was rewarded by being granted the lands of Rhufoniog and Dyffryn Clwyd together with the lordship of Hope. These were in effect a buffer zone between the English of Cheshire and the Welsh of Snowdonia. In it were built two English castles of Flint and Rhuddlan to control the coastal invasion route. Caergwrle's construction was aided by royal financial help; it is not known whether there was any English design help from Master Bertram the Engineer or Master Richard of Chester. The castle's design, as discussed by David Cathcart King and as now being excavated by John Manley of the Clwyd Archaeology Service, shows greater sophistication in comparison with Dolforwyn but on a much smaller site. Its hilltop choice is characteristically Welsh with a precipice to the south-west. Its dependence on one great tower with an internal diameter of 30ft (9m) is similar to Dolforwyn, but the protection of the wall angles by flanking towers on the east and north (and presumably at the west) is in sharp contrast to Dolforwyn. The gateway was probably a modest opening alongside a flanking tower and the internal buildings of hall and oven are little different from earlier thirteenth-century work. However the towers did provide living accommodation, as earlier at Castell-y-Bere. The loss of the west wall and the ruined state of the towers now makes it difficult to distinguish between the Welsh work of Dafydd before 1282 and the English work of Edward I after Dafydd's treachery had led to his capture and execution. However the excavation is helping to resolve these difficulties and whether a fire in 1283 caused total abandonment.

The other factor which distinguishes Dolforwyn from the earlier Welsh castles is the close association of castle and town which was normal in Norman planning, as at Ludlow, Montgomery, Oswestry and Bishop's Castle. The Welsh princes of North Wales ruled a society which had little use for 'the money-making of towns' (to quote Gerald of Wales); towns were a foreign introduction and, accordingly, were often viewed with suspicion. There were, however, hesitant moves towards urban growth at Criccieth, Nefyn and Pwllheli, but these seem to have scarcely developed before the Edwardian conquest radically changed the pattern of urban exploitation.

It is noticeable that while Roger Mortimer retained the Welsh castle at Dolforwyn he transferred the town to a position more favourable for trade passing along the valley floor of the Severn and more nodal to the district of Ceri. In distinction to the old town planned by Llywelyn [illegible]ounded a Newtown in 1279, the name it still carries. The castle served the same purpose for Mortimer as it had done for Llywelyn, namely to secure the regions of Cedewain and Ceri for their new ruler. In some ways the castle which Mortimer was granted by Edward I was similar to other castles he acquired by conquest in mid-Wales. At Cefnllys he built a strong square tower within a lightly defended hillfort bailey; at Dinbaud and at Knucklas he had isolated towers on craggy ridges (though both are much overgrown and ruinous). In strength and extent none of these Welsh castles could compare with his main castle at Wigmore. Not surprisingly, as the military situation in the Marches eased, these castles were a low priority and gradually fell into disrepair.

Ironically, by the time these border castles were next needed by the English crown during the time of Glyndŵr's rebellion of 1403–15, they were in total decay, neither held by the invader nor attacked by the Welsh. They had outlived their military purpose. Although Dolforwyn castle remained the centre of the lordship of Cedewain it was as a symbolic centre rather than as a functioning castle. Without the current excavations the style of architecture and the sequence of activity on this prominent hilltop could not be understood. Far more remains to be done since during the first ten seasons only half the internal area has been stripped. When the work is completed Dolforwyn castle will rise again from its ruins as an eloquent testimony to the desire of Llywelyn ap Gruffudd to defend Welsh territory against the English invader.

**Further reading**


R Avent, *The Castles of the Princes of Gwynedd* (Cardiff 1983).

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L A S Butler, 'Dolforwyn Castle, Powys. First Excavation Report, 1981–86', *Archaeologia Cambrensis* 138 (1989), pp78–98.

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C J Spurgeon, 'The Castles of Montgomeryshire', *Montgomeryshire Collections* 59 (1965–6), pp1–59.

A J Taylor, 'Master Bertram, *Ingeniator Regis*', in C Harper-Bill (ed), *Studies in Medieval History for R Allen Brown* (Ipswich 1989), pp289–315.



**Author**

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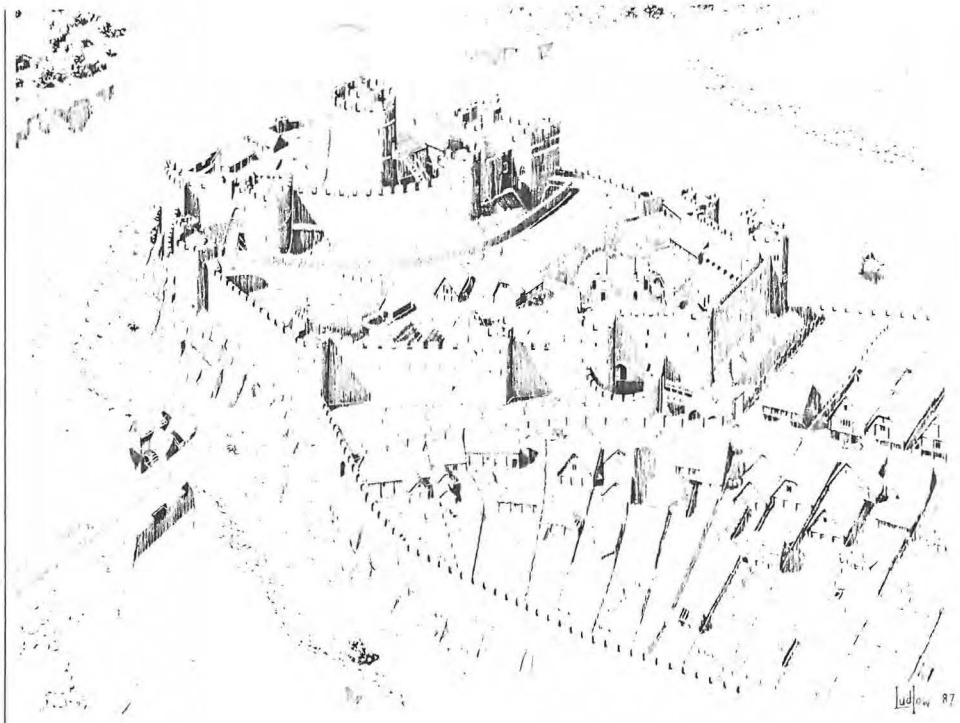



Conjectural reconstruction of Pembroke Castle c1330. *(All illustrations by the author)*

# PEMBROKE CASTLE AND TOWN WALLS

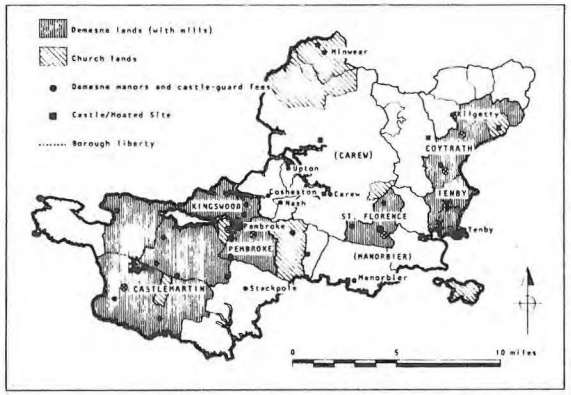
**NEIL LUDLOW** PROVIDES A REAPPRAISAL OF THE DEVELOPMENT OF MEDIEVAL PEMBROKE IN ADVANCE OF A FORTHCOMING PAPER IN WHICH THE ARGUMENTS WILL BE MORE FULLY DISCUSSED.

Pembroke Castle, with its walled town, is one of the most impressive defended sites from medieval Wales and gives an impression of military might equal to that conveyed by the Edwardian castle-boroughs of North Wales. The castle's fortification in masonry may, however, be largely a product of the later thirteenth century, and predominantly as a response to personal and social pressures rather than to purely military expedience. Its defences probably remained entirely of timber until the early 1200s; moreover, the town walls may not have been complete until well into the next century.[1]

Norman settlement of Wales was, by necessity, primarily military. In many marcher lordships this situation continued in the face of endemic native hostility. Southern Pembrokeshire was exceptional in that a fully developed Anglo-Norman system of manorial tenure was imposed almost from the first. Having gained possession of the fledgling lordship of Pembroke in 1102, Henry I established a civil administration based upon English shire models, made possible largely by the displacement of the native population. The well-known Flemish plantation was reinforced by an equally massive contingent from south-west England, constituting a sympathetic 'buffer zone' around the *caput* at Pembroke. Economic domination was like-


The county of Pembroke, subject to the county court at Pembroke. Jurisdiction intermittently extended into Cemaes and Cilgerran.

The lordship of Pembroke held directly of the earls. The manorial estates appurtenant to the castle, and castle-guard fees, are shown.




wise initiated. The establishment of a town at Pembroke was followed soon afterwards by the creation of Tenby, Haverfordwest, and Wiston.

The resulting administrative structure persisted throughout the Middle Ages, more-or-less unchanged by external developments and formed the basis of the 'palatine' county later created for the earls of Pembroke; and, as will be seen, royal involvement never entirely ceased. The rapid achievement of a sense of security allowed the presence of a royal mint at Pembroke by 1130.

The heartland of the county was indeed never seriously threatened by the Welsh. From an initial military identity as a base for territorial acquisition, Pembroke Castle was able, over the next three centuries, to develop its civil roles – residential, administrative, economic, judicial and social. It lay at the head of broad estates enjoying a stability more akin to contemporary England. Apart from two ineffective sieges immediately following its foundation in 1093, the castle saw no further action until the civil wars of the seventeenth century. The Welsh revivals of the late twelfth and thi th centuries never permeated this corner o Dyfed, and it was not until the Hundred Years War that the castle re-appeared in a military capacity (and then as part of a centralised system of national defence rather than in any feudal context).

Pembroke, then, illustrates the fundamental distinction between those castles able to fulfil manorial functions and those with more limited purpose. In high stress areas of warfare the emphasis laid on defence led to rapid innovations in fortification design (for example the influence of the castles of Philip Augustus in the Franco-Norman marches) that appeared elsewhere somewhat later. Indeed British military technology, even in frontier areas, remained remarkably conservative until the mid-thirteenth century and was generally subordinated to domestic requirements.

