, 322, 330
future directions for universities
see future directions for
universities
as organizations 313, 314
as production units 90–94, 95, 98–9,
100, 107
systems 162–3, 182, 213, 300, 343,
346
- university age 136, 138, 139–42, 143–4,
153
see also Larger (and older) Research
and Teaching Intensive
universities; Smaller (and
younger) Education Dependent
HEIs
- university–industry interaction
and academic commercialization
229–30
and conceptualizing competition in
universities 306
and future directions for universities
3, 342
Germany 163
and quality of research 226
and regional economic growth
254–5
Sweden 132–5, 225
and technology transfer in American
universities 171, 180, 182
and university alliances and
cooperation structures study 26,
27–8, 29, 44
and ‘university of innovation’ 280,
284–5
and ‘university of reflection’
286–9
USA 163, 164–5
see also elite universities and R&D
subsidiaries of multinational
enterprises study
- University of Cambridge 180, 182,
258, 260, 270, 271, 272
see also Cambridge-MIT Institute
(CMI); elite universities and
R&D subsidiaries of
multinational enterprises
study
- ‘university of culture’ 279, 280,
291
- ‘university of excellence’ 281–3
- ‘university of innovation’ 279–80,
283–6, 290–91, 293
- University of Miami-McGill
University strategic alliance 31,
36, 40
- University of Nottingham 344
- ‘university of reflection’ 285–90,
291–6
- university-owned patents
and academic patenting in Europe
study 203, 204, 205, 206–7,
208–10, 211, 212, 214
Europe versus USA 189–90, 192–3,
202, 213–14
terminology 187

- university size 132, 136, 138, 139–42, 143–4, 153
 - see also* Larger (and older) Research and Teaching Intensive universities; Smaller (and younger) Education Dependent HEIs
- university support structures 222, 225–8, 239–40, 244, 245
 - see also* incubators; science parks; technology transfer offices
- university technology transfer 16, 27, 221, 222–4, 226, 227, 342
 - see also* incubators; intellectual property rights; invention disclosures; licensing; patents; publication; merger; science parks; spin-out companies; university technology transfer in USA study
- university technology transfer in USA study
 - history 162–6
 - introduction 161–2
 - mechanisms 169–80, 181, 183
 - overview 8, 14, 337
 - reflective conclusions 181–3
 - technology transfer offices 166–9, 171–2, 173, 181
- Uppsala University 80, 84, 131, 140, 143, 146, 147, 148, 150, 152, 249, 250
- USA
 - academic patenting in Europe versus USA 188–93, 201, 202, 204, 205, 211–12
 - global education 343
 - PhD education 94, 95, 97, 122
 - ranking 3–4, 11
 - university system 162–3, 213, 346
 - university technology transfer 16, 221, 222–4, 226, 227
 - see also* university technology transfer in USA study
 - see also* Cambridge-MIT Institute (CMI); Harvard University; Ivy League universities; MIT; Stanford University; University of Miami-McGill University strategic alliance; Wharton-INSEAD Alliance
- user involvement 76–8, 85, 86
- values 38, 41–2, 44, 291–2, 350
- Väst University College 141, 144, 146, 147, 148, 150, 152
- venture capital 27, 28, 36, 179
- vertical integration 343, 346
- vice chancellors 54, 55, 307
- Victoria University of Manchester *see* merger and 2015 agenda at the University of Manchester study
- VINNOVA (Swedish Agency for Innovation Systems) 67, 190, 224, 232
- vocational education/schools 50, 281, 292, 295
- voluntary cooperation 21, 22, 39, 41
- von Hippel, Eric 252, 256, 286
- Wharton-INSEAD Alliance 24–6, 35, 36, 40, 42, 346
- White Rose University Consortium 28–9, 35, 36, 40
- Wisconsin Alumni Research Foundation (WARF) 166–7, 181
- wood technology 232, 233, 235, 249
- workshops 32, 34–5
- world class education 32, 35, 51, 58–9
 - world class research 27, 28, 30, 32, 51, 56–7, 60–61, 71, 120
- Wyeth 259, 265
- Young, A.A. 99, 156–7, 342
- Ziman, John 68
- ZISC 268–9
- Zucker, L.G. 133, 228, 229, 241