## THE EARLY SETTLEMENT

Pembroke Castle was established by Roger de Montgomery in the free-for-all that followed the murder of Rhys ap Tewdwr, Prince of Deheubarth, in 1093. Under Roger's son Arnulf a sizeable tract of land was quickly subdued. By 1102 the area comprised most of Pembrokeshire south of the Preseli mountains but Arnulf's boundaries, and the nature of his tenure, were possibly ill-defined.

His direct march to Pembroke suggests that Roger had prior knowledge of some existing defensive focus and settlement there. A deep, wide ditch cutting off the tip of the limestone headland formed what is now the Inner Ward of the castle, and the fact that neither motte nor stone wall was constructed from what would have been pure limestone spoil may suggest that an earlier fortification was remodelled. The defences were of timber. Their nature can only be surmised, but it may be that instead of a motte there was a substantial gate-tower.[2]

Henry I confiscated all the Montgomery possessions in 1102. Pembroke became a shire and shortly afterwards a borough charter was granted to the town. Civil settlement at the castle gate was thus promoted and it may be that Pembroke as a town was a deliberate plantation. It retained a quasi-independence from the castle.

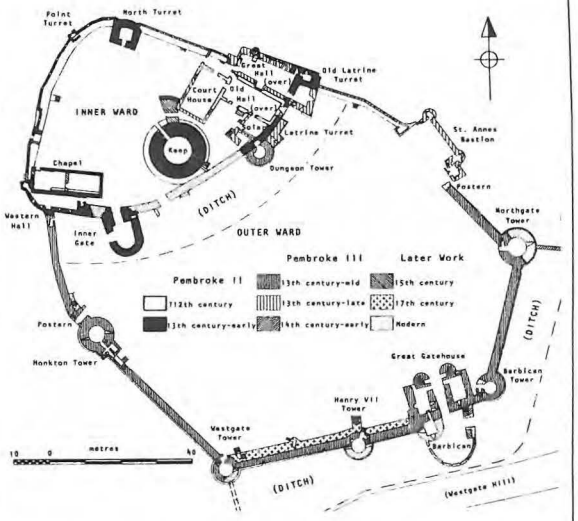
Morphological development of the settlement was dictated by its topographic situation upon a long narrow ridge, terminated by the castle, and between two tidal inlets. Settlement was necessarily along a single axial route and any formal planning unlikely h a quay and a northern bridge are alluded to within the charter. A projection of the axial route (Main Street) focusses on the gate of the present Inner Ward, suggesting that the town developed from an original settlement in what was later to become the Outer Ward.[3] A further influence on urban development was the Benedictine Priory founded in 1098 and reached by a bridge or ford. The pronounced dog-leg once present at the bottom of Westgate Hill confirms that it postdates the crossing, which trends towards a well-trodden cliff path to the castle gate, and perhaps linked the town to the priory. St Mary's church and the market place may be in a secondary position, lying beyond the route to the north.

The creation of the earldom of Pembroke in 1138 did not conclude royal interest in the county. It was reasserted following the invasion of Leinster from Pembroke by the second earl Richard Fitz Gilbert de Clare in 1171. Henceforth the King's representative remained in control of the castle until the arrival of Earl William Marshal in 1204.[4]

## THE FIRST MASONRY CASTLE

It is now established that timber castles could and did attain a high degree of sophistication. In England particularly, the native tradition of excellence in timber construction may have contributed to the longevity of its use. Within Pembroke Castle's wooden defences, however, a masonry domestic structure – the 'Old Hall' – was possibly erected under Richard de Clare. Its construction is unlikely between 1171 and 1204, while the Norman detail contrasts markedly with Marshal's 'Transitional' work.

William Marshal attained the earldom through marriage to the Clare heiress in 1189, though this was not confirmed until 1199. During the interval and until his return from Normandy in 1204 his responsibilities lay elsewhere.[5] Arriving in Pembroke, he immediately built an immense cylindrical keep directly inspired by those of Philip Augustus that he must have seen in France. It is unique in Britain, entirely unlike later round keeps. Its only affinities are with other Marshal work – the mural towers at Chepstow, Cilgerran and Caerleon Castles which variously duplicate the offsets, string-courses and batter. Despite the keep's military appearance, domestic features influenced a design which represents standards of comfort unknown elsewhere, incorporating two fire-

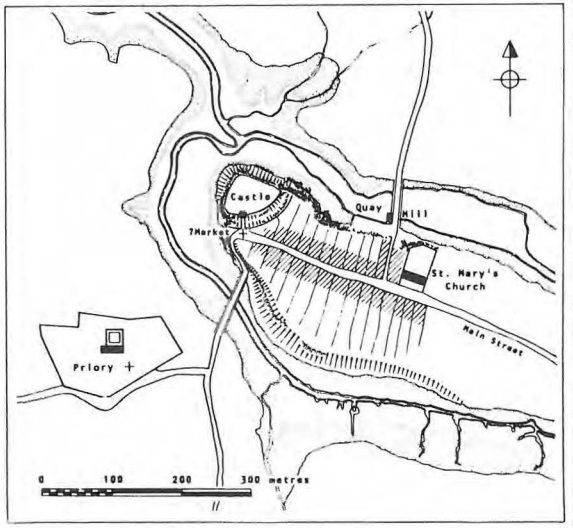



Ground plan of Pembroke Castle (adapted from King, 1978).

places, spacious windows and a domed roof.

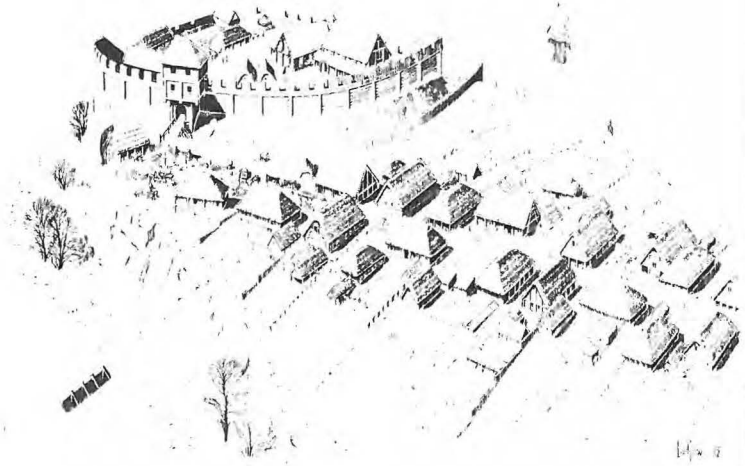
His return from exile in 1211 may have occasioned Marshal's replacement of the timber defences with a masonry curtain wall, flanked (possibly only incidentally) by a square latrine turret and a rather precocious D-shaped gate-tower entered through its western flank.

The work may have continued under Marshal's sons (1219–45). Details of the range west of the gate-tower recall William Mar-

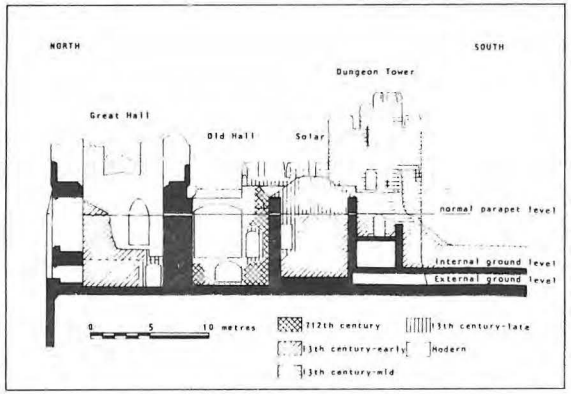



Suggested plan of Pembroke c1130 showing settlement foci. St Mary's church is not referred to until c1260 but is doubtless a twelfth century foundation.

Conjectural reconstruction of Pembroke Castle c1130.



Elevation of the north-west face of the inner curtain wall. With the addition of the Dungeon Tower the adjacent stretch of wall was heightened.




shal II's work at Cilgerran (1223+) and it might have been an addition. A well appointed hall lies alongside a contemporary building aligned east-west, now largely truncated but undoubtedly the site of a chapel.[6]

A circular mural tower projecting from the Inner Ward is certainly later. The Dungeon Tower does not bond with Marshal's curtain wall and is similar to towers on the curtain wall of the Outer Ward – the work of William de Valence (1247–96).

## THE OUTER WARD

While the Marshal earls were probably responsible for the addition of the Outer Ward and its ditch, its defences may well have been of timber.[7] The masonry outer defences demonstrate a level of sophistication unknown in Britain before the middle of the thirteenth century.

Jeremy Knight has demonstrated that refinements in fortification construction practised on the continent were not applied in Britain until later. His comparative study of the castles of the Marshal earls and Hubert de Burgh (1201–36) takes account of the close relationships within and between the two groups.[8] Features common to both include simple or 'experimental' gatehouses and limited use of drum towers, while the Marshal castles share the stylistic motifs noted in the keep. All differ from Pembroke's outer enceinte which has affinities only with much later work, and nowhere appears to incorporate earlier masonry.

The first element of the enceinte to be constructed was the most complex.[9] Pembroke's great gatehouse represents a stage between the twin-tower units of the 1230s and '40s, and the elaborate 'keep-gatehouses' built from the 1260s onwards. Whilst being an integrated unit containing two floors of apartments, it is not, however, self-defensible. Yet the same general layout occurs again as late as the 1280s at Valence's Goodrich Castle which also shares with Pembroke its deeply plunging arrow loops. The mural gallery within the south curtain also appears later at the Edwardian castles of North Wales.



The Outer Ward represents a mammoth undertaking for a member of the bar[illegible]e. But William de Valence was of royal b[illegible]od, having acquired Pembroke through the agencies of his half-brother, Henry III. Pembroke was his main seat and the castle needed to convey the necessary visual symbolism. He was also of a highly aggressive disposition, and he doubtless wished to impress his authority within a Wales reasserting its nationhood. A raid into the county in 1258 provoked Valence, according to Matthew Paris,[10] into military expenditure which may be represented by the commencement of the building programme.

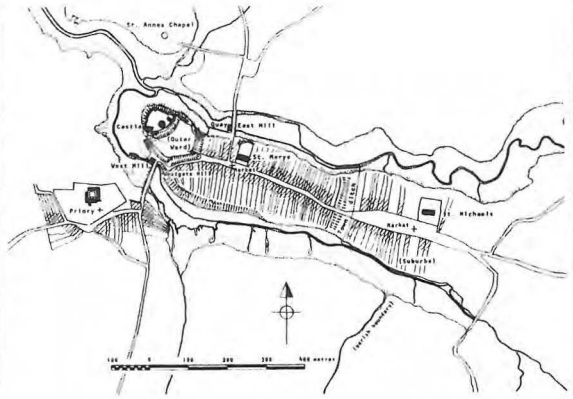
The castle continued to function in its principal manorial role, a role which occasioned Valence's second building campaign. Among the magnificent suite of new domestic and administrative buildings the Great Hall, built next to the Old, is the finest displaying late thirteenth century window tracery and bold corbel tables. Justice and estate administration were discharged within a large gabled courthouse at right angles to the Great Hall and opposite the Dungeon Tower, while a new solar and connecting latrine block were also built.

## TOWN DEFENCES

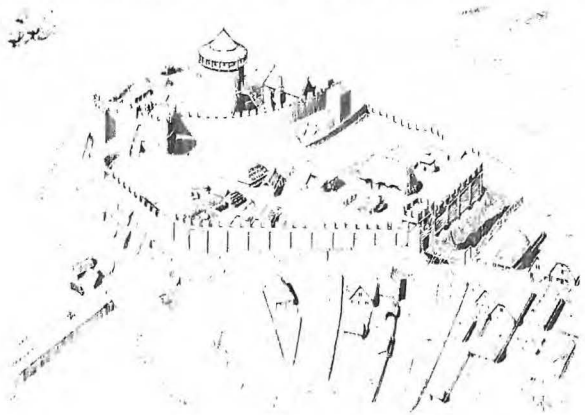
The construction of the Outer Ward may not have greatly disturbed urban settlement which perhaps already had began to drift eastwards around the area of St Mary's Church. But it led the development of Westgate Hill, which formerly respected the irregular line of the ditch. At the foot of the hill was a tidal corn mill, its dam carrying the roadway to the priory. Likewise, the northern bridge retained a pond for a further tide-mill established before 1199. The town was thus partly enclosed by water and, possibly under the Marshals, was protected by a ditch, and perhaps a palisade, cut across the peninsula at its narrowest point.[11]

Later an 'extra-mural suburb' was established beyond the ditch. This has all the appearances of having been planned, and deliberately established as a separate parish (St Michael's) with its own church and broad market-place.[12] The parish boundary follows the line of the ditch, while the burgage plots are noticeably wider than those within St Mary's Parish. William de Valence is the likely founder; under his patronage St Mary's Hospital was established beyond St Michael's, and possibly the chapels of St Anne and Saintland.

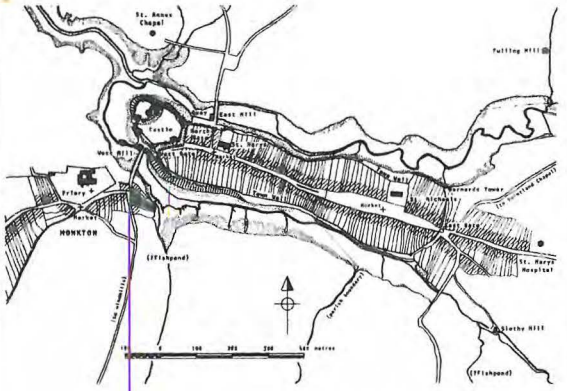
Perhaps it was under William de Valence that the masonry town wall was begun. Comparison with similar work, however, suggests that it was at least completed under his son Aymer's tenure (1307–24) or even




Suggested plan of Pembroke c1255. The outer enceinte of the castle has yet to be rebuilt in stone, but Westgate Hill and the suburb of St Michael's have been established.



Conjectural reconstruction of Pembroke Castle c1255.




Suggested plan of Pembroke c1330. Monkton is by now a market town in its own right. The kink in the northern line of the town wall was shown by Speed c1610. Two further fulling mills were established in the fifteenth century.

later. The circuit encloses both St Mary's and St Michael's parishes as a sinuous line following natural outcrops and breaks of slope (and incorporating both churchyard walls), except where it runs across the peninsula to the east. Six towers were present and three gates.[13] Of the latter only part of the west gate survives as a simple opening in the wall. To the north was a twin-towered gatehouse, while that at the east end possessed a semi-circular outwork similar to the barbican added to the great gatehouse at the castle, and to Tenby's famous 'Five Arches' gate of *c*1328.[14] The closest parallel is Aymer de Valence's barbican at Goodrich Castle. All may be derived from the Lion Tower at the Tower of London, of *c*1280.

The period 1315–25 saw a renewed interest in urban defence following something of a lull.[15] Pembroke's town wall is generally flimsy, and while hardly suitable for serious defence, may have been deemed sufficient enough protection to encourage further settlement and economic growth.

Of the six towers four remain, two of them drum towers of similar plan. Barnard's Tower is however an exceptional piece of work, stylistically reminiscent of the castle gatehouse towers and apparently conceived as a self-contained unit. Both residential and defensive arrangements are represented; indeed it is so distinct in concept from the other mural towers that it may pre-date their construction.

Neither town walls nor castle saw any military action until 1648. Both were bombarded by Cromwell's artillery before their final slighting. However, their continued influence in a variety of forms, within both landscape and local economy, remains considerable.

**Author**
Neil Ludlow is an illustrator specialising in reconstruction drawings on a freelance basis but currently working for Dyfed Archaeological Trust. He has spent the last two years preparing an interpretative exhibition at Pembroke Castle.

**Notes**

1. For a full account of the castle see D J C King, Pembroke Castle, *Archaeologia Cambrensis* 127, (1978), pp75–121.
2. Giraldus Cambrensis' supposition that the earliest castle was a flimsy affair suggests both family bias regarding its steward Gerald de Windsor (*pers comm* Robert Higham), and that it was, by 1188, represented by something more substantial (yet still of timber).
3. *cf* Brecon, Oswestry, Ludlow. Ludlow Castle in fact bears a marked resemblance in plan to early Pembroke, and may incidentally be a further Montgomery foundation. (D F Renn, 1987.)
4. Pembroke was still under the control of a royal sheriff in 1201. (H Owen, *A Calendar of Pembrokeshire Records*, Vol III (London 1911, citing Charter Roll 2 John.)
5. He had arrived at Pembroke at the head of an army to repossess territories lost to Rhys ap Gruffydd and his sons.
6. D J C King, *op cit*, thought otherwise. However its location, orientation and western entrance are surely significant. The cross wall which King thought conclusive does not, in fact, bond with the side walls.
7. D J C King, *ibid*, again thought otherwise and attributed the masonry of both wards to Marshal.
8. J K Knight, 'The Road to Harlech', in J R Kenyon and R Avent, (eds), *Castles in Wales and the Marches* (Cardiff 1987).
9. There is a clear break in construction visible in the masonry either side of the gatehouse.
10. Matthew Paris, 'Chronica Majora' in H Rothwell, (ed), *English Historical Documents* Vol II 1189–1327 (London 1975).
11. D J C King and M Cheshire, 'The Town Walls of Pembroke', *Archaeologia Cambrensis*, 131 (1982) pp77–84; B P Hindle, 'Mediaeval Pembroke', *The Pembrokeshire Historian* (1979); M Aston and J Bond *The Landscape of Towns* (London 1976). Main Street bifurcates at this point, the earlier carriageway slumping considerably.
    For the town generally, mills and other elements of the urban landscape see H Owen, *op cit*; I N Soulsby and D Jones, *Historic Towns of South Pembrokeshire* (Cardiff 1975); R F Walker, 'Henry II's Charter to Pembroke', *The Bulletin of the Board of Celtic Studies* (1989).
12. *cf* Hereford, Haverfordwest for later enclosure of extra-mural market-places.
13. L T Smith (ed), *Leland's Itinerary in Wales* (London 1906). The north gate is depicted in a watercolour by J C Buckler, 1815 (NLW).
14. W G Thomas, 'Tenby', *The Archaeological Journal* CXIX (1962), pp316–18.
15. T P Smith, 'Why did Medieval Towns have Walls?' *Current Archaeology* 95 (1985).



# MEDIEVAL FIREPOWER

QUENTIN HUGHES SUBJECTS THE NORTH WALES CASTLES OF EDWARD I TO A NOVEL ANALYSIS OF THEIR DEFENSIVE QUALITIES.

An atmospheric view of Harlech Castle from the high ground behind. (*Quentin Hughes*)

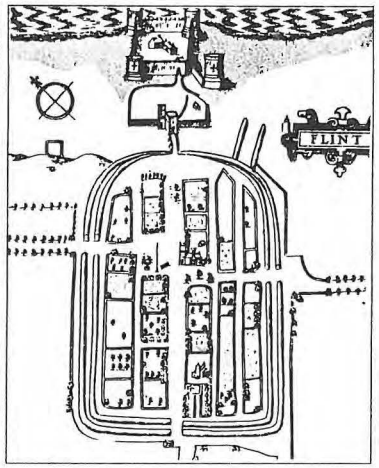
'I find that even Men of good Experience in military Affairs, are in Doubt which is the best and strongest Manner of building a Fortress, either upon a Hill, or Plain,'[1] wrote Alberti in the middle years of the fifteenth century, but it had always been a problem to choose the best site for a castle, a problem not always considered by historians in their descriptions of the medieval world.[2]

Towards the end of the thirteenth century, Edward I of England built a ring of strong castles to girdle the vastness of Snowdonia and squeeze into submission the rebellious Welsh. Much has been written about the history, the building processes and the persons involved, but little about how well these castles were defended, where they were built and why they assumed particular shapes.

Some of the material in this article is based on surveys and studies done under my direction by students at the Liverpool School of Architecture, the University of Liverpool.[3] The purpose of the surveys was to plot, using a crossbow similar to that available in the thirteenth century but mounted with a compass and a spirit level, the space in the embrasures and casemates available to a crossbowman.[4] From this, cones of fire were worked out and drawn on plans, sections and axonometrics of those castles where sufficient evidence remained for deductions to be made. The crossbow was the normal weapon of defence in those castles and it is important to realise that the splay of the embrasures is different from the field of fire of an archer which was controlled by the size of his body, the width of his shoulders, the width of the bow and the projection of his elbow.

## THE WELSH WARS

On 17 November 1276 Edward determined to crush Prince Llywelyn by driving him from his outer bulwarks in the south and east where the countryside was less favourable for the delaying guerrilla tactics of the Welsh army; then to encircle him within the natural fortress of the mountains of North Wales where, starved of supplies, Llywelyn would be forced to submit to the will of the English Crown. The English set up military commands at Chester, Montgomery and Carmarthen, using state money and organisational procedure to weld together a powerful army and navy. The ensuing campaigns were to become models of effective combined operations using pioneers to cut broad swathes through the dense forests, pushing supplies of necessary materials and foodstuff forward by sea, and paying promptly the salaries of soldiers to keep them contented in distant places, sometimes maintained for long periods of time. It is one




The town and castle at Flint, from John Speed's *Theatre of . . . Great Britaine* (London 1676).

of the best examples in the medieval world of the use of a carefully conceived strategy for the prosecution of war. The castles were part of that strategy.

There was a line of Norman fortresses in the flat country beyond the main command towns – Mold, Hawarden, Oswestry, Bishop's Castle, Ludlow and Montgomery. These were the belt to protect England. Beyond lay thickly wooded country with no coast road and sheer cliffs blocking the coastal way to Anglesey at Penmaenmawr. It was ideal guerrilla country and previous expeditions by Henry II and John had failed there. But Edward was of a different mettle. In 1274 he returned from the crusades, knowledgeable in military architecture and modern weaponry. The two wars that followed – 1276–1277 and 1282–1283 – secured Wales to England, the union only seriously threatened during the revolt of Owain Glyndŵr in 1400.

The first war saw the construction of castles at Builth and Aberystwyth with forces moving up from the south, and at Flint and Rhuddlan on the coast line of the estuary running out from Chester. The second phase of the encirclement and the securement of Anglesey, the 'bread basket' of Wales, saw the construction of powerful castles at Conwy, Harlech, Caernarfon and Beaumaris, with strengthening and remedial work carried out at Bere, Criccieth, Denbigh and Holt.

Let us place it into perspective. To put into the field an army, consisting of infantry, cavalry, crossbowmen, all with naval and marine support and pioneers, cost Edward more than twice as much money as he needed to build or complete long-lasting castles at Caernarfon, Conwy, Harlech, Criccieth and Bere.[5]

With the cessation of hostilities the field army melted away, but the castles he built remained as symbols of English power, maintained by an economy of forces and supported by English colonial settlements for generations to come. Most of the castles had a normal garrison of about thirty to forty men, including about ten to fifteen crossbowmen. Sometimes the garrisons were even smaller. Caernarfon in the reign of Henry IV was held by fourteen men, Harlech and Criccieth in 1326 had ten men each. We are dealing with very small numbers of garrison troops, but to these must be added, in many cases, the citizens of the English colonial town attached to most of the castles. Their burghers were under rigorous military discipline and were used to watch and defend their town walls.[6]

These castles demonstrate the final development in military architecture before the introduction of gunpowder artillery. The tower-keep, designed to be solid enough to keep out an enemy solely by the strength of its walls, gave way to designs based on the concept of active defence, matching a careful balance of masonry strength with the use of missiles, in this case mainly crossbows.

Building on this scale had not been attempted in the British Isles since Roman times. Only with a system of state control and a safe communication network could the overall organisation of such a complex logistical and administrative process be achieved successfully.

Before describing in detail the characteristics of some of these castles it may be useful to explain some of the problems of attack and defence and give some information on the weapons then available.

## SIEGE WARFARE

There were five main methods of attacking a castle, each one available to a great or lesser extent to the Welsh. Each method of attack had to be borne in mind during the design process. A castle could be taken by trickery, surprise or a *coup de main*. It could be battered by artillery so that part of its walls collapsed. Part could be brought down by lighting a fire in a mine. It could be assaulted using ladders, usually after the ramparts had been damaged by artillery fire. And lastly, a castle could be starved into surrender.[7]

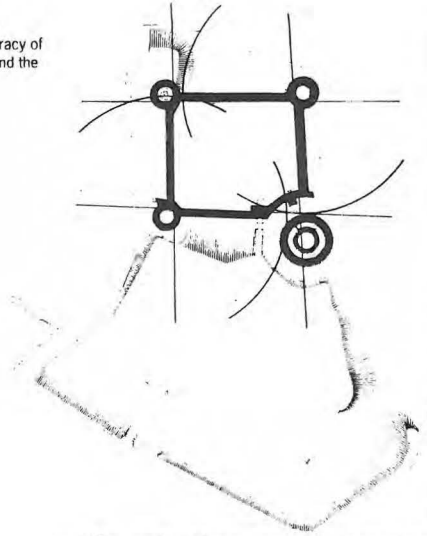
The first was always a possibility, for defenders never knew when an attack would occur. Harlech was captured in this way in 1402. It is unlikely that the English builders in the thirteenth century believed that their strongholds would be assaulted by artillery. The Welsh in North Wales had neither the equipment nor the means of transport to use it with effect against strong castles, but the masons must have considered the possibility of the use of heavy siege engines in an attack. Edward I knew better than any other English king the details and the power of such engines of war.[8] To give some idea of the immense problem of bringing heavy artillery into action for a siege, one may quote the example before Emlyn Castle in South Wales in January 1288.[9] The English engine was hauled by forty (later sixty) oxen on four four-wheeled wains, escorted by 20 cavalry and 463 foot-soldiers. Some 480 boulders had to be collected from the beach at Cardigan and taken by boat up river, and then on packhorses to the camp; an expensive undertaking. Add to this the cost of blacksmiths and of woodcutters to build a bridge and prepare hurdles for the assault and we can see that, even under comparatively straightforward conditions, the task was formidable. In the mountains of Snowdonia it would have been even more arduous and costly. If the Welsh were not likely to use such equipment, they could be reinforced and supported by allies: Irish, Scots and, in particular, by the French navy which could put ashore equipment necessary to reduce the strongholds by batter and bombardment.[10] So these factors had to be taken into consideration in the design of at least some of the Edwardian castles. Mining could be prevented by building on solid rock. Escalade could be discouraged by using moats, concentric rings of defence or by building high walls. It was difficult for an enemy to calculate the height of a castle wall and, on one occasion, the Welsh got it wrong and made their ladders three feet too short. If the castles were sited on navigable rivers or the sea coast, the English navy, which had command of the sea, could relieve a threatened garrison.

## WEAPONS

The main weapon for the defence of the castles was the crossbow. To use it, highly-paid professional archers were needed, but it had several advantages over the traditional short bow and the new longbow. It had great hitting and stopping power. It fired heavy ammunition in the form of bolts or squires and these could be stacked on the battlements ready for use. The bolts were manufactured in England and brought in by sea, which required a degree of pre-planning. But they were expensive and difficult to retrieve during a siege. One bow could be fired whilst another was being loaded, to some extent offsetting its slow rate of fire compared to the longbow. It could be used in a lower casemate than the longbow, but, with its archer, it took up quite a lot of horizontal space. There were other disadvantages. To say the least, it must have been difficult to fire downwards at a steep angle, often a necessity in high-walled castles. There are no medieval drawings that show any device for retaining the bolt on the tiller until the moment of discharge, and, unless the archer held on to the bolt with his left hand, a difficult operation at extreme depression, the bolt would just have dropped out of the crossbow.[11] The longbow can be fired downwards because the arrow is held in place by the fingers. In any case, plunging fire is not very effective. The attacker presents a small target from above and the bolt has to hit a vulnerable point directly. If it misses it will bury itself harmlessly in the ground and stand little chance of inflicting additional damage on other targets.

The effective range of the crossbow at that time is debatable, but it was probably between 200 and 250yds (180–230m), when it could penetrate armour. However, the archer had to see his enemy in order to hit him. A barrage of arrows, as depicted at the Battle of Agincourt in the film *Henry V*, only lasted a short time, and would not have been possible in the defence of a castle during a long siege. In any case, the short bow and the longbow were more suitable for that tactic.

To be protected from the enemy and yet to see him and have a space large enough to accommodate the trajectory which yaws considerably for about the first 25ft (9m) of its flight, was a problem. Crenels exposed the archer to view, and merlons had to be pierced by loopholes, normally vertical but sometimes with cross-slits to improve vision.[12] Behind the loophole an embrasure was splayed to increase the angle of fire and vision. On the lower floors this opened into a casemate in which the archer could stand, its dimensions being related to his task. Although his freedom of action would be increased by standing back in the casemate, the passage or on the rampart, the danger of his hitting the masonry would increase because of the yaw of the bolt or arrow.



Flint Castle: a plan showing the inaccuracy of the square layout and the triangulation.

The springald or espringale, sometimes called the ballista, was also used to defend the castles. It was a large, very accurate crossbow mounted on a tripod and normally operated by two men. Two are mentioned at Conwy and elsewhere towers which mounted them were sometimes named after the weapon. Fired from an elevated position they had a good range and, certainly at Criccieth and Harlech, they were intended to cover the landing place below the castle so that supplies could be unloaded from the ships in safety. It is unlikely that the English intended using heavy machines on the castle walls for, when fired, they tended to damage the masonry and imperil the stability of the walls.

Objects could be dropped on any attackers, particularly if they were bunched together. Hot water was useless because it was cold by the time it hit the ground. One has only to drop a stone from the battlements of Caernarfon Castle to realise how long it takes to land and individual soldiers could easily dodge it. Stones had to be carried up narrow spiral staircases, lifted laboriously to the battlements and stored there, obstructing the passage way. But they could be dropped on battering rams and masses of infantry. Boiling oil needed cauldrons which took time to heat up and required much fuel which also had to be stored on the battlements. Greek Fire, used extensively in the Crusades but difficult to obtain in Wales, was the most effective material to throw or drop. Sometimes called naphtha, it was made up of a mixture of petroleum and oil, to which pitch was added to make it burn longer, and sulphur to help it adhere to its target. It could also contain quicklime which would cause it to ignite on contact with water. It was deadly stuff, much feared and extremely difficult to extinguish. The only things that were said to be able to put it out were sand, vinegar and urine.[13]

For the Welsh attackers theoretically it was possible to use the missile weapons described, plus the mangonal, the trebuchet, the ram, the bore and the belfry. The mangonel or catapult was a large machine with a wooden arm that pivoted in the centre on a vertical frame. It had a spoon at one end to hold the missile, usually a stone, and a rope torsion mechanism at the other end. It had a long range, increased with the aid of a sling, and could fire objects into a castle courtyard. But, because of problems with its torsion material and the hazards of weather, it was not as effective in medieval times as it had been in classical times. The trebuchet was a mechanical sling operated by a counterweight at one end of the arm. Introduced into siege warfare by the French in the twelfth century, it was widely used to bombard and destroy battlements prior to escalade. It had a range of about 300yds (275m) which could be increased if it were fired from a hill top, thus the need to site the castles out of range of nearby hills. Rams and bores could be makeshift devices constructed from local timber close to the site of the siege. Sometimes they were mounted on wheels and protected by a pitched roof. The belfry, or mobile tower, built to overlook the battlements, could have many floors, and would use ladders and a drawbridge to put assault troops onto the battlements. But it needed smooth ground for its approach and was expensive to construct and vulnerable.

Armed with these devices of active defence and threatened by these assaulting machines, the English castles in Wales had three purposes: acting as armament stores and small enclosed camps, designed to police a district, to defend themselves in a hostile environment until relieved by the navy; in turn, to defend and be sustained by an English colony attached to the castle; and to act as a deterrent, impressing the Welsh through the symbolism of military architecture.

Reference to a map will reveal how regularly spaced they were around the mountains of Snowdonia. It remains to describe in some detail the design of individual castles. However, it is not the purpose of this article to describe the historical development of these buildings about which many admirable books have been written.[14] Rather it is to describe the peculiarities in plan and form and to demonstrate the strength and weaknesses of their architecture. The siting of each castle largely dictated its architectural form.

## THE DESIGN OF THE CASTLES: THE FIRST PHASE

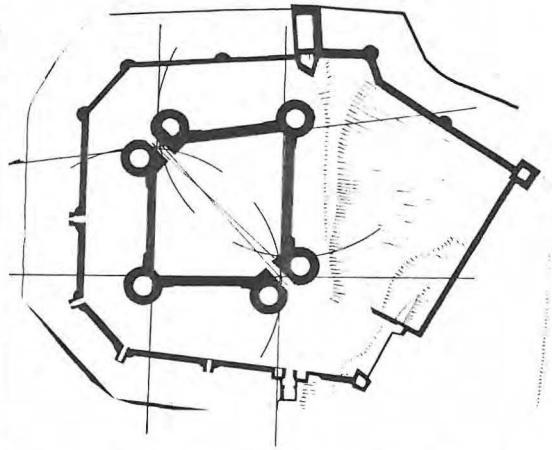
**Flint Castle**, begun in July 1277, could have been almost anywhere along the flat coast of the Dee estuary but, at 12 miles (19km) from Chester, it was an easy day's march and a placid sail from the command base. It was built on a small outcrop of sandstone abutting the estuary with marshes on both sides. It could well have been a concentric design of walls within walls, and one wonders why it was not. Perhaps its easy relieving distance from Chester made the extra expense unnecessary for it could certainly hold out until help came.

The plan consists of a quadrilateral of curtain walls forming an inner bailey with three round towers at the corners.[15] On the fourth side there is a large elaborately conceived keep defended by its own ditch and modelled on the much earlier castle at Coucy in France. The keep adjoins an irregularly shaped outer ward from which a bridge led to the grid-iron of the colonial town of Flint, running inland from the coast and surrounded by a ditch and palisades.

The battlements are destroyed and the castle is in a ruinous state so it is impossible to plot an accurate layout of the arcs of defending fire. Entrance to the inner bailey was over a drawbridge and through a comparatively simple gatehouse in the corner close to the keep. Although the approach to the bridge could be covered by crossbow fire, the gate appears to have been inadequately flanked except at long range from an embrasure in the south-west tower.

**Rhuddlan.** Another 20 miles (32km) along the coast the River Clwyd discharges into the sea and up that river the English chose a site for their next castle. This, to be called Rhuddlan Castle, was a more ambitious design intended to be the advanced headquarters for the campaign in North Wales.

The plan is concentric, with a low outer wall protected by a broad revetted dry ditch upon whose counterscarp a palisade was erected. A strange innovation was the use of numerous small square towers, each with a staircase leading directly to a sallyport at ditch level. This would certainly have provided the opportunity for active defence for a large garrison, but equally it would have made it more difficult for a small garrison to secure the outer ward. Perhaps for this reason three of the sallyports were later sealed. Cantilevered out from each side of the small towers there were quarter-circular battlements, strange devices probably intended as platforms from which crossbowmen could flank the curtains. Between the square towers, the outer curtain wall was pierced by arrow-slits which alternated on two levels, the lower ones being tilted downwards to cover the floor of the ditch. They appear to have had extremely poor lines of fire and it would have been almost impossible to use a crossbow in that depressed position.

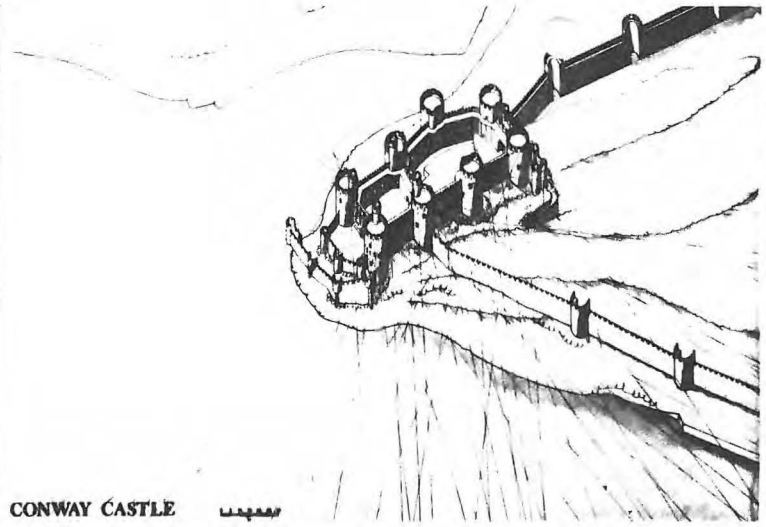


Rhuddlan Castle: a plan showing the irregularity of the square layout and the triangulation.

The scarps of the ditch continued towards the river, but the ditch itself was interrupted by a barrier, a vulnerable point in the event of an assault, and then continued as a wet ditch forming a little port for vessels coming up river. At this point the walls of the outer ward were beyond effective range of archers on the higher battlements of the inner ward, negating, to some extent, the value of the concentric design. Thus the outer curtains had to be strengthened by two additional substantial square towers. At great expense the River Clwyd was canalised for much of the two-mile stretch to the sea to take large boats, but it could have been a precarious passage if an enemy lined the banks.

The inner ward was surrounded by higher curtains from whose battlements archers could cover those on the ramparts of the lower ward. At each of the four corners there were round towers but these were doubled in

Conwy Castle and town walls from the river, showing the arcs of fire available to the defence. (*University of Liverpool archive photograph No 78/2882*)



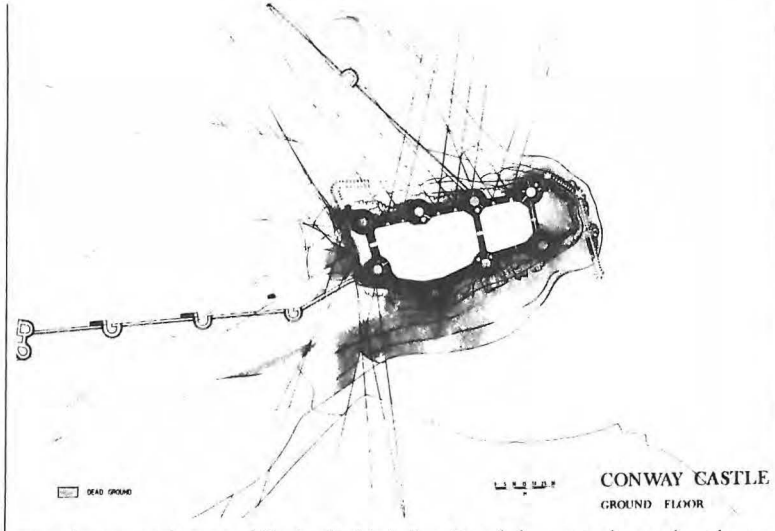

two opposite corners to form *two* powerful keep-gatehouses. Why two, one wonders?[16] One faced the most likely direction of attack, the other did not. Could it have been a desire for symmetry? A fascination in perfect symmetry permeates the work of military architects in all periods. This also raises the question of the shape of the inner ward, for this is also nearly, but not quite, a square. To have done it once at Flint is understandable but to have done it again is inexplicable. The fact that the two entrances are not quite aligned suggests an error in laying out the plan. One author has written, 'In the Middle Ages, the theoretical base of architecture was geometry. Geometry determined proportion and fixed position. Large scale issues of plan and elevation depended on it no less than the definition of the smallest detail.'[17] Masons had the means to lay out a right angle,[18] but the slightest inaccuracy extended over uneven ground could lead to distortion in the overall plan. It would have been easier to have pegged out a pair of triangles, but from the plan it can be seen that the dimensions are not identical.

**Others.** At Builth Castle practically nothing remains, and Aberystwyth was largely destroyed, although a reconstructed plan has been made. This shows a concentric castle laid out in the form of a lozenge with a powerful keep-gatehouse at one angle. It appears to have been a good design but insufficient detail remains for one to draw conclusions about the effectiveness of its fire paths.

## THE SECOND PHASE

The second phase of castle building resulted from the second Welsh War of 1282–83 when Hawarden and Flint towns were sacked, and Hope, Denbigh and Aberystwyth captured. Edward never knew where the next blow would fall.

**Conwy.** In March 1283 the English began to build Conwy Castle a further 23 miles (37km) down the coast from Rhuddlan. The site chosen sat on an outcrop of rock, secure from mining and lying between a navigable river and a small stream which was to safeguard the southern flank. A Cistercian abbey had to be uprooted and moved up river and with this work of demolition went the destruction of the tomb of Llywelyn the Great – surely a symbolic gesture which could have influenced the choice of site. There was the disadvantage that the water supply was poor and, on the far side of the stream, stood the high ground of Benarth Hill which could command the castle and the colonial town. As a result all the main living accommodation built in the courtyards had to abut the south wall, adjacent to the hill, to avoid it being overlooked and threatened by an enemy. A further problem lay in the fact that the site of the town rose steeply to its western point where its towers were also commanded by high ground beyond. Another site was available on the other side of the river at Deganwy where an English castle had stood until destroyed in 1263, but it was




Conwy Castle: a plan of the lower floor defences showing the dead ground shaded. (*University of Liverpool No 78/2895*)

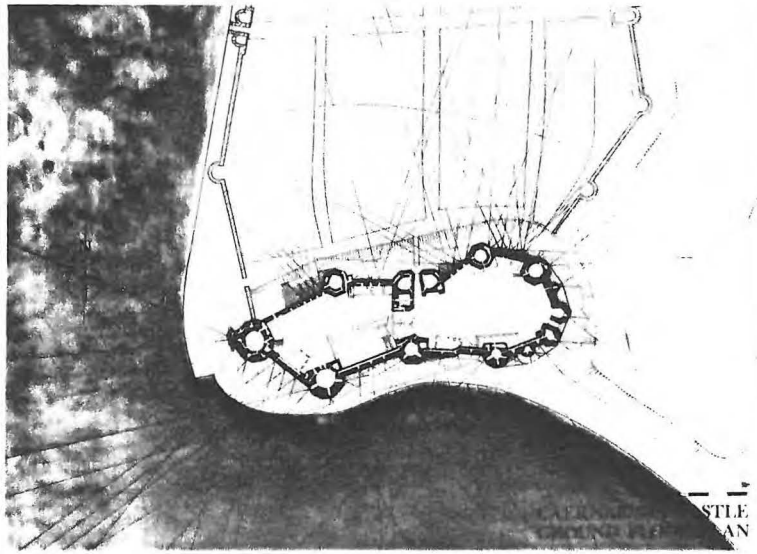
somewhat cramped on two hillocks. Had it been chosen, a bridgehead could have been secured at less cost by converting the abbey for military use.

Conwy is really two castles joined together, each entered through its separate barbican. One, the inner ward, is almost, but not quite square and is separated from the outer ward, which is pentagonal in plan, by a rock-cut ditch once spanned by a drawbridge. Both wards run parallel to the Gyffin stream and face the high hill which must have put them in range of archers or artillery. Because of the hill it was decided to build the castle high, relying on curtain walls which rose some 90ft (27m) from the rocky base in front of the stream. Because of the height and disposition of the arrow-slits, this left alarmingly large areas of dead ground surrounding the castle, but, because of the terrain, the attackers could not use a ram and there was no way a belfry could have been wheeled up close enough to the wall for an assault to be made. The ramparts were too high for scaling ladders to be used. Thus the most vulnerable fronts were the north and west curtains which faced the town. Walled and guarded by twenty-two towers, most of them open at the gorge to facilitate recapture and to act as circuit-breakers, the town would have to be taken first – indeed it was, when the castle had been captured by a trick in 1402, and the English were forced to bombard it from the main street in order to retake it. In 1646, it also surrendered after bombardment from the town. As a result of this threat from the direction of the town, the north and west faces are better defended by arrow-slits and there is less dead ground in front of the castle. It should be pointed out that, although fire paths were plotted from the loopholes in the town walls and towers, these, because of the danger of the town falling first, were not taken into consideration when working out the dead ground around the castle. The western front had additional cover from its barbican.

The vulnerable north curtain was strongly defended by six embrasures at ground floor level which covered most of the ground away from the base of the walls to the north. This was supplemented by fire from the flanks in the north and east towers to cover the ground effectively outside the town walls. The architects seem to have been infatuated by a desire to maintain symmetry in placing their embrasures in plan. They are uniform in shape and not angled in the direction of attack. They are regularly spaced. The arrow-slits in the merlons were arranged in an alternate pattern, high and low, right round the eight towers even though their tasks were different when covering the courtyards and the ground outside. If more had been set at a low angle, tilted down, there would have been less dead ground. Because of the ineffectual nature of plunging fire, the maximum number were needed to cover this role.

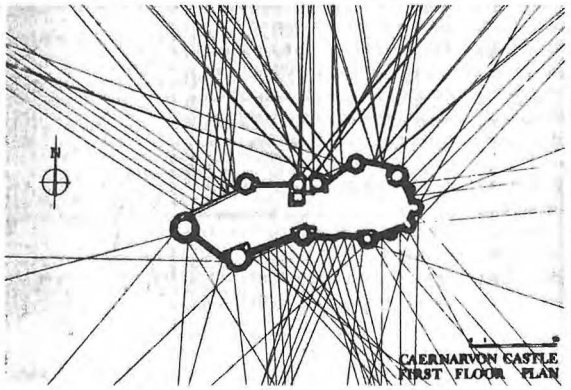
Wooden *hourds*, if they could be erected in time, would have been an added bonus, but they were vulnerable and could be easily damaged or burned. No notice has been

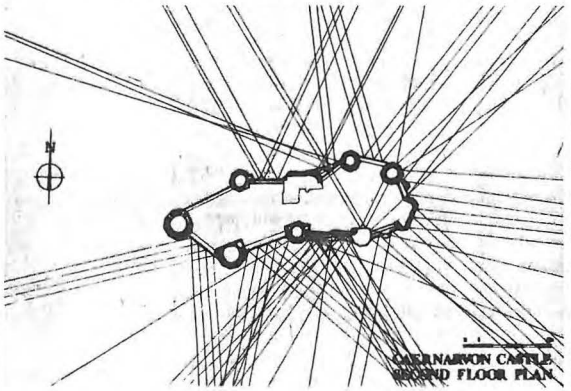
Caernarfon Castle: a plan of the lowest floor defences showing the dead ground shaded. (*University of Liverpool No 78/2879*)



Caernarfon Castle: a plan showing the arcs of fire of the defence from the first floor. (*University of Liverpool No 78/2893*)

Caernarfon Castle: a plan showing the arcs of fire of the defence from the second floor. (*University of Liverpool No 78/2896*)




taken of them in the plotting of the fire paths of the defence.

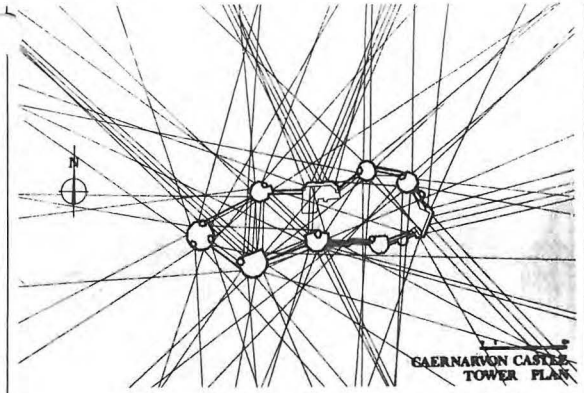
The drawings show large areas of dead ground where no arrows could kill. The might of Conwy lay in her massive stone walls, her appearance of impregnability, rather than in her missile defences.

**Caernarfon.** A further 24 miles (38km) by sea from Conwy, in the spring of 1283 the English chose the site for their most important and impressive castle. A peninsula, upon which there had stood a Norman motte and bailey fort, lay between the River Seiont and the Cadnant stream which, in those days, curved round from a pool, leaving a comparatively narrow land approach. The site was ideal to resist a close attack, but it had a disadvantage. Across the river to the south stood the hill of Coed Helen, about 330yds (300m) from the courtyard of the new castle. Although beyond the range of most stone-throwing machines, it was probably within arrow range and from its crest an enemy could watch the movement of troops in the castle.[19] Possibly the advantages outweighed this disadvantage, but it clearly ruled out the use of a concentric design whose low outer walls would have been overlooked. High curtain walls would obstruct the line of sight, indispensible for effective archery, and would prevent escalade. The water of the river, which in those days lapped the base of the southern walls, would have prevented assault and close-range battery. If there were a danger it could only be from harassment.

A high, curtain-walled castle was als more impressive, portraying the dignity and power needed to symbolise this, the most important of the North Wales castles and residence of the king. It seems likely that symbolism played a considerable part in the design of Caernarfon Castle. The use of polygonal towers, banded masonry and the name of the 'Golden Gate' suggest that Edward, to enhance his image, modelled his fortress on the land defences of Byzantium, 'the old city of the Emperor Constantine'.[20]

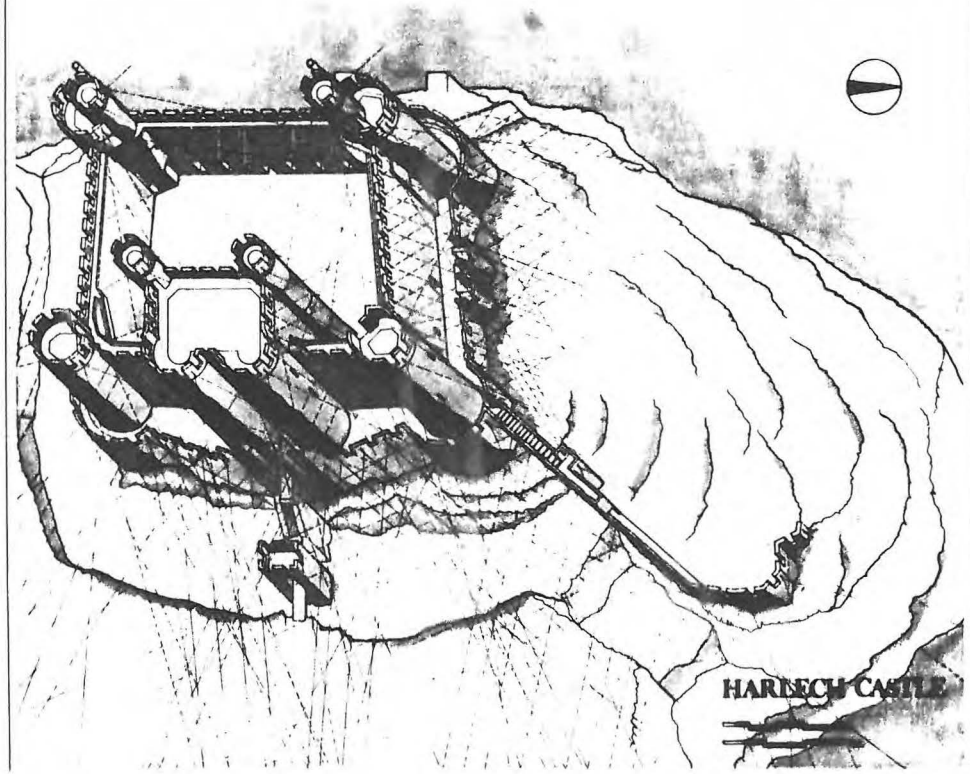
Generally speaking, it could be said that, the higher the archer, the better his view and the greater his range; the lower the archer, the more restricted his outlook, but the greater effectiveness and hitting power of his missile.

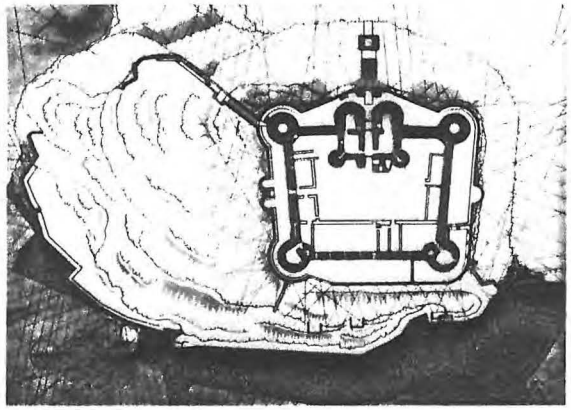
In plan, the castle consists of two long wards running parallel to the river, strengthened by angular towers, from which spring little towers rising to a great height. The barrier between the upper and lower wards was




Caernarfon Castle: a plan showing the arcs of fire of the defence available from the towers. (*University of Liverpool No 78/2887*)

Harlech Castle: An isometric drawing from the likely direction of attack. It was difficult to plot accurate cones of fire because the crenellations have been destroyed. Assumptions are based on evidence in the other castles and these are shown in dotted lines. Also a crucial part of the outworks of the barbican has gone. (*University of Liverpool No 78/2912*)





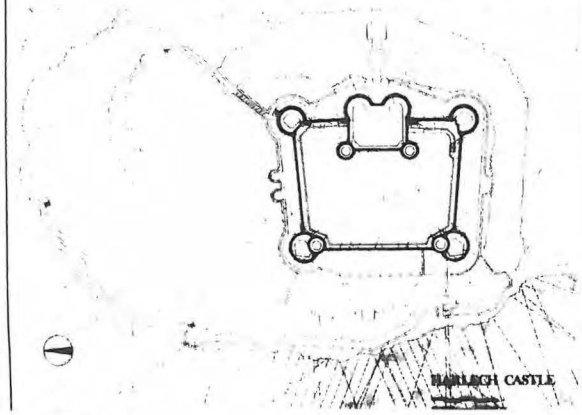
Harlech Castle: fire paths from the arrow-slits in the outer ward. This shows the large amount of dead ground towards the sea at the bottom of the drawing, and the comparatively small amount in the ditch facing the hill. (*University of Liverpool No 78/2904*)

never completed. Additional living accommodation was ranged behind the south curtain to shield it from Coed Helen hill. Although it discouraged escalade, the height of the curtain and the towers made the task of archers difficult and the castle had to be secured on its single ring of walls, although, to some extent, some of the towers could be used for final defence; the Eagle Tower is really a keep. The vulnerable entrances were guarded by twin towers to form keep-gatehouses. Because of the height of the curtain wall it was possible to insert two levels of casemates with a passage behind, plus a wallwalk, giving, in all, three levels of defence plus those embrasures in the higher levels of the towers.

To the north stretched the grid-iron plan of the town, guarded by a wall and twelve towers open at the gorge, with four at each of the two town gates. The most likely direction of attack was through the town whose defences might delay it, and against the north curtains of the ca The north-west curtain was the last to be completed, between 1313 and 1322, so, unfinished and only protected by a dry ditch, it formed no great impediment to a Welsh attack in 1294 which carried the castle.

The embrasures along the north side are shorter and broader than those on the south facade and in some cases they were arranged so that three men could shoot through one loophole. Other ingenious embrasures allowed one bowman to shoot in three directions from one position. The most powerful concentration of fire could be put down along the eastern streets of the town and its adjoining wall, and across the land strip between the River Seiont and the Cadnant. There appears to have been dead ground in the north-western ditch, beyond the sea walls of the town and on the south-western approaches. There was further dead ground below the walls to the east, but most of the main ditch was well covered. One must add to this the support obtained by dropping objects from the battlements.

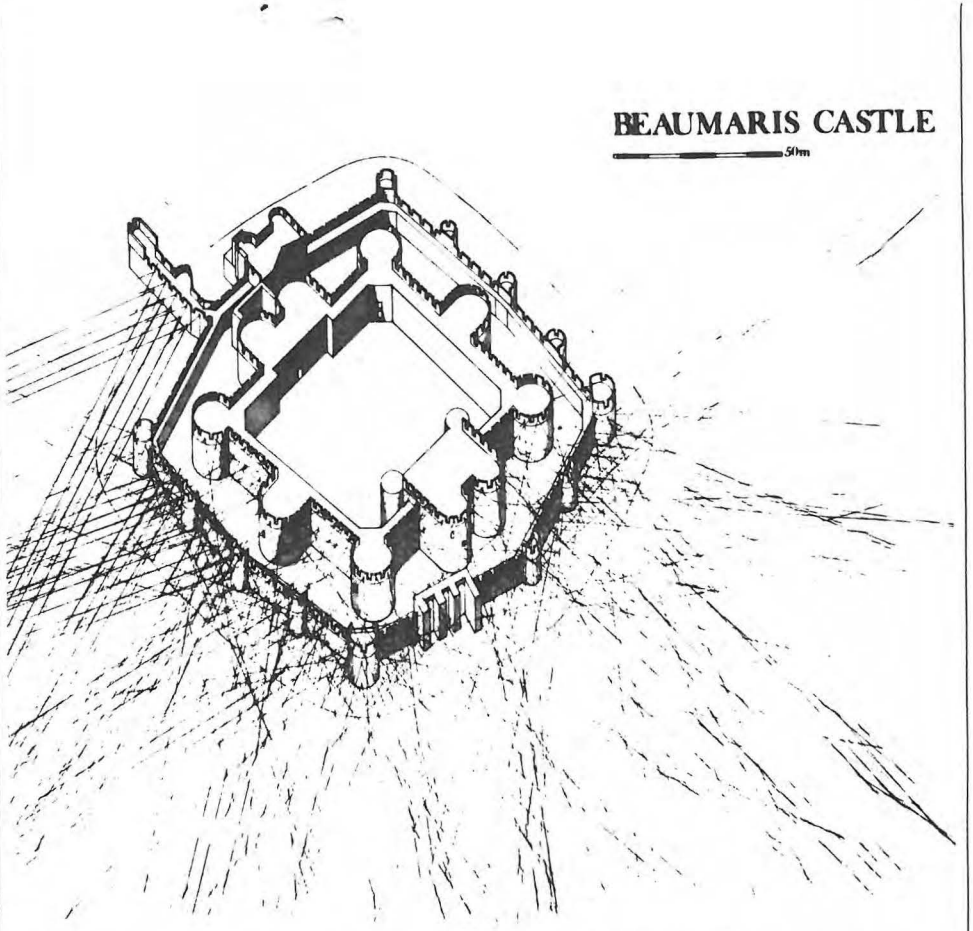
If the symbolism of power was meant to impress, it also taunted an enemy into concentrating his attack on that object; in this case the castle at Caernarfon. Owain Glyndŵr besieged the place in 1401 but was driven off with a loss of 300 men. Two years later there was a second attack, this time by the French fleet, which was also not successful. In January 1404 there was a Franco-Welsh siege, using siege weapons and scaling ladders against an English garrison of 28. The town and castle withstood the attack.




Harlech Castle: arcs of fire from the battlements and towers of the inner ward. (*University of Liverpool No 78/2903*)

**Criccieth.** Criccieth saw the conversion of an old Welsh castle with all the problems of trying to build a concentric stronghold on too tight a site, perched on the top of a small hill. Badly damaged and containing inconclusive evidence, it was impossible to draw effective conclusions on its ability to withstand attack.

**Harlech.** Harlech faces Criccieth across the waters of Cardigan Bay. On a rocky ledge, half way down a steep slope to the sea, it hardly seems a propitious place upon which to site a castle. Yet Harlech was remarkably successful and immensely strong. An attack was beaten off in 1401 and, two years later when the French fleet blockaded the place – the English admirals having refused to sail off the west coast in winter – it eventually fell to the Welsh in 1404 when it had only a garrison of 16. For the English it took a lot of hard work to recapture it three years later. During the Wars of the Roses it survived the longest siege in English history when, in 1468, it was starved into an honourable surrender. One must remember that, designed exclusively for military use, it had only a normal garrison of about fourty men, of whom ten were crossbowmen.



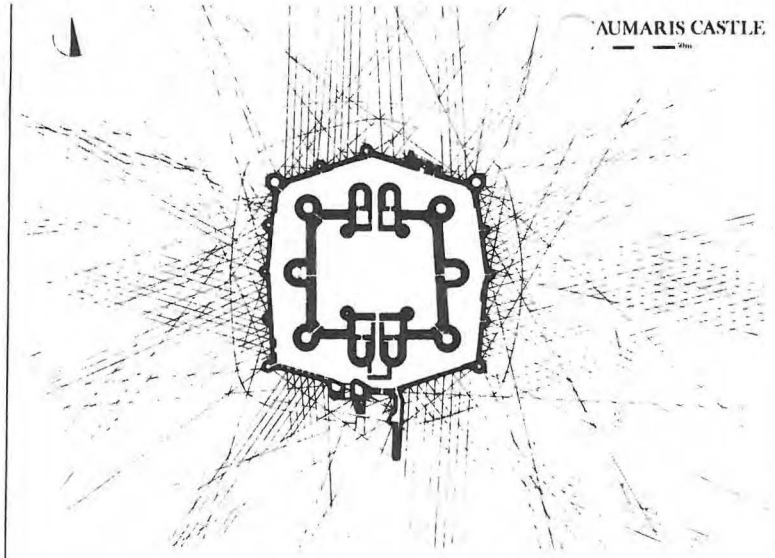

The side adjoining the sea was precipitous and safe, although much of it was dead ground from the castle walls. There was really no need for concentric defences on that side. Goods had to be hauled up the steep slope to supply the castle, probably guarded by springals which could cover ships on the beach.

Any attack would come down the hill and across the ledge, so there the English, at great expense, cut from the solid rock a broad, deep ditch. And behind it they piled an elaborate barbican and a great keep-gatehouse, running concentric walls right round the site, close in to the inner curtain walls. From the high battlements archers could cover those on the walls below, with most of the ditch and the land beyond open to their fire. However, because of the high ground to the east, the walls and towers of the inner ward had to be built to an excessive height, providing only plunging fire on the ground in front.

**Beaumaris**, a concentric design, is a nearly perfect solution, both aesthetic and practical; the summit of the achievement of the building of Edward's castles.

It has always been suggested that the con-

Beaumaris Castle: an isometric drawing showing the arcs of fire available on the south and east sides of the castle. One must imagine a repeat of this to the north and west, but, for simplicity, these arcs have been omitted from the drawing. (*University of Liverpool No 78/2909*)



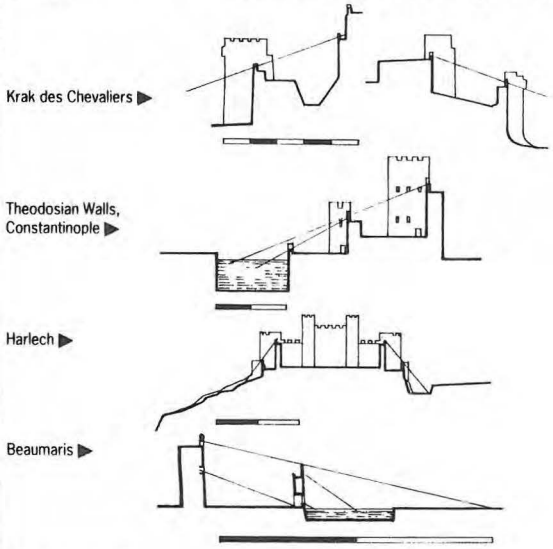

Beaumaris Castle: the fully integrated design shows an effective cover from arrow-slits providing fire paths which leave practically no dead ground. This drawing shows the fire paths from the battlements and casemates of the outer ward. (*University of Liverpool No 78/2907*)

centric design had two purposes: to provide a defence in depth to permit a step by step withdrawal, leaving killing ground between the walls and, secondly, to provide a system where archers on the lower walls could hold-off an enemy, being covered from the higher walls behind. One has only to look at the section of the Crusader castle at Krak to see that this covering fire would not have worked in this early, and often quoted, example. However, at the Theodosian Walls, the land defences of Constantinople, and at Beaumaris it could have been effective.

The site, which is not overlooked, is almost flat. It adjoins the waters of the Menai Straits and has a colonial town attached on its western side. Surrounded by a broad moat to delay assault and prevent mining, the layout of the castle is almost symmetrical except for the projection of a dock, capable of taking a 40-ton vessel, and its related defences. In fact, symmetry seems to have been carried to extreme lengths with the construction of a second, matching, keep-gatehouse facing the safety of the sea. The curtain walls of the inner ward are fairly low, but of sufficient height to allow archers on their battlements to cover those below at a range of about 33yds (30m) beyond the outer walls and about 17yds (15m) beyond the moat.

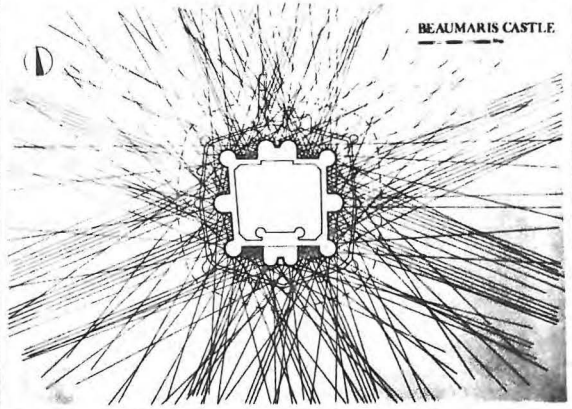
But the most remarkable feature of Beaumaris castle, and the one that raises it in quality above all the others, is the integration of fire paths with masonry defences in a carefully worked out pattern so that hardly any dead ground exists beyond the fortress walls, and certainly none beyond the moat. It is the apex of the science of active defence, the masterpiece of medieval military architecture.

Sections showing the way in which archers on the upper battlements of some concentric castles could cover those below with effective fire. At Krak des Chevaliers the cover was practically useless. On the Theodosian Walls at Constantinople it was very effective. At Harlech they were well covered, but the fire was plunging. At Beaumaris a good cover was provided against an enemy beyond the ditch.




**Notes**

1. Leone Battista Alberti, *Ten Books of Architecture*, translated by James Leone (London 1755), Book V, Chapter iv.
2. Except, for example, E Neaverson, *Medieval Castles in North Wales: a study of sites, water su nd building stone* (Liverpool 1947).
3. Surveys were carried out and reports written by the following students: Robert Chandler, *Caernarfon Castle*; Nigel Hartley, *Beaumaris Castle: a study of its defences*; Adrian Thompson, *Conwy Castle: a study of its defences*; Douglas Turnbull, *Military History of the Welsh Castles of King Edward the First and detailed studies of the defences of Harlech and Criccieth*, Typescripts (Liverpool 1978). See also Douglas Turnbull 'Some problems about the origin of Criccieth Castle.' *Fort* 7 (1979), pp53–68. Subsequently studies were produced by Gareth Carr, *The use and development of the stone fortresses during the Welsh rebellions of the 13th century*, Ian Edward Quale, *Edward I's fortifications at Flint and Rhuddlan*; Gareth Wyn Thomas, *Aberystwyth: a History of Fortified Development*; Mark S Willacy, *The Town Walls of Conwy and Caernarfon*, Typescript (Liverpool 1980–83).
4. The dummy crossbow had a span of 2ft 8in (820mm). It is interesting to note that, so far as I am aware, Derek Renn was the only other person pursuing this line of investigation at the time, plotting arcs of fire obtained from longbows and crossbows. See 'Defending Framlingham Castle', *The Proceeding of the Suffolk Institute of Archaeology* XXXIII, Part 1 (1973) and Peter N Jones and Derek Renn, 'The military effectiveness of Arrow Loops. Some experiments at White Castle', *Château Gaillard* IX–X (1982), pp445–455.
5. John E Morris, *The Welsh Wars of Edward I* (Oxford 1901), pp196–7. Out of a total military expenditure of £98,421, the castles cost £23,166.
6. Edward Arthur Lewis, *The Mediaeval Boroughs of Snowdonia* (London 1912).
7. Terence Wise, *Medieval Warfare* (London 1976), p164.
8. He had experience in their use and designed a large weapon called the 'War-wolf' which was sent in parts by land and sea to bombard Stirling. Sir Ralph Payne-Gallwey, *A summary of the History, Construction and Effects in Warfare of the Projectile-throwing Engines of the Ancients* (London 1907), p33.
9. Morris, *op cit*, p216.
10. For example, French ships attacked Caernarfon Castle in 1405 and two years later the French sailed a force of 800 men-at-arms, 600 crossbowmen and 1200 light armed troops to help the Welsh. J E Lloyd, *Owen Glendower* (Oxford 1931), pp77 & 101.
11. I am indebted to G M Wilson at the Armouries in HM Tower of London for this information. Letter dated 5 January 1977.
12. Loopholes are said to have been a Greek invention, first used at the siege of Syracuse in 215 BC. They were introduced into England towards the end of the twelfth century and their use spread rapidly. Sometimes it is a problem to distinguish arrow loopholes from windows, which look the same, but whose primary purpose is to light the interior.




Beaumaris Castle: this drawing shows the fire paths from the battlements of the inner ward and towers. (*University of Liverpool No 78/2908*)

13. Terence Wise *Medieval Warfare* (London 1976), and *The Wars of the Crusades: 1096–1291* (London 1978), pp160–61.
14. Some of the most important publications are: The Royal Commission on Ancient Monuments, Wales, volumes on *Anglesey* (HMSO 1937) and *Caernarvonshire*, 3 volumes (HMSO 1956, 1960, 1964); *The History of the King's Works*, general editor H M Colvin, Vols I & II, (HMSO 1963); A J Taylor, *The King's Works in Wales: 1277–1330* (HMSO 1974), being a reprint of some of the material in the last mentioned work; Arnold Taylor, *The Welsh Castles of Edward I* (London & Ronceverte, West Virginia 1986); Arnold Taylor, *Studies in Castles and Castle-Building* (London & Ronceverte, West Virginia 1985); T F Tout, *Medieval Town Planning* (Manchester 1934); P H Humphries, *Castles of Edward the First in Wales* (HMSO 1983) is useful for its illustrations. Cadw: Welsh Historic Monuments publishes excellent monographs on the individual castles.
15. Although there was not much standardisation in the Welsh castles, there was in the diameter of the round towers at Flint, Rhuddlan, Conwy and Beaumaris – 40ft (12.5m).
16. And it occurs at Beaumaris.
17. David Friedman, *Florentine new towns: urban design in the Middle Ages* (Cambridge, Mass & London 1988), p118.
18. The medieval surveyor used a *groma* made from a pair of rods set at right angles.
19. This is debatable. It has been maintained that a crossbow could fire with effect at a range of over 380yds (350m). However, Sir Ralph Payne-Gallwey in *The Crossbow* (New York 1958), p23, maintains 'If medieval archers shot from 350 to 400 yards, as they are alleged to have been able to do easily, Carnavon Castle would never have been built where it is; as a company of bowmen could have poured their shafts into its garrison from the hill that overlooks the fortress.'
20. Arnold Taylor, *The Welsh Castles of Edward I* (London & Ronceverte 1986), pp78–79.

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